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ABSTRACT

This paper synthesizes current thought about the role of networking technologies in instruction and addresses the need for higher education to create affordable and flexible student-centered "distributed learning environments" employing networking technologies. First, relevant trends are identified in the areas of information volume, technology competency of the workforce, telecommuting, collaboration, reskilling, demographics, selectivity, government influence, and increasing demand for higher education. The current status quo is college instruction is characterized by the dominance of the lecture, little interaction, inefficiency, and the factory model. The need for change and the role of the distributed learning environment in new instructional models are emphasized. Guidelines for planning for change focus on values implicit in technology, the role of shared values, curriculum design, and computer mediated communication. The importance of institutional support is stressed in discussion of technology adoption patterns, support structure, funding, and organizational structures and relationships. Aspects of technology architecture considered include network infrastructure, content file servers, groupware infrastructure and content creation and access. The Internet's role in a distributed learning environment is also discussed. Finally, future requirements for distributed learning are suggested. Throughout the paper, sidebars provide examples of implementation at various institutions. A company profile of IBM completes the monograph. (Contains approximately 70 references.) (DB)

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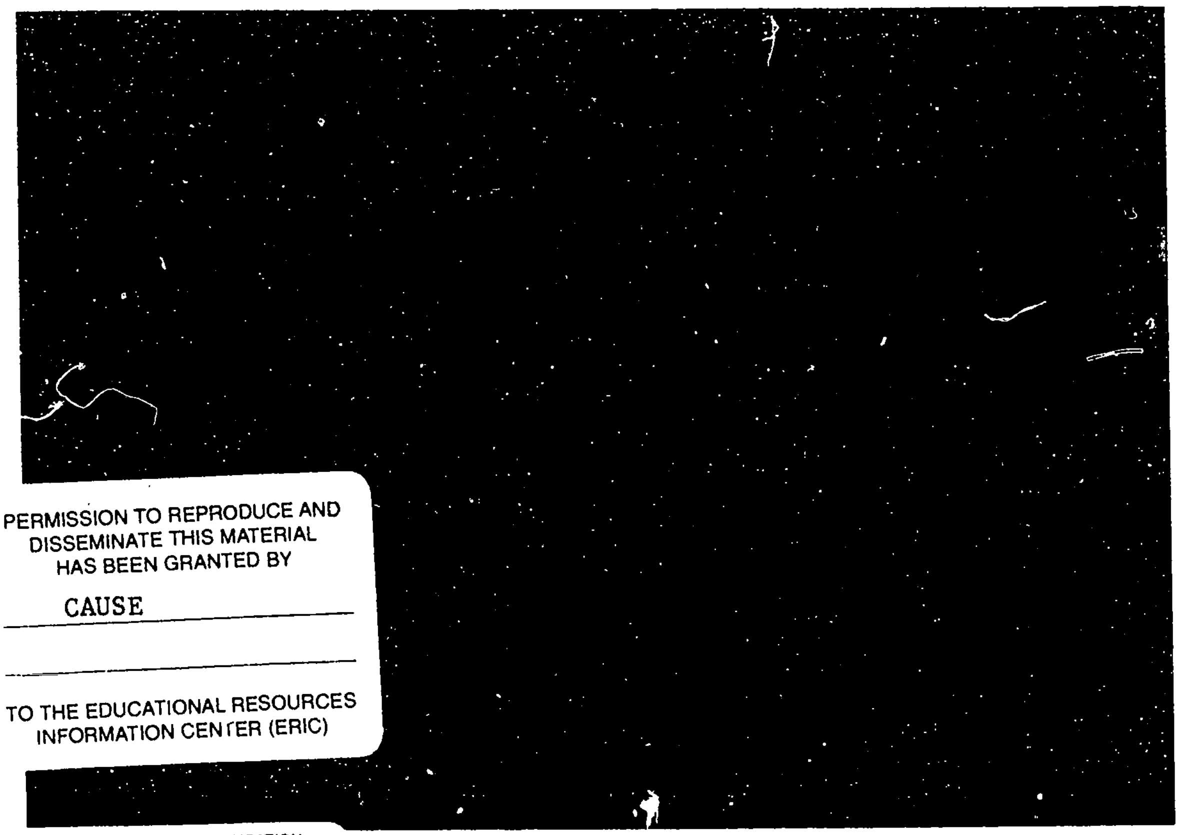

CAUSE Professional Paper Series, #14

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Distributed Learning

by Diana G. Oblinger and Mark K. Maruyama

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About the Authors

Diana G. Oblinger is the manager of academic programs for the Higher Education Division of IBM North America. Known for her "thought leadership" for teaching and learning, including advancing the concept of student mobile computing and distributed instruction in the U.S. and Canada, she has consulted with numerous colleges and universities on delivering high quality, distributed instruction as well as faculty development.

During the past four years Dr. Oblinger has provided direction to the Institute for Academic Technology, a collaboration between IBM and the University of North Carolina at Chapel Hill. Prior to joining IBM, Dr. Oblinger was responsible for managing the academic programs of seventeen departments with 250 faculty and over 2,000 students at the University of Missouri, where she was recognized for pioneering work in student recruitment and retention, faculty development programs, and establishing computer clusters in support of academic programs.

Mark K. Maruyama is a consultant with the Higher Education Division of IBM North America, specializing in helping colleges and universities integrate multimedia and networking technologies into classrooms and laboratories for effective instruction. He has advised institutions on the use of leading edge technologies for interactive instruction and presentation, with a focus on network delivery, and is involved in digital library projects pertaining to secure preservation of unique content and the management, storage, and searching of multimedia objects and courseware.

Maruyama is also an advisor to the Institute for Academic Technology at the University of North Carolina at Chapel Hill, and has spoken at numerous higher education institutions and conferences on multimedia courseware development, multimedia networking, distance learning, and the significance of the National Information Infrastructure (NII) to education.

Foreword

In this CAUSE Professional Paper, Diana Oblinger and Mark Maruyama capture in a comprehensive and original way the rationale for the growing movement to deploy networking technologies strategically in instruction. They articulate the need for higher education to create affordable and flexible student-centered "distributed learning environments" which differ in fundamental ways from today's teacher-centered classrooms. Their ideas about distributed instruction add value to a growing body of thought[1] that derives its broadest framework from a seminal paper in this CAUSE Professional Paper series edited by Robert Heterick in 1993.

In that earlier paper, *Reengineering Teaching and Learning*, Heterick sounded the first call in this movement by asking us to connect our investments in information technology to higher education's primary challenges, especially its need to contain instructional costs while also becoming more flexible and relevant in meeting the needs of its "customers."[2] Shortly thereafter, in his role as president of Educom, Heterick initiated conversations with Carol Twigg and me that were to lead to Educom's National Learning Infrastructure Initiative (NLII). The conceptual framework for the NLII was first outlined in 1993[3] and the initiative was launched in late 1994. Oblinger and Maruyama describe the essence of the collective thinking that is shaping it as a national movement. They also offer several examples representative of the efforts of many colleges and universities to utilize information technology in instruction. Some of these efforts, such as Rensselaer Polytechnic Institute's "studio" courses and Project Synergy sponsored by the League for Innovation in the Community College and Miami Dade Community College, have been systemic in their scope and impact and are major exemplars of the NLII message.

At the same time that the NLII was being launched, academic leaders from outside higher education's information technology community were beginning to realize that information technology could be an enabling tool for a systemic change from an inwardly focused learned society to a student-centered learning society. For example, the following observation is extracted from a 1994 report of the Pew Higher Education Roundtable:

> The changes most important to higher education are those that are external to it. What is new is the use of societal demand— in the American context, market forces— to reshape the academy. The danger is that colleges and universities have become less relevant to society precisely because they have yet to understand the new demands being placed on them. ... [Americans need] real assurances that shifting economic and political fortunes will not place a higher education beyond their grasp. ... It is precisely that promise that is being imbedded in the new electronic superhighway— which may turn out to be the most powerful external challenge facing higher education, and the one the academy is least prepared to understand.[4]

Shortly after the Pew Higher Education Roundtable placed information technology at the center of its change agenda, the American Association of Higher Education introduced its AAHE Teaching, Learning, and Technology Roundtable program.[5] Modeled on the Pew Roundtable program, this program facilitates campus-based discussions focusing on the role of information technology in the overall context of instructional quality.

Through these initiatives from Educom, Pew, and AAHE and through forces at work on their own campuses, academic leaders began to realize that information technology could be more than an expensive "bolt on." They began to speak of investments in information technology as strategic, rather than as means to automate administrative processes and to moderate the messy clamor among students and faculty for personal productivity tools, such as word processing and e-mail. The role of information technology in institutional productivity thus entered higher education's collective consciousness. But institutional productivity ultimately must focus on instructional productivity since most of higher education's costs and resources are dedicated to its instructional mission.

Needless to say, technology was not standing still during this recent period of academic awakening. Indeed, the Internet's World Wide Web had begun a dazzling ascent from its base in the academic and research communities to the pinnacle of star status in the public and commercial limelight. The Internet itself was in transition. The commercial sector was inheriting responsibility from the National Science Foundation for the range of interlocking transport and access services that underpin the Internet. This transition was already accomplished when, in September 1995, a range of groups representing higher education convened a conference in Mor erey, California, "Higher Education and the NII: From Vision to Reality." Indeed, the conference was precipitated in part by this sea change in operation of the Internet.

The Monterey conference focused and articulated higher education's vision for the future of networking, identified barriers to realizing the vision, and recommended an action plan to realize the vision. Oblinger and Maruyama's paper, expanded and adapted here from the conference proceedings,[6] was one of several that framed sessions about the future of network applications, one of the conference's three main discussion areas. It was no surprise, then, that discussions about network applications returned repeatedly to the need for higher education to utilize networking in a systemic attempt to meet increasing demands for more affordable and accessible educational opportunities while improving the quality of students' learning.

Not only do Oblinger and Maruyama synthesize the current state of thought about the role of networking technologies in instruction, but they also provide a plethora of "sidebar" examples of implementation. We should not be surprised that two observers from the commercial sector, who in their jobs interact with hundreds of colleges and universities each year, have a keen sense of both the challenges we face in higher education and our most promising attempts to meet those challenges.

