DOCUMENT RESUME

ED 394 400 HE 029 094

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| AUTHOR | Mingle, James R. |
| TITLE | Vision and Reality for Technology-Based Delivery Systems in Postsecondary Education. |
| INSTITUTION | State Higher Education Executive Officers Association. |
| PUB DATE | 7 Dec 95 |
| NOTE | 31p.; Paper presented at the Governor's Conference on Higher Education (St. Louis, MO, December 7, 1995). |
| AVAILABLE FROM | SHEEO, 707 Seventeenth St., Suite 2700, Denver, CO 80202-3427 ($5 prepaid). |
| PUB TYPE | Reports - Research/Technical (143) -- Speeches/Conference Papers (150) |
| EDRS PRICE | MF01/PC02 Plus Postage. |
| DESCRIPTORS | *Delivery Systems; Distance Education; Educational Finance; Educational Media; *Educational Technology; Educational Trends; Futures (of Society); Higher Education; Information Dissemination; Information Technology; Needs Assessment; *Resource Allocation; State Regulation; *Technological Advancement; Technological Literacy; Technology Transfer; *Telecommunications |

ABSTRACT

This paper explores the implications of technological advancement and telecommunications services on postsecondary education, especially in relation to educational effectiveness, costs, increasing deregulation, and financing. Four scenarios illustrate different educational delivery modes. Common elements of educational delivery systems of the future include the unbounded fashion of delivery systems, the curriculum's high relevance to the world of work, its affordability, its provision of a much greater element of choice, and its learner-centered approach. Currently the major factors influencing technology development and application include vendors, early adopters, competition, student enthusiasm, and cost-cutting policymakers. Seven prerequisites are seen as necessary for implementing the vision of a national information infrastructure including ubiquitous systems, commitments to life-long learning, shifts from teacher-centered to learner-centered structures, re-engineered delivery systems, more customized intellectual content, productivity gains, and financing and regulatory reform. Policymakers are urged to consider goals before delivery systems, invest strategically, remember equity, focus on the learner, and press for partnership and collaboration. The paper concludes that, when instructional technology and change are properly mixed with the right amount and kind of faculty mediation, newer and better modes of delivery will result. (Contains 10 references.) (NAV)

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# VISION AND REALITY FOR TECHNOLOGY-BASED DELIVERY SYSTEMS IN POSTSECONDARY EDUCATION

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HE 029 094

# Vision and Reality

# for Technology-based Delivery Systems

# in Postsecondary Education

James R. M'ngle

Prepared for the
Governor's Conference on Higher Education
December 7, 1995
St. Louis, Missouri



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The State Higher Education Executive Officers is a nonprofit, nationwide association of the chief executive officers serving statewide coordinating boards and governing boards of postsecondary education. Its objectives include developing the interest of the states in supporting quality higher education; promoting the importance of state planning and coordination as the most effective means of gaining public confidence in higher education; and encouraging cooperative relationships with the federal government, colleges and universities and other institutional state-based association. Fifty states, the District of Columbia and Puerto Rico are members.

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# Vision and Reality for Technology-based Delivery Systems in Postsecondary Education

## The Vision

In January 1994, Vice President Al Gore announced the intention of the Administration to connect every classroom, library, hospital and clinic in the United States to the "national information infrastructure" or NII by the year 2000 (NTIA, June 1995). While the NII is a loosely defined term, it is evolving to mean a broad-band digital network capable of transmitting at high speeds a wide range of voice, video, and data transmissions. In outlining the vision of the NII, Gore articulated five principles that would form the principles of telecommunications legislative reform: (1) encourage private investment; (2) provide and protect competition; (3) provide open access to the networks; (4) avoide creating information "haves" and "have-nots" and (5) encourage flexibility and responsive government action (Gore, 1994).

Since that time, a number of states have taken initiatives to deregulate telecommunications services at the local level and Congress has drafted a comprehensive piece of federal legislation which, while opposed by the Clinton Administration in some elements, is the first step to a more competitive marketplace for telecommunications services. It charts a course for further competition in long-distance services by allowing regional "bell" companies to compete in this market and allows competition at the local level by permitting cable operators to compete for local phone service. Most importantly, its language portends future technological developments — namely, digital networks where the separate realms of voice, video, and data transmissions are carried over the same networks. Such networks promise much higher levels of quality and interactivity between sites, including such services as "video dial tone" or "video to the desktop services."

Given the rapid changes in technology, it is an open question as to which technology or provider is likely to dominate the development of the NII. Telecommunications providers, cable companies, public utilities, direct satellite companies, and wireless companies all are competing for their share. It is clear, however, that postsecondary institutions will face increasing complexity and choice in the application of technology to the mission of their institutions. Fortunately, the cost curves are heading in the right direction as the cost of transmission is dropping, as is the unit cost of computing capacity and memory. (This is in direct contrast to the costs of other goods and services postsecondary education purchases, especially human costs.)

Many questions remain as to the vision outlined by Vice President Gore and other advocates of the NII vision. Estimates of the cost of connecting individual homes, classrooms, and buildings to the NII backbone (often referred to as the "last mile" problem) have been estimated at somewhere between $50 and $100 billion. Commercial interests that focus on entertainment and retail activity are likely to dominate this development, driven by the size and demand of the market. This raises important questions for educational institutions, especially those outside major metropolitan areas.

More importantly, the vision of the NII requires fundamental rethinking of the nature and structure of our educational institutions. It may not be possible to take advantage of these digital networks without rethinking a number of assumptions upon which our institutions rest. The implications range across the board — from the way we develop intellectual content and curriculum, to the delivery mechanisms and organizational structures we have built, to the financing and regulatory policies that guide and govern our institutions.

The purpose of this paper is to explore some of these implications, especially those that relate to the educational effectiveness of our institutions, to their costs, and to the nature of our financing and regulatory policies.

## Scenarios for a Technology-based Curriculum and Delivery System

To understand the nature of education in a technology-based environment, it may be helpful to speculate on what such an education might look like and feel like in the years ahead. This exercise carries some risk — technology and our response to it is creating new delivery modes every day. Witness, for example, the number of institutions now providing "on-line" courses over the Internet as well as the emergence of new institutional types. But the scenarios below are not fanciful. In many cases they represent existing institutions and delivery modes; in other cases they describe what potentially may emerge in the medium term — the next three to five years. But they are limited by our own historical frame of reference and may be quickly outdated (or unrealized!) by developments in technology and the marketplace response.

> Scenario 1: Jack Smith is a 26-year-old head-of-household living in a rural section of his state. He currently is working for a discount retailer restocking shelves and checking inventory. Since his days in the Army he has hoped for a career in law enforcement. While there are openings in the local sheriff's department, Jack knows that the state requires 400 hours of classroom instruction in law enforcement, physical training and weapons training *before* he can become a permanent employee in a law enforcement agency. Instruction is available at a community college in the next county, but the round-trip auto distance is nearly 100 miles. Furthermore, the local community college *only* offers the course when there is a sufficient enrollment to justify the cost. Fortunately, the licensing agency in his state has joined together with other states in the region to produce (under contract with a private company) a high quality interactive CD-ROM which covers the necessary pre-employment training. It includes a variety of "situation" simulations of how to respond to various challenges of a crime scene, as well as tutorials on criminal offenses and statutes. Jack does not have a computer at home, but his local library does. He works on the CD-ROM instruction evenings and weekends, completing the work and the computerized assessment over a period of six weeks (the state had waived the "seat-time" requirement) His assigned tutor answers his questions through an e-mail connection. At the end of his self-directed study, he makes the trip to the local community college to complete the "live" portions of the course (physical test, firearms and driving instruction). Instead of being away from his home and job for four weeks, he's away for four days. Jack is now making $6.00 more per hour and, more importantly, is on a career path in law enforcement.

Scenario 2: Bill Crawford is a 21-year-old high school graduate living in a major metropolitan area. He currently works at a medical complex as an orderly, commuting from home. He has taken several courses from the metropolitan university in general education, but the demands of his job and the urban commute make this difficult. He hopes some day to be a physical therapist. But he has had trouble getting into all of the classes he wants at the university. Recently his employer opened, in partnership with the state and the regional telecommunications company, an electronic community education center with classrooms with two-way video capacity and banks of computers connected to the Internet. (Other community centers are located in shopping malls, libraries, and major employment centers.) The center is staffed by tutors, mentors, and technical staff paid for by the providers of courses. Bill has a "smart card" (issued by the state Education Trust Corporation), which he passes through a reader to pay the cost of the courses, modules, Internet access, and student advising services he uses. These debits to his card are offset by credits provided by his employer and by the state through the financial aid system (he and his parents also have made contributions through a state-sponsored savings plan). He has chosen from among the offerings at the center an on-line Internet course on Civil Rights in Literature from Virginia Tech in Blacksburg, Virginia and a CD-ROM course in Principles of Organic Chemistry from the University of Illinois. Next term he plans to take traditional courses from the metropolitan university, along with one asynchronous course in Introduction to Economics offered by the British Columbia Open Learning Agency in Vancouver, B.C. He expects to eventually receive his degree from the metropolitan university, although there are other "credentialing" options from both the "virtual university" of his region and the professional association.