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On the Horizon

Society is being transformed by global competition and the power of technology. An understanding of the interaction of information and technology contributes to the competitiveness of both individuals and institutions. We believe that higher education's competitiveness will increasingly require that it serve society's needs and the enablement of its missions through information technology—and that the campus of the future will embody distributed learning. Knowledge of relevant trends is a prerequisite to anticipating what the future workplace will be like and how higher education can serve the needs of society. Among the trends to watch are these:

Volume of information

The volume of new information is increasing at such a rapid pace that the class of 2000 will be exposed to more new data in a year than their grandparents encountered in a lifetime. Knowledge doubles every seven years. Ten thousand scientific articles are published every day.[1]

Technology competency

Technology is now a competency that is required in the workforce; it is becoming another basic skill. Sixty-five percent of all workers use some type of information technology in their jobs. By the year 2000, this will increase to 95 percent.

Telecommuting

Thirty-seven million U.S. households, 38 percent of the total, contain at least one person doing income-generating work at home. Although many of them are self-employed, the 8.4 million telecommuters (corporate individuals working part- or full-time at home during business hours) represent the fastest growing segment. A person working one to two days a week at home can save a company $6,000 to $12,000 a year because of increased productivity, reduced office space, and lower turnover.[2]

Collaboration

Individuals are increasingly required to be able to to use technology independently and collaboratively in their work.[3] No one person has all the competencies needed in today's high performance workplace.

Reskilling

It is estimated that the shelf life of a technical degree today is only five years. Although many of the critical skills required in the high performance workplace (e.g., science, engineering, finance, and law) have not changed, the pace of knowledge advancement requires constant updating.[4]

Reskilling is becoming a requirement for workers. Companies are reengineering themselves and revamping fundamental work processes, resulting in fewer people left to do more things.[5] According to the American Society for Training and Development, by the year 2000 75 percent of the current workforce will need to be retrained just to keep up.

Demographics

The changing demographics of higher education are placing new demands on institutions. Students are more diverse: they are older, must balance other life and career priorities, and prefer to attend college on a part-time basis. Individuals expect to have greater access to educational resources and alternatives, particularly from beyond the campus.

Five million working adults are enrolled part-time in American colleges and universities. This number masks an even larger adult population that would like to receive a college education but cannot attend a traditional college due to inconvenient class hours, campus inaccessibility, family responsibilities, business travel, or physical disabilities.[6]

Selectivity
Students are using their "purchasing power" to be more selective about which institutions they attend. They expect to participate in a learning environment that fosters measurable improvement in their skill development, not just during college, but throughout their careers. They are increasingly selecting curricula that enhance their chances of initial and sustained employment.

Government influence
Governors and other policy makers are pushing to make higher education more affordable and accessible to older, working students, and to make institutions more responsive to the changing workplace where many jobs now require continual retraining.[7]

Increasing demand
In many countries, the demand for higher education cannot be met. The need for educational expertise to support social and economic development is forcing higher education to look for new educational systems and new delivery mechanisms.

Optimists see higher education as a growth market with new niches that traditional delivery modes do not fill. There is tremendous demand for training and education, yet we are not taking advantage of the greater effectiveness and efficiency technology can provide. We have known that technology can augment traditional instructor-led training and make it more effective and efficient through the use of multimedia, e-mail, collaboration, and simulation. Yet we fail to capitalize on the advantages brought to us by computers, networked communication, and a better understanding of how humans learn.

Overall, there is a mismatch between what education provides and what society and our economy need. Forman's comparison of education's traditional orientation with today's business requirements (see Exhibit 1) points to a diminishing relationship between what is taught in schools and what is needed in the workplace.

Exhibit 1

Traditional Orientation	Business Requirements
Facts	Problem solving
Individual effort	Team skills
Passing a test	Learning how to learn
Achieving a grade	Continuous improvement
Individual courses	Interdisciplinary knowledge
Receiving information	Interacting and processing information
Technology separate from learning	Technology integral to learning

David C. Forman, "Use of Multimedia Technology for Training in Business and Industry," Multimedia Monitor 13 (July 1995), 23

The Status Quo

Many question whether today's classrooms prepare students to be lifelong, adaptable learners. A majority of institutions construe teaching almost entirely in terms of lecturing.[8] Although lecture may be an effective instructional style for some students, it is not for all. Research on the effectiveness of lecture does not support it as the best method of developing learner competencies of critical thinking, problem solving, and lifelong learning, or as the most effective *learning* modality. Characteristics of typical classroom styles today include:

Dominance of lecture
Collaboration is an atypical style in higher education classrooms. Lectures dominate: approximately 80 percent of teaching is in the form of lecture.

Teaching emphasis
As Randal A. Lemke observed, "Much of classroom teaching is based on faculty presentation of information to a group of students who are then responsible for demonstrating that they have accumulated it. The instructor is on center stage and determines the official agenda of the course. In the audience of lecture halls and classrooms, students are called on occasionally to demonstrate their comprehension and are tested periodically to determine their retention. The emphasis is clearly on teaching with the expectation that if it is done well, students with ability and ambition will learn."[9]

Little interaction
Interaction— student-to-faculty, student-to-student, and

student-to-information— is directly related to improved learning.[10] However, most lectures lack significant interaction. Research on classroom activity shows that, irrespective of class size, interactions between faculty and students are limited to a few individuals. In classes of under forty students, four or five students dominate the interactions. The remaining thirty-five are relatively passive; they abdicate in favor of a vocal few. For classes of over forty students, the number of students who interact is even smaller.[11] In a fifty-minute lecture period, questions and interaction take up less than five minutes.

Whatever the reason, the existing lecture model lacks significant interaction among faculty and students. However, most students apparently find peer interaction a powerful mode of learning: 85 percent of first-year higher education students in the U.S. have already studied with other students, and 40 percent have tutored their friends, yet only 19 percent have asked a teacher for advice after class.[12]

Inefficient learning experience

According to Johnstone and Su, "The common assumption— that lecturing is an efficient way of transmitting information accurately— is wrong." In the average lecture, the instructor delivers about 5,000 spoken words, of which students record only about 500. In a study of chemistry lectures, students recorded about 90 percent of the blackboard information; they assumed that the blackboard information was sufficient. However, some parts of lectures went almost entirely unrecorded: demonstrations, examples of applications, detailed sequences of logical arguments, and the meanings of technical terms and symbols. Because of differences in student note-taking skills and in working memory, only one-third of students leave lectures with most of the information units recorded. Because lecture notes form the principal source of study material for students, the conclusion was that for two-thirds of the students, lecture was an inefficient medium: "At best, lectures are overviews or outlines of what has to be learned rather than learning experiences in themselves."[13]

Re-creation of known results

Classroom experiences tend to be insular. According to Alpert, "In an average classroom, students are persistently asked to produce work for which they can expect no audience other than their teacher. Furthermore, the work assigned to students often involves the re-creation of known results. Often students can assume that their teacher not only has little to learn from their work, but is knowledgeable enough to "fill the gaps" if it is incomplete or ill-presented. This combination of factors makes many students' work grudging and perfunctory."[14]

Factory model

The way we choose to spend our teaching/learning time conveys messages to students about what is valued and important. Adams, Carlson, and Hamm believe that "If large amounts of time are devoted to listening to the teacher or working on independent tasks, we do not emphasize the skills needed in today's workplace where power is frequently shared, collaboration encouraged, and higher levels of thinking required. Long held educational models of teacher talk, textbook memorization, and moving people from box to box are poor examples for future workers and professionals." Even students who adapt to this model are finding that the skills they learned no longer count for much when they leave school. "The factory model, with its top down organization, has been replaced in the world outside by new concerns about collective responsibility. This leaves today's students ill-served by the silent and frequently isolated teaching techniques formed in the days of factory assembly lines."[15]

Need for Change

There is a need for change, ranging from new approaches to course and curricula design to rethinking course development and delivery. Open to question is the role of campuses and the process by which degrees are earned.

Educators and policy leaders are envisioning a new approach to instruction based on communications and computer technology, using learning-on-demand and learner-centered instruction. In fact, some see a future where students will receive their education on three "campuses":

- a residential college community where— for a summer or for four years— students study and receive guidance, support, evaluation, and motivation;
- a global electronic campus that they can enter via a computer, "commuting" from home, dormitory room, or community center; and
- the continuing education and training provided at their workplace by employers and community organizations.[16]

Education in an information-age environment differs from our long-standing educational practices, as suggested in the outline of Jostens Learning Education Forum provided in Exhibit 2.[17]

Exhibit 2

Long-standing Educational Practices	Preferred Educational Practices
Teachers lecture; students listen.	Teachers guide, coach, motivate, and facilitate. Students are active "doers," presenting, analyzing, solving, constructing.
Working as an individual is prized. Working together is discouraged and even disparaged as "cheating."	Working together is prized because it emulates the way people work most often in real life, within a team. Individual work is given less importance.
Content is balkanized into "subjects" that are treated without much connection to other subjects. Students have no clear idea of relationships between subjects such as history and science.	Subjects are usually integrated, to provide different perspectives on skills and issues, assist in solving problems, or help students relate their interest in one subject to another.
The curriculum is fact-centered. Students often memorize facts and concepts in isolation from the real world and from other subjects.	The curriculum is problem-centered. Students engage in tasks related to the real world in which they must collect and assess information to solve problems.
Teachers are regarded as the primary source of knowledge.	There are many rich resources for learning. Teachers help students access and interpret many sources, including traditional print materials, the Internet, online lessons, and dialog with experts.
Second only to the teacher's words, print media are the primary means of communication: "reading and writing" are the essence of the curriculum.	There are ample opportunities to explore concepts using a variety of media— video, graphics, sound, and speech, as well as print. Students not only master reading and writing but also gain experience in other media and in "multimedia."
Student success most frequently is presumed when students remember what teachers and books say and can report back.	Student success most frequently is presumed when students solve problems, communicate ideas, present information, and learn how to learn.
Schools are insular, largely separated from the rest of the community.	Learning is everybody's business and takes place throughout the community. Computers connect the world to the classroom and the classroom to the world.

Jostens Learning, 1995, http://www.jlc.com/edures/teachers/edforum.html

Future Scenario: From Webspace to Cyberspace

A number of students gather at the Virtual Academy's home page, where they await their professor. Dr. Hoffman is a noted art historian and Websurfer. He shows up and asks the students to follow him to an art site in France, where he will begin talking about impressionism and showing many examples.

The students follow him to a page with a number of pictures of artwork. He drags two into the conversation and talks about the particular colors that the artists used. He goes to a page that has a picture of a color wheel and talks about why the particular colors that were chosen work so well: they are complementary colors. He asks students to go off and find some good examples of artwork with similar color schemes, and gives them a list of a half-dozen links to sites at which they can start searching. After about ten minutes they regroup, and each one drags their offering onto the page. Dr. Hoffman talks about how each picture uses colors to achieve different effects and pastes some of his favorite quotes from artists regarding color onto the page. After the students have left, Dr. Hoffman decides to keep the lesson transcript in his folder of tours so he can remember it for the online textbook he's working on.[18]

As these characteristics indicate, there are a number of reasons for developing new instructional models. Consider the rationale of one institution for investigating the creation of a *distributed learning environment* (DLE). The DLE approach is based on learner needs, and allows students and faculty to enter the learning environment at different times and from different locations. This university's rationale, which is similar to that of other institutions with whom we have consulted, centers on four institutional issues:

- *Productivity.* With declining budgets and increasing enrollments in higher education, there is a push to get "more scholar for the dollar." The institution must find new ways to accomplish its teaching mission while competing with other institutions for a limited pool of funds.
- *Quality.* The institution takes pride in both its faculty and students and seeks to enhance quality rather than diminish it in the pursuit of productivity. Maintaining high standards in the context of rapid change will require great attention to the institution's academic and social values. The commitment to both access and community are obvious and provide a foundation on which to strengthen the manifestation of quality.
- *Access.* There is greater demand for the institution's educational services than the current infrastructure can provide. This demand is expected to continue. The commitment to students, both traditional and non-traditional, is causing the institution to look for more flexible ways of providing education to students.
- *Competitiveness.* Other colleges challenge the institution's strategic position for funds and students. It is expected that competition with other institutions for high quality students will intensify. Each institution will need to establish a competitive edge in a student-based market.[19]

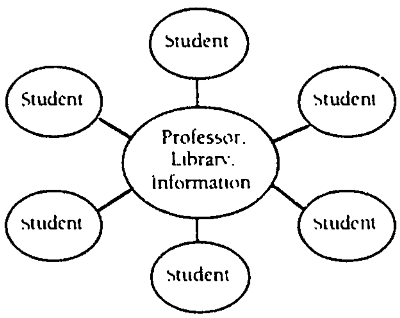
According to one educator, four factors should come into play in developing a more efficient and effective learning environment: cognition, collaboration, communication, and computing:[20]

- *Cognition.* In recent decades, developments in cognitive psychology have told us a great deal about the way students learn and the obstacles they face when learning. Their findings have been only minimally incorporated into our present educational system.
- *Collaboration.* Increasingly we are defining the learning experience by the interactions we want to encourage: interaction with information, interaction with other students, and interaction with the instructor.
- *Communication.* Today's students and educators have access to powerful communication tools to reach colleagues, experts, and diverse sources of information.
- *Computing.* Students must be familiar with technology and its uses as part of everyday life and work. In addition, technology enables the transformation of learning.

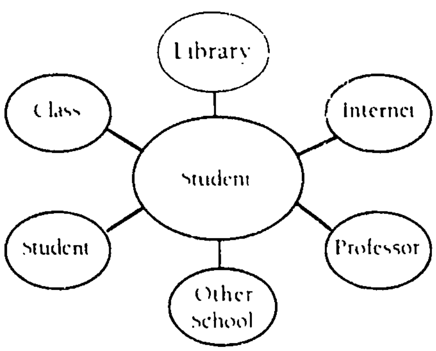
The development of new instructional models is facilitated by the availability of a reliable and ubiquitous network infrastructure as well as access to computers any place and any time. A real strength of technology is its flexibility. It frees us from such constraints as time, place, and institution. Most institutions have yet to take advantage of these new freedoms in the exciting ways exemplified in the Future Scenario shown on the preceding page.

But the framework of the learning environment is changing. Many institutions are exploring ways of improving access to education and the quality of the educational experience while, ideally, reducing cost. Some serve traditional, residential populations. Others are concerned with reaching new constituencies. Motivations range from financial crises to executive vision.

In the current model, an institutional organization or function is at the center; students must move from place to place or person to person:



The emerging model for learning environments places the student at the center. with more flexible access to people and information:



Distributed learning environment

Based on our work with several colleges and universities, there are common components among each institution's unique approach to these issues. We believe these elements comprise a distributed learning environment (DLE) as described briefly on page 5, where the learning environment exists among a dispersed student population, is structured according to learner needs, and tends to integrate traditional institutional functions (e.g., classroom and library). Students and faculty may enter the learning environment at different times and from different locations.

The three factors which change in this model are the role of the instructor and the concepts of place and time:

- *Instructor.* In a transformed learning environment, the instructor becomes the designer of the learning environment. Content can be accessed in a dis-intermediated manner, i.e., the instructor need no longer be the "gatekeeper" to learning. Instruction is learner-centered rather than teacher-centered.
- *Place.* Place need no longer be restricted to the classroom; it may be extended to the virtual classroom or a "virtual environment" in which learning takes place. A class is made up of a virtual community of learners.
- *Time.* Time can become a variable instead of the fifty-minute lecture. In a transformed learning environment, the course entry point may vary with student preparation. The exit point may change depending on depth of mastery required. The length of the learning activity can expand or contract to fit the learner's schedule and educational goals.

Achieving a DLE requires the use of information technology and networked delivery of education through both synchronous and asynchronous communication. as illustrated in experiments at Drexel University described at right. To create distributed learning environments, institutions must address both human and technological issues through planning, institutional support. and technology architecture— the subjects of the next three sections.

Planning for Change

What we know about cognition, collaboration, and communication should allow us to redesign the learning environment. Initiating and sustaining an institution-wide redesign of education will require strong executive leadership and a viable process model, because it entails fundamental rethinking of instructional strategies. Critical questions are:

Why do we do what we do?

Why do we do it the way we do?

What must we do? (What is critical to our success and that of our students?)

What should we do (regardless of what is currently done)?[21]

Why do we do what we do? Why do we do it the way we do? Among the answers are because that is how we were taught and because the culture of higher education emphasizes autonomy. The tradition, the existing infrastructure, the lecture-based experience of faculty, and the fact that it is more comfortable to preserve the status quo than to change it all contribute to higher education's lecture-based approach to learning.

The tough questions are: What must we do? What should we do? Although there are no specific answers for all institutions, a general principle may be to move from a faculty-centered to a learner-centered approach.

"We are in the process of shifting what it means to be literate from the memory base of knowledge acquisition to knowing how to find and use channels of information. Knowing how to learn is more important than the facts accumulated."[22] This shift carries with it technology implications, as outlined in Exhibit 3.

Designing a revitalized learning experience calls for hard thinking, understanding the core values on which we operate, and effecting change in long-established instructional patterns. Following are five considerations:

Presumption of value

The assumption of technology advocates is often that the use of technology is value free, meaning that it something can be done better with technology than without, technology will be used. Experience shows this is not true. Faculty do not perceive technology as neutral. "The microcomputer is a symbol of a new way of life. It represents the "disconnect" many educators feel between their background and training and the current needs of society."[23]

Time and Location Independence: Drexel University

Drexel's asynchronous learning network (ALN) uses Lotus Notes to support communications and problem-solving. Students access the ALN via Windows-based PCs and Macintoshes. Each student has Lotus Notes and a suite of cross-platform compatible design tools. Lotus Notes is a "groupware" tool that permits students to interact asynchronously—that is, any time, any place—via a technique known as replication which allows Lotus Notes users to get on a network, send comments and messages, and simultaneously receive comments and messages that were sent since the last time they logged onto the network.

Five courses have been offered using Lotus Notes thus far at Drexel. Others are in development. The early results are encouraging. In approximately eight weeks there were 800 interactions for an average course of ten students. Thirty-six percent of the interactions were between 8:00 p.m. and midnight; twenty-two percent were between 4:00 p.m. and 8:00 p.m. In response to questions about the course, student feedback was:

- 80 percent would take another ALN course
- 85 percent felt that they had more access to the instructor than in conventional courses
- 80 percent felt that conventional courses were more boring than the ALN course
- 75 percent did not miss class lectures
- 75 percent felt that they had more communication with fellow students than in conventional courses
- 70 percent felt that they learned more on the ALN-based course than they would have expected to learn in a conventional course
- 95 percent felt that seeing the ideas and assignments of others was useful

In general, students found the ALN more convenient and an excellent learning environment.[24]

The use of technology in the curriculum is perceived as change. Organizations experience change as a disruption, particularly when the organization must change its habits to implement technology.

When technology is incorporated into the curriculum, several "habits" change: the amount of preparation time for class; the amount of control in class, since active learning environments require faculty to relinquish a degree of control to students; even the skills required of faculty members. Faculty are content experts but, when using technology, often feel compelled to become experts in instructional design, application design, and technical implementation. Technology makes many faculty anxious. "The anxiety of [instructors] to technology is a resistance to the revisioning of the values and purposes of [education] itself. It is about self-interest and self-definition."[25]

Shared values

According to Dill, "Planning requires a sense of community; community implies we have values in common."[26] In many respects, the sense of community in higher education is low. "At work over these more than four decades is an academic ratchet that has loosened the faculty members' connection to their institution. Each turn of the ratchet has drawn the norm of faculty activity away from institutionally defined goals and toward the more specialized concerns of faculty research, publication, professional service and personal pursuits." [27] Kennedy is more blunt: "The university is a place in which people do exactly what they want to do."[28]

Our redefined learning environment calls for a major shift in this scenario. As William Plater comments, "Faculty have probably reached the limits of personal autonomy. We must find a new balance between the independence that led many of us into academic life and the responsibility to serve a purpose that transcends self-interest, no matter how enlightened. ... We do not need a curriculum defined around faculty specializations of interest that have ossified into departments. ... My university has the right to ask me to pursue other topics that better match its mission."[29]

Creating shared values is essential to the success of any effort to incorporate technology-based resources into the learning environment. If faculty do not share a set of values, such as a learner-centered approach to instruction, then the planning process is in peril. Ideally, the energies of talented faculty would be channeled toward common goals. Academia's centuries-old traditions present a big challenge: "Teamwork comes hard to those who have chosen academic life— in part because of their desire for independence. For university faculty, autonomy is assumed; teamwork and cohesion must be created."[30]

Curriculum design

If higher education is to be responsive to the needs of students and employers, the curriculum will require frequent revision. On many campuses, however, curriculum design is essentially a process of adding new courses to a historical base. True reassessment of needs, determination of competencies, and reevaluation of objectives is the exception. "Faculty and their interests dominate the teaching infrastructure. The infrastructure is based on the abilities and interests of faculty members who build individual courses, curricula and requirements around those interests. Design all too frequently begins with the question 'What do I want to teach?' rather than 'What do students need to learn?'"[31]

Collaborative learning

Dissatisfaction with the efficiency of the lecture paradigm is leading many to advocate a different educational model.