Scenario 3: Pamela Jenkins is a 43-year-old high school mathematics teacher. Her school district is in the process of implementing a new standards-based curriculum and she has decided to use some of the new software tools being developed in mathematics in her classes. Training for the program is being provided by the statewide training and curriculum development center under an arrangement with an institute at the University of North Carolina at Chapel Hill (the North Carolina institute trains the trainers in her state and provides materials). The course modules include word problem-solving for her Algebra I class and "real world" problems that require geometry and trigonometry. Both are available over the Internet and can easily be downloaded to the file server and computers in her classroom. She has completed, along with her colleagues in the district, a training course in the use of the software which was taken in large part in a self-directed mode on her computer. (She often works in a group with her fellow teachers at school.) Upon completion of her training course (which culminated in a two-day onsite seminar at the statewide training center), she underwent an assessment of her competencies in teaching the new curriculum and will receive a competency credential from the Virtual University of the West (VUW) which serves as the "credit bank" for all her certifications.

Scenario 4: Alice Jackson is a 17-year-old high school student participating in a school-to-work program that includes an apprenticeship with a manufacturer of publishing equipment. Early in her program she engaged in "job shadowing," i.e., looking over the shoulder of an experienced technician who was jointly designing a new component with engineers at corporate headquarters using shared "white boards" and video conferencing capabilities of their computers. In her academic program at the high school, Alice's teachers are using software developed by a national R&D center for the course, Principles of Technology. The class is arranged in the "studio" model pioneered at Renneselaer Polytechnic. Each student is working on a personal computer that is running the networked software. The modules developed consortially include both "lecture" and "lab" components. The faculty member works with individual students as they have problems and occasionally stops the class to give directions for the next module. The course has been shortened from its standard six hours to four hours while student performance has improved.

Common Elements: In looking at the four scenarios, several common themes emerge that may increasingly characterize educational delivery systems of the future. First, delivery systems may not be tied to existing physical plants; rather, they will deliver "anytime, anyplace" education in an unbounded fashion. This capacity of technology currently is reflected in the enormous interest in distance education, although it is apparent from these scenarios that the difference between "on-campus" instruction and "distance education" are blurring. Students and faculty both off and on campus are interacting in similar fashion through such devices as e-mail and computer conferencing in asynchronous (or time independent) modes.

Secondly, the curriculum and mode of delivery is highly relevant or "contextual" to the world of work. The place of delivery, the type of faculty or mentor mediation, as well as the pedagogical models used, attempt to put abstract content into a real-world context. The visualization of mathematical concepts and the computer simulation of real-world problems are good examples of this contextualization made possible through technology. Not only is the content contextualized, but the setting in which the content is received often is closely tied to the workplace. In these scenarios, one can sense this merging of learning and work, which Dolence and Norris (1995) discuss in their report, *Transforming Higher Education*.

> **Postsecondary Education in the 21st Century: The Vision**
>
> - Unbounded (anytime, anyplace)
> - Relevant
> - Affordable
> - More Student Choice
> - Learner-centered
> - Value-centered

The third important characteristic of the scenarios is the affordability of the experience. In each of the cases described above, savings accrue to the individual learner, making his/her investment in education and further training possible. While some policymakers, especially hard-pressed legislators and governors, expect reductions in higher education budgets because of technology, future "cost avoidance" is a more realistic goal. Savings also can accrue to individuals, primarily in the form of expanded access to higher quality learning experiences that are relevant to their particular needs. "Just-in-time" education that is modularized and can be quickly, easily, and conveniently accessed is at the heart of making an educational experience affordable. While students may not see drops in tuition and fees, they should expect increases in service, relevancy and availability. This will not only cut their time and travel costs significantly, but also increase their marketable job skills.

Choice is the fourth fundamental characteristic of the new technology-based delivery systems, whic is driven by market demands. Students may choose *where* to receive education (on campus, at work, in community institutions, at home) as well as *who* will provide the education (public, private, and proprietary). This element of choice is most problematic for our current financing and regulatory policies, which are based for the most part on funding eligible providers (e.g., in-state public institutions) rather than students. Another element of choice is apparent from the scenarios — namely, that technology-based delivery is not an either/or proposition. Both students and providers will continue to "mix and match" a variety of technologies — including traditional media such as print and lecture — to come up with the right delivery system to meet the needs of the market.

Closely related to affordability is the learner-centered characteristics of these scenarios. Whether it's the design of software, the availability of personal computing devices, or the access to student support services, it is the needs of the customer, not the provider, that dictate the shape of the delivery system. In this paradigm, educational effectiveness is judged in terms of learning needs, learning satisfaction, and learning outcomes. Resources, including teaching pedagogy, faculty training and support, are means to these ends. Taking such a learner-centered approach fits well with emerging technologies, as do the concepts of learning productivity discussed later in this paper.

Limitations: Technology-based delivery systems are not without their limitations, of course, and many critics have rightly pointed to concerns about such models. In the scenarios outlined above, students receive courses and "intellectual content" from multiple sources in multiple settings. Such a deinstitutionalized, modular approach to postsecondary education may further fragment an already fragmented and uncohesive educational experience. Critics charge that students will not make good choices in this environment, nor will they receive the kind of guidance and support that they need. Others believe that technology undermines the central functions of an educational experience — namely, the promotion of a value-centered curriculum that creates group cohesion and unity. (Numerous studies of the higher "values" impact of a small sectarian college experience bolster these arguments. See Pascarella and Terenzini, 1991.)

The above concerns are legitimate, but the solution is not to try and recreate the "colonial college" of past ages, but to build new structures and opportunities to overcome these limitations. For example, technology has the potential for greatly increasing the level and quality of consumer information available to students about choices and career paths than the current labor-intensive approach that characterizes much of the traditional student service functions of colleges and universities. In contrast, a counseling and advising center similar to what is being developed in the workforce training arena ("one-stop" shopping centers) can provide comprehensive information on both career and education opportunities. It also can include systematic evaluative information that can be accessed widely through electronic means.

Developing a value-centered curriculum is more problematic in a technology-based delivery system because of the potential "disconnect" with other students and from faculty role models. But technology also can aid in such "connectivity," both cross-culturally in the United States as well as through international "electronic" exchanges. Nor is this issue being ignored by builders and designers of technology-based delivery systems as they constantly look for opportunities to increase the human connectivity of the systems and the pedagogy.

From a societal perspective, we may need new institutions that serve to "unite and civilize," rather than expecting higher education institutions to solely carry out this function for youth. For example, the expansion of national service obligations and opportunities for young people may be a more powerful method of value clarification than the traditional residential experience of college campuses.

**The Technology Express: Who's Driving?**

To judge from the constant barrage of technology developments reported by the media, one might easily conclude that the vision of the "national information infrastructure" outlined by technology proponents has already been realized. Computer sales already outnumber purchases of new television sets and Internet access grows at an astounding rate. In 1987 there were approximately 16,000 users of the Internet; in 1995 estimates range to near 30 million; by 2001 (a mere five years from now), estimates are that there will be over 1 billion users of the Internet worldwide. The use of the World Wide Web (the graphics, multi-media portion of the Internet), also is undergoing mind-boggling growth. As recently as June 1994 there were about 1500 Web servers world-wide. By the end of 1995, there were an estimated 100,000 Web sites (Tapscott, 1995).

The use of video conferencing also has greatly expanded, especially with reductions in transmission costs through video compression technology. In the public sector, states such as Oklahoma, Iowa, North Carolina, Georgia, Maine, and Utah all have expanded their distance-learning networks using primarily interactive video networks to reach isolated rural areas and to extend offerings and "education commerce" across institutions and sectors and even states (the expansion of these networks is documented in a variety of statewide telecommunications plans).

Taken together, technology developments are having a phenomenal effect on the American economy, creating thousands of new companies and billions of dollars in new wealth — all created because of the wisdom of investments made by the public in the 1970s and 1980s through such entities as the Department of Defense, the National Science Foundation and leading research universities. This public-sector investment in networked computing and the backbone fiber optics network at the heart of the Internet is quickly being "commercialized" but the fundamental R&D was done through public-sector investments.