Exhibit 3

Alternative Educational Model

Lecture Model	*Alternative Model*	*Technology Implications*
Classroom lectures	Individual exploration	Networked PCs with access to information
Passive absorption	Apprenticeship	Requires skills development and simulations
Individual work	Team learning	Benefits from collaborative tools and e-mail
Omniscient teacher	Teacher as guide	Relies on access to experts over the network
Stable content	Fast-changing content	Requires networks and publishing tools
Homogeneity	Diversity	Requires a variety of access tools and methods

J. R. Bourne, A. J. Brodersen, J. O. Campbell, M. M. Dawant, research on Asynchronous Learning Networks for Engineering Education, unpublished handout, Vanderbilt University, 1995.

Greater interaction— student-to-faculty, student-to-student, and student-to-information— is directly related to improved learning.[32] Because of the workplace emphasis on teaming, collaboration is growing as an alternative to lectures.

In collaborative learning, the modus operandi is for students to work in teams to negotiate the process; actively share information, ideas, and problem solving; and jointly achieve the outcomes. This form of learning is a more social method than the lecture. The most distinctive features are a team approach, extensive communication, and interaction with significantly increased self-direction. Collaborative learning can be either synchronous or asynchronous. It can occur in a classroom or in dispersed locations.

A major goal of collaborative learning is the involvement of students in active learning activities. By using massive, open-ended data from the Internet rather than just selecting facts memorized from the traditional lecture, students must find and process information as they will have to when they are not in the controlled environment of school. Students who become responsible for their

Alternating Resident and Distributed Learning: Duke University

In the summer of 1996 the Fuqua School of Business at Duke University will launch its Global Executive MBA (GEMBA) program. GEMBA is a nineteen-month program leading to the Masters of Business Administration (MBA) degree. Designed for high-potential managers of global organizations, the program includes a series of residential modules in Europe, Asia, South America, and the United States which are complemented by continuing communication using interactive distance learning technologies.

The overall objective of the program is to help managers excel within a globally oriented organization. Each student will gain a thorough understanding of

- the core disciplines of business
- the nature of cross-cultural global work
- team-oriented learning
- the use of information technology for collaborative work

There will be eleven weeks of residential education. During this time the students will receive 300 hours of instruction and be asked to put in an additional 200 hours of self-directed study. Courses will be clustered, with three courses offered concurrently. A total of fifteen courses will be delivered in five modules.

Modules will begin with three weeks of self-directed study and distance communication followed by two weeks at a residential site. After each residential module, students will have one week off to respond to the demands of their jobs before continuing to work on course materials for twelve additional weeks. This material will be delivered by the Fuqua faculty using interactive distance learning technology which will complement and extend the classroom experience. Throughout the program there will be sixty-eight weeks of distance education with 300 hours of instruction and 700 hours of self-directed study.

A "room" metaphor, implemented on the World Wide Web, has been chosen as the organizational structure for course delivery. Each course room will contain

- a library
- conference tables
- agenda
- participant/team lists
- surveys/student feedback

The distance education portion of the program will utilize a number of different hardware and software approaches. However, the core of the instruction will be accomplished using e-mail, bulletin boards, ScreenCam movies, ProShare, Real Audio, and Netscape. Each student will have a laptop computer.

While remaining in the workplace in a highly productive way, the students will study the full range of material contained in an MBA program. The GEMBA program also aims to develop managers who understand how information technology can and should be used to successfully manage global corporations. While learning how to use information technology for corporate advantage, GEMBA students will also gain experience in using relevant technologies.

http://www.fuqua.duke.edu/programs/gemba/index.htm own learning and collaboration are more likely to acquire lifelong learning skills.

The process of creating, analyzing, and evaluating (higher-level thinking skills in Bloom's taxonomy) in collaboration with others strengthens socialization skills; increases cross-cultural awareness and appreciation; and increases general interest, focus, and synthesis efforts.[33]

In a collaborative classroom, the instructor's role changes from that in the traditional classroom. "Learning becomes as important as teaching. Faculty still determine what is to be learned and set standards for students to meet, but their role is no longer just to present the information. The stage is not full of professors; instead the professor is to be found among the students."[35]

Computer-mediated communication

When using the Internet, we are using computer-mediated communication (CMC). CMC can offer new and enhanced avenues for teaching and learning. It can help break down time and location barriers, enable students to access information in a self-paced exploratory fashion, reinforce learning, and allow for and encourage self-directed learning. CMC can involve a large range of activities— e-mail, electronic discussion lists, computer conferencing, the use of databases, collaborative projects, real-time chat, etc. CMC can include all the permutations of teacher-student, teacher-teacher, and student-student interactions, as well.[36]

Results from computer-mediated conferencing studies show several improvements over the traditional classroom:

- Online courses are distinguished by active peer-to-peer discussion and exchange.
- Messaging is fairly evenly distributed among students. Online interaction displays fewer extremes such as dominant input by a few individuals and little or no participation by anyone else in class.
- There are increased opportunities for access offered by the asynchronous, place-independent environment.
- Asynchronicity provides learners with time to formulate ideas and contribute responses. Students report that asynchronicity enables them to participate more actively and effectively.
- Group interaction motivates students and exposes them to a diverse range of perspectives. Students read input from all other students, rather than only the ideas of the instructor and a few students.
- Students report that they work harder and produce higher quality work online; one reason given was that their work is visible to their peers.[37]

Delivery of education through a collaborative, computer-mediated environment alters the relationships between the instructor, the students, and the course content. The many-to-many, asynchronous nature of the medium democratizes access and encourages student input.[38]

One of the key arguments for the face-to-face classroom environment is the human connection, the opportunity to develop a sense of community. And yet some experiences suggest that students do not necessarily require the kind of socializing that goes on in most classrooms. Jaeger has concluded that "teaching online can and does foster a sense of closeness between student and instructor."[39]

The Guiding Academic Principles: University of Wisconsin

Academic principles are the vision that drives the University of Wisconsin's information technology plan. "The University of Wisconsin System institutions will collaborate to provide the greatest possible support of the educational and economic needs of Wisconsin citizens. To help meet this objective, the members of the University of Wisconsin System community will assure that:

- Students demonstrate cutting edge skills for use and applications of technology;
- Institutions demonstrate assessable improvements in teaching and learning, by using information technologies to allow change in the way traditional outcomes are realized;
- Institutions demonstrate real improvements in educational quality and cost effectiveness through technology;
- Technology provides access to courses and programs off campus and between institutions.

"Changes in our society make it necessary for every university to re-think how, where, and when an education will be provided to citizens. The prime objective of the UW System Plan for Information Technology is to provide for development and use of an updated infrastructure of modern tools (both on and off campus). This will provide students, faculty, student support staff, and administrative service personnel the best possible environment for enhancing education in the UW System."[34]

Institutional Support

Based on observations of technology initiatives at numerous institutions, we believe that institutional support issues do not receive adequate attention in the process of planning for change. Support issues, though difficult to deal with, are perhaps more critical to an initiative's success than the specific technology chosen.

Technology adoption patterns

When any new technology is introduced, there are three major groups of adopters:

- *Early adopters.* These visionaries are willing to experiment with instructional technologies because they see potential for real improvements in teaching and learning. They are willing to surmount difficulties because the technology promises something new. This is, at best, 15 percent of the population.
- *Mainstream.* Most people fall in the mainstream category. The mainstream group uses technology when it is relatively risk free and there is a compelling reason for adoption.
- *Late adopters.* The remaining 10 percent are unlikely to adopt technology.

The challenge is extending the use of technology from the visionaries to the mainstream.[40] National estimates of the penetration of technology into the curriculum range from 5 to 10 percent, which indicates that we have not bridged the technology adoption gap.[41]

One of the reasons for the continuing gap is that we have not adapted our support structures to accommodate the differences between the early adopters and the mainstream. Working with these two populations requires very different approaches. The most significant differences are that mainstream faculty are more interested in gradual improvement, and require more and different support than early adopters. The support most campuses are able to provide to technology users is modest, at best. Budgets are tight. Equipment is not always available. Classrooms are unimproved. Support is often inadequate. If technology is really to penetrate the curriculum, a more substantial investment in supporting mainstream faculty will be required.

Support structure

Few campuses claim to have adequate resources to support the use of technology in the curriculum. The support required can be enormous. It begins with the necessity of a ubiquitous infrastructure— networks, servers, dial-in ports, and personal computers. If a common infrastructure and a baseline of technological skill can be assumed, new learning strategies can be deployed.

A New Approach to Curriculum Design: Rochester Institute of Technology

About two and a half years ago, a cross-disciplinary team from RIT's Colleges of Business and Engineering began putting together a new Master of Science program in Manufacturing Management and Leadership. Starting with a completely blank slate, and with continuing requirements input and feedback from potential customers (area manufacturers, students, etc.), the team built a complete masters-level curriculum from the ground up. Curriculum content— both breadth and depth of topical knowledge and skills— was determined by customer requirements. A modular design approach focused on learning modules with clearly defined outcomes and assessment methods. Only at the end of the process were these modules combined to form "courses" that met academic calendar and unit requirements. The net result was a program based on customer needs rather than faculty interests, one that could be easily modified to adjust to changing industry practices and requirements.