**The Technology Express: Who's Driving?**

- Boys with Toys (vendors)
- Early Adopters (universities)
- Competition
- Student Enthusiasm
- Cost-cutting Policymakers

The impact of these public-sector investments counters the growing myth among conservative politicians that nothing "public" can ever produce market value. The University of Illinois was the creator of Mosaic, which led to Netscape, the most successful new company in the history of the New York Stock Exchange. Opponents of public-sector investment in technology also should be reminded that higher education has historically been an "early adopter" of technology — universities were among the first to use microcomputers, among the first to use computerized databases, among the first to develop and use computer networking. And, of course, higher education institutions were instrumental in building, designing and setting the standards for the Internet.

Other factors also are driving the adoption of technology in postsecondary education. Now that a wide variety of vendors ("boys with toys") have entered the education technology business we are seeing an expansion of education software, of connectivity of networks, and the availability of ever-better, faster, more purposeful computing machines. The danger, of course, is that these "boys with toys" will sell you something you do not need or are not prepared to fully utilize. Competitive forces also are operating at the institutional level as colleges and universities advertise themselves as technology-connected in order to attract and retain students. Student enthusiasm itself is a factor, as new students often more sophisticated than faculty in the use of technology arrive on campus. Finally, cost-cutting policymakers enamored of technology-based delivery systems are encouraging developments in this arena. They are looking for substitutions of capital for labor and of networks for buildings in order to meet the burgeoning demand for postsecondary education on a limited state tax base.

**Realizing the Vision: Necessary Prerequisites**

Taking full advantage of technology development in postsecondary education — necessary prerequisites, if you will — requires more than just competitive forces and student enthusiasm. This paper suggests seven prerequisites or conditions that are fundamental to the vision outlined by the NII and the scenarios above: (1) ubiquitous systems; (2) commitments to life-long learning; (3) shifts from teacher-centered to learner-centered structures; (4) e-engineered delivery systems; (5) more customized intellectual content (or "stuff"); (6) productivity gains; and (7) financing and regulatory reform.

Ubiquitous systems. Underlying many of the scenarios are assumptions that infrastructure will be adequate to deliver high quality, broad-band connectivity to college and university campuses and to homes and worksites throughout America. This broad-band infrastructure is developing rapidly but is by no means ubiquitous and may not be for some time, especially in rural areas. Nor is end-user, send/receive equipment as widely available as it needs to be, whether this is a sophisticated "smart classroom" on a campus or in a community education center, or a laptop or desktop computer in the home and workplace. (Patterns of use and ownership of computers vary widely, with some campuses approaching 100% computer ownership or access and others at less than 20%.)

**Necessary Prerequisites to Realize the Vision**

- Ubiquitous Systems
- Commitments to Life-long Learning
- Shift from Teacher-Centered to Learner-Centered
- Re-engineered Delivery Systems (more cost-effective)
- Productivity Gains
- More "Stuff"
- Financing/Regulatory Reform

Commitments to Lifelong Learning. It seems unlikely that the scenarios outlined above, or any alternative "technology-based" scenarios, will be realized without greater societal, employer, and individual commitment to life-long learning. If we are to move to an "unbounded" system, we must think of merging education and work and gaining greater commitments to an educational process that is not something obtained and purchased only by youth. Rather, education is a commodity that is acquired, revised, updated, and accessed throughout life. While this access is likely to come in much different forms in the future (e.g., modules instead of whole 'degrees"), its necessity is no less important. Many policymakers, especially at the state level, continue to think of postsecondary education as an activity of youth and budgetary and regulatory policies continue to show this bias. At the same time, only a small minority of employers have actively committed themselves to a "high skills/high wages" strategy for their workforce in which education and training is viewed not so much as a cost, but as an investment. In addition, not enough individuals are committed to the time, effort, and money that a continuing education process requires to ensure competitiveness in the workplace.

In short, to realize the full vision of what a technology-based delivery system can provide, policymakers need to recognize that *this is fundamentally about growth of postsecondary services, not budget-cutting*.

Shifting from teacher-centered to learner-centered thinking. Much of the current infrastructure of postsecondary education is built and organized around the needs of the providers — the need for a "place" to conduct research and to carry out teaching. The standards for conducting research and teaching — student/faculty ratios, square-footage standards for labs, etc. — also are centered on provider and professional needs. These are legitimate concerns but they are not fundamentally the concerns of a "learner-centered" enterprise. This shift in thinking is often subtle but most important. The question for state boards and policymakers is this: How can the structures and investments we make in the system better serve the end goal of student learning? How can we make the system more responsive and more affordable to the student?