The new joint MS in Manufacturing Management and Leadership sailed through the New York Board of Regents in near-record time, and the two colleges were able to bring the program online a year earlier than anticipated. With only six weeks lead time, they were able to attract an entering cohort of twenty-two high quality students, so impressed were area firms with what the program had to offer.[42]

The support model for instructional technology that became entrenched during the 1980s had an overriding technology focus, and was developed in large part by and for the early adopters. There was relatively little support offered for pedagogy and the instructional process.[43]

A new model for instructional technology support takes into account the differences between early adopters and the mainstream, and achieves a more fitting balance between the instructional component and the technology component. The mainstream's social networks tend to be peer-based, organized along the lines of individual disciplines. Individuals typically look for advice, assistance, and collaboration within these networks. Providing support services that are peer-based can be an effective approach to meeting mainstream support needs.

One experiment in peer-based support is going on at Stanford University, with a pilot project using Information Resource Specialists (IRSs) to support faculty in individual departments. IRSs are employed in the department and are members of the department staff. While they must have certain technical skills for the job, their formal education is in the discipline they are supporting. They are familiar with the field's typical curriculum, its instructional practices, and its intellectual issues. The underlying idea is to build a core of peer-based support.[44]

Another approach involves the use of cross-functional teams in the design, implementation, and deployment of instructional applications. Teams typically consist of three to five members, including a content expert (usually the faculty member), an instructional design specialist who provides expertise in pedagogy and assessment, and one or more individuals to provide necessary technical skills. This approach allows the faculty member to concentrate on core instructional issues.

Such team approaches carry a success risk. If the mainstream faculty adopt technology, the number of faculty needing support could grow by a substantial factor— three to five times the number supported today. It is difficult to imagine support organizations being able to triple their budgets or increase their FTEs by 200 percent.

The solution may be to use peer support, building it on a unit-by-unit basis. Rather than spreading limited resources so everyone has a small share, individual programs or departments would be targeted. Efforts would concentrate on building a critical mass within a single unit, convincing the unit to provide a form of ongoing internal support (perhaps along the lines of Stanford's IRS model), and then moving on to the next set of departments or programs. The goal would be to build a self-sustaining critical mass one unit at a time, rather than spreading resources so thin that a self-supporting critical mass never develops.[45]

It should be emphasized that support and access to education and training should expand beyond technology to include instructional design, learning theory, collaboration, and other areas related to understanding how people learn. According to Gibbs, few faculty have any knowledge of the literature about learning. As teachers, he says, we are amateurs: "Even the best TA training in the United States represents a tiny fraction of the master's and PhD research training that postgraduates have undergone."[46]

Funding

Providing the infrastructure and support needed for a distributed learning environment will require significant funding. According to Green, "The movement toward the information/knowledge economy of the 21st century highlights the need for colleges and universities to invest in and maintain the technology resources needed by students and faculty. But we're not going about it well— or right. Colleges, universities and academic departments cannot build or maintain a technological infrastructure on year-end funds or 'budget dust.'"[47]

In an article about expectations of the potential of technology in higher education, Green and Gilbert note that the level of investment in user support (personnel and dollars) at colleges and universities often runs at one-half to one-fifth of recommended levels when compared to widely cited standards for corporations.[48] In addition to an insufficient level of support, only one-fifth of the nation's colleges and universities have a capitalization or amortization plan for their computer purchases.[49]

Part of the funding problem may be due to not recognizing technology as a critical infrastructure necessary to support the learning environment. Five years ago Heterick pointed out, "We must find our way out of the tar pit of justifying technology applications because they demonstrate tangible cost savings and into the integration of technology because it significantly improves the learning process."[50] "Besides improving the learner's productivity by more participation in the interactive learning process, information technology resources remove the constraints of space and time-- no longer do teacher and student have to be in the same place at the same time."[51]

Funding for technology is a difficult issue, particularly when overall funding in higher education continues to be constrained by reductions in research funding, declining state and federal support, and uncertain tuition dollars. However, if creating a distributed learning environment is a priority, reallocation of funds may be necessary. A different pattern of allocation may also be necessary, with more funds supporting mainstream faculty needs.

Organizational structures and relationships

Creating a distributed learning environment has implications for how institutions organize their resources. Historically, organizations have revolved around a technology: books belong to the library; television-based programs belong to the AV department. This technology-specific approach is less viable in a distributed learning environment, where many media are in digital format and user service is the dominant role. Organizational structures that do not facilitate a mixing of technologies will find it difficult to reach their full potential in this new environment.[52]

Creating a distributed learning environment also has implications for how institutions work together. At the end of the 1970s, institutions generally acted individually with regard to distance education. They created their own

Feedback and Information Repositories: University of Maryland–College Park

Brad Wheeler at the University of Maryland at College Park is pushing students toward immersion in technology-supported communication and collaborative learning, using Lotus Notes as the primary learning support tool. The four Notes uses for class are:

- one-minute paper
- discussion database for in-class collaborative learning exercises
- class notes
- repository for students to post assignments

One Minute Paper. With the one-minute paper, students can anonymously address the professor with three questions:

- What is the main thing you learned in class today?
- What questions still remain?
- Other feedback?

The one-minute papers are collected at the end of class, although the students can also respond at any time outside of class. The professor reviews the comments and electronically posts responses for the students to view. The purpose is to provide a feedback tool for the professor to gauge the quality of what "stuck" in the students' minds and what needs to be clarified. The database of responses is also used to improve the course in subsequent semesters. The one-minute paper improves the quality of interaction between faculty and students. As an example, Wheeler finds that students pose questions in this forum that they would not have raised in class.

Discussion database. This database is a place where students collaborate with a partner to write a policy or analyze a situation in response to a structured learning activity. The students view each others' responses and comment on them, many times taking the role of the teacher— for example, identifying points a student missed or adding emphasis. Because of the limits of class time, the discussion database has extended "air time," allowing students more discussion than in a traditional course.

Class notes. Wheeler posts class notes in Lotus Notes to reduce the transcription burden on students. His goal is to allow them time to be more involved in class. When students arrive in the classroom they can launch the class notes and annotate them during class. The database is available both inside and out of class. Students who miss a class have access to the notes on campus or off campus via the World Wide Web and Lotus Internotes. Others who want to review the material have access whenever needed.

Assignment repository. One of the assignments in Wheeler's class is for students to post a "Current Issue in Technology" article. Included are an executive summary and an analysis of how it relates to the class. Over the past several semesters the course has accumulated an archive of over 300 postings. Students use this repository for the remainder of their time in the MBA program to research news on companies or technology topics as they write papers for other classes.

http://www.bmgt.umd.edu/~bwheeler

courses or purchased materials from other institutions. The use of satellites in the 1980s saw the development of consortia designed to share the cost of course development and delivery. Driven by the Internet, the 1990s have seen an important shift in interest from creating and maintaining local repositories of information to national and international repositories.

The growing interest in distance education has led colleges to work together to offer more courses. Some see consortia as harbingers of a future in which colleges and universities share courses and accept credits from other members of their alliances. A few college officials suggest that the consortia themselves could become accredited and award degrees.[53]

Miller predicts that as the 1990s unfold, there will be innovations in institution-to-institution relationships, the most visible being the networked open university (e.g., National Technological University).[54] For the first time, we are seeing the emergence of national universities that attract their students from around the U.S. Several organizations are exploring how to extend the national university to a global scale.

Technology Architecture

Implicit in a distributed learning environment are multiple access points and learning opportunities, supported by a common technological infrastructure. The technologies behind a DLE enable two key capabilities: content distribution and collaborative computing.

Content distribution allows a student or faculty member to access instructional resources from anywhere via the network, on or off campus. Possible scenarios include a student interacting with a multimedia self-study module, a faculty member updating a Web page for the next

Increasing Interaction and Communication: Bentley College

At Bentley College the philosophy is for students to have the same tools available to them in college as they will have in their careers. Planners felt that encouraging students to work in teams is difficult but important, since modern business is built on teamwork. In the summer of 1994, Bentley began a project using Lotus Notes in the major management information systems course, "Information Technology in Organizations," which is taken by all business majors. Students use Notes as a tool to conduct research, contribute to group decision-making, and provide feedback. Faculty report that the quality of collaboration is higher than in traditional classes. They have seen an enormous increase in online communication among students.

Among other conclusions of Bentley's work:

- Everyone on the team is equal; there are no "bosses." Individuals collaborate without knowing each other personally.
- Barriers related to gender, ethnicity, age, and shyness are eliminated.
- Face-to-face time was used more efficiently due to the online collaboration.
- Online databases of lecture notes allowed students to listen and think in class rather than just take notes.
- Databases allow successive semesters of students to build on each other's work. Now classes at Bentley offer current students access to research done by previous students. As a result, research moves into new territory and advances to a new level of originality.
- The use of Notes has helped students with careers or other responsibilities to participate in group collaboration. Students tend to dial in and access discussion databases to contribute to group projects at their convenience.
- Faculty can stay in touch even when off campus.
- Notes is well suited for groups with different schedules and needs because it enables asynchronous interaction.[55]

Encouraging Faculty Innovation: Penn State University

In the fall of 1995, the Pennsylvania State University's Commonwealth Educational System (CES) piloted a program called Project Vision. The purpose was to prepare students for the 21st century and a world based on rapidly shifting technology and educational demands. In particular, Penn State saw a need for students and graduates who could use electronic communication technologies to locate information, express their own ideas, and work collaboratively with colleagues they rarely, if ever, met face to face.

This goal stipulated, as a first step, a curriculum for first-year students that gradually weaned them from dependence on scheduled class meetings and lectures, and helped them become active and collaborative learners. Students worked in local and multi-campus teams to complete courses based on a combination of guided World Wide Web research, personalized mentoring via e-mail, and group conferencing software and team projects. Students' multimedia projects were posted in groupware for review and feedback from others.

A key component of Project Vision's design was faculty selection, training, and support. Faculty were selected on the basis of their leadership in teaching rather than for technological experience. Faculty were teamed in cross-disciplinary groups that also spanned campus boundaries. They were given release time for one semester to re-examine their pedagogical approaches and develop new, interdisciplinary courses that would be delivered to students in an asynchronous environment. Faculty training included discussions of instructional design, collaborative learning techniques, and technology. Their training consisted of a high-speed "ramp-up" to appropriate uses of both electronic technology and collaborative learning. Project Vision faculty were supported by instructional technologists from the CES's Center for Learning and Academic Technologies (C-LAT), as well as by technology coordinators and librarians at each participating campus.

C-LAT is implementing a three-tiered process for expanding, refining, and exporting innovations begun at Vision campuses to the entire seventeen-campus undergraduate system. In addition, sophomore-level courses will be developed and three more Vision campuses will join the project in the fall of 1996. At each development tier, C-LAT's plan includes:

- involving key support players and structures
  - personnel: appointing an instructional development specialist at each campus
  - technology: creating learning studios with ports for students' laptop computers and improving the inter-campus and intra-campus telecommunications infrastructure
- faculty incentives, such as
  - use of a laptop computer
  - software required for an instructional innovation they want to try
  - training in the use of communications and instructional technologies
  - training and dialog concerning active and collaborative instructional methodologies
  - ability to document instructional innovation as part of a promotion/tenure package
  - peer recognition; opportunity to collaborate with other faculty
  - some release time to concentrate on the design of interactive learning
- faculty-generated projects that emphasize collaboration with instructional developers, technologists, and other faculty

The CES is committed to systemwide utilization of appropriate technologies in support of extending access to active, collaborative learning at Penn State.

For information, contact Dr. Ann Deden, Director, Center for Learning and Academic Technologies, Penn State Commonwealth Education System http://www.clat.psu.edu/

class, or a student reviewing an online syllabus.

Collaborative computing allows multiple individuals to work together on a group project, either synchronously or asynchronously, from independent locations. Possible scenarios include three students working on a document from separate locations at independent times, or a faculty member and student sharing a common "whiteboard" on their respective computers during an "office hours" videoconference. This kind of learning environment requires certain technology components:

- Network infrastructure
- Content file servers
- Groupware infrastructure
- Content creation sites
- Content access sites

Distributed Media Servers: University of Wisconsin

In the University of Wisconsin's plan for distributed learning, benefits of distributed media servers will include faculty support, departmental cost efficiencies, and expanded library selections.

Information stored on distributed media servers will range from CD-ROMs to instructional graphics; pre-recorded video and audio; instructional software; automated student support service systems; tutorials for students; borrowed, downloaded, or purchased electronic classroom media; and course catalogs.

Typical uses will include:

- Course development software and other instructional enhancement tools for faculty
- Software and information files to help student support staff serve students
- Academic databases and media files too large to store on office computers
- Synchronized "broadcast downloads" of new updates to personal computer software
- Standardization of automated procedures at department, campus, or systemwide level
- Protection of copyrighted intellectual property
- User authentication and network security measures[56]

Network infrastructure

Of paramount importance to a distributed learning environment is the network infrastructure, which carries information to the learner and facilitates the sharing of information by all. In a DLE, every learner must have access; therefore, the network must be robust enough to support very high volumes of traffic and a variety of data types.

Most of the data carried on the network are character based, posing no unique problems. However, the attractiveness of multimedia file types (especially digital video) for visualization or conferencing and collaboration levies special challenges on the network. Since multimedia data are bandwidth intensive and time sensitive, the network must ensure the smooth, uninterrupted delivery of these data, even at peak network loads. Technologies are emerging that will allow DLE networks to eventually guarantee quality of service to multimedia users by reducing or eliminating any negative effects such as latency and jitter.

Today's technology does not yet allow us to affordably design a network in which every student is guaranteed real-time access and instantaneous delivery of multimedia data. This is especially true in wide-area networking where the ISDN basic rate of 128 kilobits per second (kbps) is the highest speed for the average user. As a result, compromises must be made to determine when a "store and forward" file transfer strategy is adequate and when real-time delivery is a firm requirement.

Content file servers

In a DLE, servers are repositories of educational content or work in progress. As with networks, the advent of multimedia introduces special demands on servers. The servers must have very large storage capacity (one hour of video requires 600 megabytes of storage, on average). These repositories must be reliable and secure, with the ability to back up valuable files to multiple storage media. Seldom-used materials should be archived to slower-speed, lower-cost storage, while frequently used files must be available for immediate delivery via uninterrupted streams of data.

Content file servers must have the ability to deliver digital video to multiple, simultaneous users in a timely fashion. This is generally achieved using multiple physical hard drives and enhanced file management facilities within the network operating system. Because the server may be providing several digital video files simultaneously, faster or enhanced interfaces to the network may be necessary.

"Video servers" or "StreamServers" may be appropriate for some types of content in a DLE, but they are gener-

Studio Courses: Rensselaer Polytechnic Institute

Realizing the benefits of a DLE, the faculty at Rensselaer Polytechnic Institute (RPI) in Troy, New York, have completely reengineered the physics and calculus courses using networked multimedia technology to engage learners. Not only have they integrated technology, but they have completely redesigned courses and classrooms.

The result is the "studio" model of instruction, "an improved educational environment for students that combines lecture, recitation, and laboratory activities into a studio or workshop setting that de-emphasizes lecture and intertwines the laboratory and problem-solving sessions into one team-based activity."[57] RPI faculty have successfully cemented the relationship between course and laboratory activities.

Students in the Studio Physics course, for example, find themselves in a redesigned classroom in which multiple foci are possible. Students can easily work together in teams of two or four with access to integrated computer and laboratory equipment. This integration of laboratory devices and computer equipment gives students access to digital video files, data acquisition, data analysis, and visualization tools. A high-speed network connection to the "studio" ensures that this multimedia educational content is available on demand from a multimedia file server. Within this distributed learning environment, the focus is on student activities, problem solving, and active learning rather than on student observation and teacher-centered lecturing.

http://www.ciue.rpi.edu/studio/studio.htm

ally proprietary in nature and allow very limited interactivity. These servers were originally designed for the linear delivery of videos for the cable/telephone consumer marketplace. Multimedia file servers, on the other hand, are designed to accommodate most standard network operating systems and workstation file types, maximizing flexibility and interactivity.

Groupware infrastructure

Much of the traditional interaction between faculty and students takes place via electronic means in a DLE. In addition to a robust network infrastructure optimized for the delivery of multimedia, a DLE requires a groupware software infrastructure that provides information sharing to support collaborative functions such as communication, storage, sharing, and organization of information. It also provides security and integrity for information transferred across distances.

Groupware manages class login, access, and other administrative functions. Faculty can distribute homework to students and then collect and log student submissions. Course materials, which in a conventional classroom are printed, duplicated, and distributed in class, can be made available through groupware. Whether a class is synchronous or asynchronous, groupware can collect and tabulate student responses to an instructor's questions or be used by students to conduct discussions with each other. Local functionality is available to the student even when not connected to the network.

Content creation stations. Content creation stations are access points to the network where images, sound, and videos are digitized, presentations are created and edited, and courseware is designed.

Faculty, staff, and student assistants may have workstations from which they can contribute content and collaborate on projects. Content creation is supported by multimedia development labs which include content creation stations, various peripheral equipment for digitizing and editing, and personnel with expertise in hardware, software, and instructional design. Alternatively, instructional content may be acquired from commercial or off-campus sources which instructors can then test, evaluate, and load onto the network.

Increasingly the function of a multimedia desktop machine is being replicated on a multimedia laptop computer. Video capture and other multimedia functions are already becoming available on laptop computers allowing individuals to have portable, personal creation stations.

Content access sites

The final component of the DLE technology architecture, content access sites, allows learners to access the educational material which may reside on the network, on CD-ROMs, or on the machine itself. These sites may be multiple client workstations in a student access lab in which students engage in self-directed study activities; individual laptops which connect to the network, providing mobility; or a single workstation in a lecture hall delivering technology-enhanced presentation via projection.

The workstations must have the necessary hardware and software to accommodate network connectivity and the information resources that are integrated into their educational experience (e.g., multimedia file types). The user must be presented with a transparent network interface which resembles the normal desktop. Ideally, accessing the resources of the DLE should be as intuitive and comfortable as accessing files on the learner's local hard drive. Access sites must be convenient and numerous enough so that all learners have easy access, on or off campus. As a result, an increasing number of institutions are adopting universal access strategies. The purpose of such strategies is to make a laptop computer and access to the network available at all times to every student.

Characteristics of optimal universal access include:

- *Twenty-four-hour access.* Twenty-four-hour access to a computer and the Internet, along with any other networked resources that the student's institution makes available. is needed. Network connections are critical to extend the computer from a productivity tool/word processor into a communications tool.
- *Mobility.* The computer should provide mobility which not only enables students to integrate the computer into everyday work but also fosters social interaction and peer learning. Leaders of institutions that have invested in laptop computers report that it is common for students to gather around laptops over lunch or in the "quad" as they work together solving problems.
- *Possession.* The strategy should allow students to possess a computer even if they do not own it. The ability to personalize the computer and trust it will be in the same condition as they last left it are critical. Possession is required to ensure twenty-four-hour access.
- *Upgrading.* Even though universality is a requirement, certain disciplines require higher levels of performance or greater network capability. Students should be able to avail themselves of these options, if necessary.
- *Guaranteed service.* The program should provide access to shared resources (e.g., dial-up facilities and access ports) with constant, reliable service.[59]

Universal access should get the institution out of the equipment replacement business. No institutional budget is large enough to keep up with nine-month product cycles. Universal access may also resolve some space problems associated with building computer labs. Institutions have too many competing needs to dedicate space to computer labs unless they are absolutely necessary.

Plan for a Distributed Learning System: University of Wisconsin

In the 1995 plan for a distributed learning system at the University of Wisconsin, one of the components is the "integrated personal access station." It incorporates five integrated functions:

- conventional desktop computing tasks
- World Wide Web access
- on-screen graphics, data, and text sharing and updating among multiple sites
- CD-ROM and other multimedia reference materials
- live multi-point two-way video, including voice processing systems

The integrated personal access stations will be used by

Instructors

... to develop course materials and teach live classes

Students

... to participate in class and access supplemental learning aids

Support Staff

... to provide advising, registration, financial aid, etc.

Administrative Staff

... to exchange architectural drawings, administrative transactions

Library Staff

... to share financial accounts data, provide electronic interlibrary loans, and offer access to multimedia holdings[58]

The Internet as a DLE

The Internet is becoming an integral part of life. It is used in education, business, and leisure, and students will need to become familiar with the Internet to become prepared citizens.[60] With the birth of the Internet in colleges and universities, it is not surprising that it is rapidly assuming significance as a vehicle for electronic learning.

The easy accessibility of the Internet has allowed higher education to explore distributed learning environments. In response to the tremendous learning resources it offers, campuses across the globe are engaged in Internet activity:

- *Teaching.* Faculty members are using the Internet to support a variety of courses and teaching functions:
  - Virtual seminars and text-based lectures are delivered daily.
  - Entire courses are taught online with students never coming to campus.
  - Students engage in online case studies, debates, and role-playing.
  - Electronic office hours and discussion groups provide students with twenty-four-hour access to learning opportunities.
  - Posting syllabi and assignments improves access to relevant information.
  - Electronically submitting homework enhances overall efficiency of instruction.
  - A subset of the campus library resources is made available online.
- *Research.* Professors and students are moving beyond data collection, analysis, and exchange into areas of preprints, online publications, and electronic scholarly journals.
- *Publications.* Electronic serials are growing in number and legitimacy. Some electronic journals mirror paper-based journals while an increasing number exist only in electronic form. Both paper-based journals and e-journals often accept submissions and deal with editing via the Internet.
- *Service.* The Association for Information Systems has used the Internet to debate and vote on a constitution and bylaws. Increasingly, access to the Internet and the creation of temporary lists and newsgroups are part of scholarly meetings. In times of limited funding, the Internet enables participation.

The Virtual College: New York University

In an effort to meet the needs of a broad range of distant learners, New York University's School of Continuing Education began work on the Virtual College teleprogram using Lotus Notes as the instructional management system. Students used the group information manager to collect, organize, and share information over the network. The initial program utilized a Lotus Notes server, a national 800-number communications network using 14,400-baud modems, and notebook PCs.

None of the first three Virtual College faculty were resident at NYU. As new instructors joined the program, they were trained to use Notes in the same way as students: by actively participating in an ongoing telecourse. This eliminated the need for faculty to travel to a remote training site and provided instructors with more hands-on experience than those who attended remote training sessions. Students chose independent times and locations from which to participate, as well. Student evaluations of the 1993 Systems Analysis telecourse showed that 72 percent of students most often worked from home and 86 percent generally worked on the course from 6:00 p.m. to midnight.

The Virtual College highlights the movement of education from campuses to the home. As U.S. telephone and cable companies build interactive television systems, the infrastructure necessary for the home-based college student will emerge. Anticipating this trend, interactive video telecourses delivered via personal computers over high-speed digital phone lines are being offered as of the summer of 1995. The teleprogram utilizes 128 kbps ISDN lines that deliver quarter-screen, 15 frame-per-second (fps) video to home PCs over copper wire. Remote access to servers is through 800-service analog lines to a 28,800-baud modem pool.[61]

Content Development: California Polytechnic State University at San Luis Obispo

While technology is a key component of any DLE, it is the educational content— courseware, presentations, multimedia educational materials— which delivers the true value to the students. California Polytechnic State University at San Luis Obispo (Cal Poly) prides itself on fostering an environment conducive to rapid development of content. To address the many challenges of successfully developing multimedia materials, the University established the Faculty Multimedia Development Center (FMDC).

The FMDC serves as a central on-campus resource which provides faculty with access to equipment, assistance, and consulting. Recognizing that most faculty are not technologists, the FMDC is staffed with student assistants who provide the technical expertise. This marriage of a content expert and one or more technology experts has been productive. In addition, hands-on classes are offered covering the use of all major hardware and software packages for faculty who enjoy the challenge of multimedia development.

The FMDC uses an established methodology by which a faculty member's idea evolves into a well-planned project. Resources such as student assistants and equipment are assigned to faculty based on strict criteria weighing such factors as the level of departmental commitment and the availability of technology-enabled classrooms.

Software is developed using a modular or template approach and stored in a central multimedia repository which faculty and students leverage for reuse in future projects. The repository of completed courseware, software templates, and digitized media resides on a centralized file server which is accessible by all developers in the lab. Classrooms that are connected to the file server give faculty and students ready access to educational materials created in the FMDC, thus eliminating the need to duplicate large media files on local machines.

http://bishop.calpoly.edu/

- *Jobs.* Faculty and other academic job openings increasingly are being listed at Internet sites.
- *Administration.* Many colleges and universities provide admissions information, public relations, sports, and other information on the Web or Gopher in a CWIS (campuswide information system). These sites often contain local information for use by students, faculty and administrators as well as information meant to assist with recruitment, alumni relations, and other campus outreach.[62]

The Internet can be viewed as a broad, yet relatively immature, model for the distributed learning environment concept. All the technology components mentioned earlier are present to some extent:

- *Network infrastructure.* The Internet's "network of networks" paradigm constitutes a communication infrastructure that spans the globe, with the TCP/IP protocol as the unifying "language."
- *Content servers.* There are tens of thousands of Internet servers with content that can be beneficial to the learning process, and a subset of these servers houses content that was designed specifically for instruction.
- *Groupware infrastructure.* A number of software tools available on the Internet provide a modest capability for collaborative learning and team/project work.
- *Content creation.* The majority of higher education institutions have already established Web servers with their own educational content, ranging from instructional Web pages to electronic journals to digitized images.
- *Content access sites.* Because of the standardization and democratization of the Internet, learners have access to content regardless of what technology platform they choose, whether it be an IBM laptop, an Apple PowerMac multimedia desktop machine, or a high-end UNIX graphics workstation.

The almost ubiquitous access that the Internet provides users is one reason for its widespread adoption. The TCP/IP ad-hoc communications standard which emerged from a basic need for communication and research has spawned a highly functional suite of cross-platform software tools. And in addition to being cross-platform, most of these tools will also run on fairly "low-tech" machines, further expanding the learner population which can gain access.

However, in spite of all the value it brings to teaching and learning processes, today's Internet might be viewed as a "first-generation" model, which has inherent limitations as a DLE:

- *Low bandwidth.* The Internet is a relatively low bandwidth network infrastructure that only supports text-based information and small graphics files with a high degree of efficiency. Large graphics, audio, and video can be a challenge, especially for those seeking modem access from the home.
- *Limited interactivity.* Web browsers, which represent the standardized way of accessing information graphically, are currently limited in their interactivity. While they enable hypertext, hyperlinking, and simple forms-based inputs, they fall far short of the level of interactivity built into commercially available educational software.
- *Access costs.* The Internet is currently a connection-based technology model; that is, most or all of the learning process requires a live connection. With the rapid disappearance of the "free Internet," this becomes an increasingly costly model, especially if access is through a commercial Internet access provider.
- *Limited groupware tools.* The collaborative capabilities in the forums, listservs, and discussion groups are useful but lack the robustness of commercially available groupware software.
- *Security and student tracking.* While security measures such as password protection and encryption are available on the Internet, they are fairly limited and inflexible. The ability to track student progress is virtually non-existent.

We envision the Internet maturing beyond its current limitations with the integration of existing technologies and the advent of emerging ones. New programming languages such as Java promise to bring much more feature, function, and interactivity to the Web. Networking technologies such as asynchronous transfer mode (ATM) and cable modems promise a higher bandwidth Internet in the future with optimization for the delivery of multimedia. Some software development tools, such as Lotus Notes and Macromedia Director, are already Web-enabled (e.g., Lotus InterNotes and Macromedia Shockwave).

Thus, the Internet is steadily advancing towards the capability of supporting the high-function multimedia software that currently runs on desktops, while the lower function Internet software tools are gravitating towards higher functionality. Therefore, we believe that the future DLE will comprise both Internet tools (today conducive to ubiquitous wide area network, or WAN, distribution) and higher function, higher bandwidth implementations (today only deliverable in campus-based local area networks or LANs). Bandwidth at the WAN level will eventually evolve to support the highly interactive multimedia software which to-

Universal Student Access: University of Minnesota, Crookston

As a part of a very intense strategic planning process to ensure that students receive a high quality education, the University of Minnesota, Crookston (UMC), established four technology-related evaluative benchmarks:

- All full-time students and faculty have notebook computers.
- Computer technology is incorporated into all courses.
- Students, faculty, and staff communicate via e-mail on the local area network and Internet.
- Off-site dial-in access facilitates the use of the UMC library and other electronic libraries.

According to Chancellor Don Sargent, the reason for notebook computers was the growing need for computer literacy in the workplace and the difficulty of financing computer labs. The result is that the computer has moved to the forefront in teaching and learning. Students now have access to their instructors, advisors, support offices, and information resources. Because all computers have built-in modems, off-campus residents can study and complete assignments or ask questions from their homes, reducing the need to come to campus. Faculty have noticed an increase in student motivation. They observed that with computers they are able to cover more material in class. The notebook computer solution placed more responsibility for learning on the learner and provided equal access to all resources on campus.[63]

day is supported on campus LANs. In the interim, Internet tools such as file transfer protocol (FTP) can be used to transport these interactive multimedia educational modules across the WAN in a store-and-forward mode.

The Internet and the World Wide Web have introduced a new mode of self-directed learning to the current generation of students. They have also enabled a new form of electronic interaction— free of the constraints of time and place— between faculty and student, mentor and learner, guide and explorer.

Future Requirements for Distributed Learning

There are three primary waves of technology relevant to multimedia-based distributed learning. The first wave was based on the availability of analog multimedia equipment. Adopters of this technology used multimedia in stand-alone applications. The second wave, which encompasses today's environment, provides digital support of multimedia data types. This transition from analog to digital has substantially increased the range of applications by allowing multimedia to participate in the client/server and Internet revolutions under way. The third wave of technology— very high bandwidth, broadband delivery of content across wide area networks— is just beginning to appear. This broadband technology will open up enormous opportunities for services delivered to the home, such as information retrieval and education.

Clearly, the widespread adoption of the distributed learning model will depend not only on sociological change and well-planned institutional transformation, but also on the progression of our technology base. In addition to the existing and emerging technologies mentioned previously, development of new technologies will be driven by rapidly evolving requirements for future distributed learning functionality. Faculty, students, and administrators will need new capabilities to manage information as institutions migrate toward an all-digital environment. The emergence of vast, distributed repositories of educational materials will necessitate new capabilities for storing, searching, retrieving, and managing digital information. Five capabilities will be necessary: creation of content, storage and management, search and query techniques, distribution and access, and rights management.

Content creation

Institutions already face the challenge of transforming physical media into secure digital form. In addition, they will seek to maximize the value of information already in digital form by making it more accessible, flexible, and usable. Enhancements to current technologies will be needed in the areas of compression, format conversion/transformation, and recognition.

To reach the home learner over low bandwidth telephone lines or cable, more efficient compression techniques must

Digitized Information: The Vatican Library

Since its founding in 1451 by Pope Nicholas V, the Vatican Library has been an extraordinary repository for many of the world's rarest books and documents. In order to preserve the priceless treasures of the library and make them more accessible to scholars, the Vatican Library and the Pontifical Catholic University of Rio de Janeiro, Brazil, are using special imaging technologies to capture and enhance high-quality images of the collection.

A special digital camera developed by researchers from IBM captures ultra-high-resolution images with excellent color fidelity directly from original manuscripts. Image processing techniques, including color correction, edge enhancement, and digital magnification, are used to correct and enhance the scanned images for scholarly study. Once in digital form, selected manuscripts from the Library can then be accessed by scholars through international networks such as the Internet. To ensure protection of distributed images, the system also provides for electronic watermarking to prevent unauthorized copying or alteration.

http://www.software.ibm.com/is/dig-lib/vatican.html be developed to deliver educational content in multiple media formats, including full-motion video. Since a single standard for media formats (i.e., WAV audio versus MPEG audio) seems unlikely in the near future, a music student accessing Beethoven's Ninth Symphony will want his or her machine to transparently convert between types as insulation from format differences. Likewise, a librarian at the Vatican would welcome the ability to digitize and preserve perishable works of art only once, without having to worry about future format changes. A French student would benefit greatly from the ability to translate a Japanese text "on the fly" over the network. Speech-to-text conversion could automatically document and archive collaborative conversations or debates for the benefit of others. More efficient handwriting recognition will allow the creation of educational content without the need for large, keyboard-based systems.

Storage and management

The digital revolution and the resulting vast amounts of digital information will increase storage requirements exponentially. Institutions will require the ability to back up valuable educational resources, as well as archive infrequently accessed materials to lower-cost storage media. Underlying all storage and management issues is the necessity to provide network access to huge repositories of knowledge and learning, reducing constraints of time and place. Currently one hour of video can require from 600 megabytes to tens of gigabytes of storage.

An institution with an analog videotape or newsreel library may eventually convert all content to digital form. It will need storage options capable of handling the enormous volume in an economical manner. An audio/visual department may want to make frequently accessed content available to students "on demand" from more expensive storage, while offering infrequently accessed materials at "near on-demand" rates, to be loaded from more economical archival storage.

Search and query techniques

With the emergence of immense repositories in the future, digital resources must be organized for efficient search, regardless of language or format. Students and faculty need the ability to search these vast repositories to find specific information quickly and easily. Experimentation is under way to enable traditional electronic library automation systems to support the search and retrieval of digital information, eliminating the need for students to obtain a physical copy of a book or picture. New media types offer unique challenges and opportunities for content search. For example, a single one-hour video could contain information relevant to hundreds of different disciplines, with valuable information on culture, time period, human interaction, fashion, weather, etc. Learners and researchers may search for patterns, shapes, colors, and instances of content within visual media types.

A learning resources librarian will be challenged to make available all subjects of a film, without having to manually index every occurrence of every object in every frame. Faculty will want search-and-preview tools which are linked to creation tools, so they can capture what they see, hear, or read, and seamlessly integrate content into courseware.

Electronic Search and Retrieval: Florida Center for Library Automation

The Florida Center for Library Automation (FCLA) is embarking on a project designed to extend the traditional electronic "card catalog" to provide access to electronic journal articles online. The FCLA serves more than 205,000 students and 9,000 faculty at ten state universities throughout Florida. The current electronic card catalog, based on the traditional Z39.50 library automation search protocol, contains approximately 17 million journal articles, many of which have abstracts.

Currently, students first use the electronic library system to search for materials, then make a photocopy of the physical document once they find it in the library shelves. The new system will deliver an electronic copy of the material directly to the students' desktop computers for analysis or printing. Over 100,000 electronic journal articles will be made available in the first year of the project, with 5,000 new articles added each month thereafter. This ability to link the electronic materials directly with the search mechanism eliminates the barriers of time and place for students who wish to do research off campus or after hours.

http://ike.engr.washington.edu/news/bulletin/florida.html

Variations: Indiana University

The Variations project at Indiana University (IU) is one of the first large-scale multimedia library projects attempting the distribution of digital audio and video information across a campus network.

The vision of the Indiana University School of Music is to enhance both teaching and research by enabling its 1,500 students and 140 faculty members to access recordings, musical scores, and other online databases and information services related to music. The multimedia server in the music library will distribute compact-disc-quality digital audio (and some full-motion video) for all musical works on course reserve (about 300 titles). The development of musical score databases and access to musical score notation is planned for future phases of the project. In addition, the School of Music plans to expand services to include the other IU campuses throughout the state, and eventually to share out-of-print and unobtainable collections with other universities around the world.

Users of the Variations system are presented with a graphical World Wide Web browser interface and are able to do traditional Z39.50 library searches. Many of the multimedia materials resulting from the search will then be immediately available for listening over the high speed network. The project will provide a testbed for understanding the distribution of digital audio and full-motion video across building, campus (Indiana University Bloomington), and inter-campus (including Indiana University Purdue University at Indianapolis) networks using emerging ATM (asynchronous transfer mode) technology and switched Ethernet technology.

http://www.music.indiana.edu/variations

A German language professor may wish to search digitized audio records of human speech and automatically isolate accents and dialects relevant to a particular geographic region. An aspiring artist may want to glean instances of a particular color from the digitized works of a favorite painter, and look for correlations to events within the artist's life.

Distribution and access

The importance of the network infrastructure cannot be overemphasized. High performance file systems, multimedia servers, and high bandwidth networks will facilitate the crucial link between learners and educational content. Tomorrow's network-centric approach to information access will require that networks have the ability to reserve bandwidth and ensure quality of service. Learners will demand that applications and content delivered over the network have performance comparable to that of local applications. Because of the growth of multimedia content, the infrastructure must ensure on-demand access from campus, corporation, community center, and the home.

Many futurists predict the media and industry "convergence" will spawn new access devices which will allow students to educate themselves from home or while traveling by using "information appliances." Possibilities range from set-top boxes to personal digital assistants (PDAs), to wireless video wristwatches. Client-to-client access will improve as teachers strive to stay close to their learners. Professors will want to videoconference with students at a distance, while "marking up" student compositions on a shared screen during virtual office hours. Employees in the commercial sector will demand just-in-time education from colleges and universities to keep pace with a rapidly changing business climate.

Rights management

The need for intellectual property protection and rights management is immediately apparent with digital content. Because digital data are easily copied and modified, there is concern about providing ubiquitous access to materials. Technologies such as authentication, encryption, and watermarking will minimize unauthorized access, distribution, and modification of information in the future. In addition, charging and billing will gain importance as institutions reach new audiences and seek new sources of revenue. The distributed learning environment must allow content owners and creators to make their intellectual capital available while protecting unauthorized copyright and distribution.

A business professor from an accredited degree-granting institution will desire to preserve and differentiate the value of his or her work from that which may be offered via similar technologies by the commercial/entertainment sector. Administrators of colleges and universities will wish to continue to pursue a business approach to reaching non-traditional students, and will require a method to ensure electronic billing and compensation on an increasingly modular basis. In the end, higher education will demand the ability to extend the philosophy of today's campus to an electronic audience by maximizing freedom of expression and intellectual pursuits, and ensuring an unfettered ability to distribute content for the purpose of education, while preserving and protecting the value of its intellectual assets.

Rights Management: Case Western Reserve University

Case Western Reserve University (CWRU) is a private research university that strives to satisfy the academic interests of its faculty and encourage independent study by its students. In support of this goal, CWRU is enhancing its traditional resource center of shelves and manuscripts, textbooks, and journals with an online multimedia library. This digital library delivers image, audio, and video data in digital format directly to the desktop computers of students and faculty.

Of paramount importance to this project is the development of the RightsManager application, a tool that administers the retrieval and presentation of materials in compliance with site-negotiated licenses and contracts. RightsManager accesses a variety of information regarding copyrights, royalty, and permission agreements. Each workstation application is written to be compliant with RightsManager and is capable of monitoring and enforcing the terms and conditions specified in the license agreements. As a result, transaction records can be processed to issue patrons' bills and to compensate intellectual property owners.

http://www.software.ibm.com/is/dig-lib/cwru.html

Conclusion

Forward-thinking institutions have begun developing materials for their local networks, with confidence that the desired network bandwidth and related technologies will be forthcoming on a wide area basis. The reality of delivering quality digital education to other institutions, global corporations, and the home draws closer daily. Much of the required technology exists today; more is under development. It is up to technologists to deliver the enabling infrastructure, and it is up to institutions of higher education to build and package educational materials which deliver maximum benefit to the learner.

We believe it is imperative to engineer a transition from the present instructional model— one that focuses on the teacher and the institution— to a new instructional model that is learner centered. Enabling that transition will require not only the creation of a ubiquitous network architecture but also significant modifications to our models of instruction and to long-standing institutional policies that inhibit change.

There is no single best method for education. Not all students have the same learning styles, needs, or preferences. But network scholarship provides higher education with a unique opportunity to reach any learner, anywhere, at any time. Learning and knowledge will come from a broader range of sources. Information-age networking technology gives higher education an opportunity to improve its ability to deliver quality education.

As Michael Dolence and Don Norris point out, "Realignment to the imperatives of the Information Age begins with an assessment of how the needs of one's stakeholders, clients, customers, and beneficiaries will change in the Information Age. Guided by this understanding, organizations can determine how they must change their structures, roles, and functions to serve those needs."[64] The unique power of networked communication will catalyze the transformation of higher education into a new model for the 21st century.

Endnotes: Foreword

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