This shift in thinking has led many institutions to adopt strategies that put computing and information resources directly in the hands of all students, letting these investments drive curricular and structural change in the institutions. Examples of these types of "student-centered" investments include financing arrangements for student ownership of computers, contracts for Internet access, and software acquisition that can be used in self-directed tutorials. (For further discussion see Resmer, Mingle and Oblinger, 1995.)

The concept of learning productivity, coined by Bruce Johnstone, former chancellor of the State University of New York, is at the heart of the shift from "teacher-centered" to "learner-centered" delivery systems. One of the disadvantages of referring to students as "customers" (and there are many advantages) is that this obscures their central role as "producers" of knowledge, in this case their own skills and knowledge of the world and their discipline.

> **earning Producti·ity: What is it?**
> (Better, faster, more purposeful)
>
> - Self-directed: How can we reorganize the learning process so that students take more responsibility for their own learning?
> - Focused and purposeful: How can we make our curriculum relevant and non-repetitive?
> - Appropriate faculty intervention: How can faculty redesign their work so that they have the time and skills to mediate learning when and where it's needed?

Learning productivity has three essential characteristics: (1) it is, to a greater degree, self-directed; (2) it is more focused and purposeful (and thus less repetitive); and (3) it employs the appropriate level of faculty mediation, when and where it is needed. This will require significant investment in faculty development and training, but within the context of more self-directed pedagogies. It is not training faculty to teach better as much as improving the nature of their mediation in the learning process. The question for policymakers and institutional leaders is this: If we were to take these three characteristics of learning productivity, consider the potential of various technologies, and reorganize our delivery systems accordingly, what would the system look like?

Re-engineered delivery systems. Given the costs of technology and its failure to date to produce the kind of productivity gains expected by many policymakers, it is apparent that new approaches need to be taken. For the most part, technology is a "bolt-on" to the existing system, adding costs and complexity. This is neither a strategy for educational effectiveness nor cost reduction. As Jack Wilson, creator of the studio course that is receiving national acclaim, puts it: "The current teaching/learning paradigm is one where the faculty is expected to work very hard (preparing for class and lecturing) while the student sits back and listens. I want to reverse that dynamic."

**Educational Effectiveness: What is it?**

A delivery system the learner can access
- easily
- quickly
- conveniently

A pedagogy (instructional mode) that is
- individualized
- customized
- modularized
- contextualized

Outcomes that include
- program completion
- high levels of skills acquisition
- values which unite and civilize
- a high level of satisfaction

Let me briefly describe the studio course as it has developed at Renneselaer Polytechnic and other major research universities. It is a perfect example of how re-engineering can avoid the cost problems of "bolt-on" strategies. The studio course, developed first in physics but now being extended to other sciences, replaces both lecture and lab (computer-assisted learning has long been used as lab tutorials). Instead of a course with four hours of weekly lectures (averaging about 300 students) and two hours of lab (about 30 students per lab), Renneselaer now has a physics studio course of four hours with 50 students each working off of a networked personal computer. Software developed collaboratively with other engineering schools consists of hundred of modules from which to choose. Students work in a self-paced mode through the software while the faculty member and the teaching assistant circulate through the room. Periodically, the faculty member asks students to stop working on the computer, turn around, and the faculty member gives a "mini-lecture."

How effective is the studio model? One piece of evidence is student performance, which has remained high even though faculty contact was cut by one-third. Student enthusiasm and participation is another strong indicator. Student attendance in studio courses averages 95% as compared to about 40% attendance in the traditional lecture format. The additional costs in this model are for the classroom equipment and curriculum development (or licensing). The savings are in faculty time, which can be devoted either to research or in expanding enrollments.[1]

In a similar model, Professor Stan Smith of the University of Illinois is using instructional software for chemistry labs. The advantages are several: fewer TA's, less lab space, safer "virtual" experiments, and higher levels of student engagement.

At Virginia Tech, Professor Lucinda Roy is teaching "Civil Rights in Literature" using materials accessed through the Internet, e-mail, and English composition software. The course also has altered the traditional seat time/credit paradigm. Students are going through the course in a shorter period of time with a higher level of engagement with the material and with each other than in traditional classes. Next summer Professor Roy plans to offer the course to her "distant learners."

In all of these examples, technology has been used to engage the learner in his/her own learning — in essence to put more of the responsibility of success on the student and not the teacher (a "learner-centered" versus a "teacher-centered" approach).

Re-engineered delivery systems also may mean whole new institutional types. The land-grant university of the 19th century emerged to meet the needs of the new industrial economy. New institutions of the 21st century are in the process of being developed to meet the needs of a digital economy of the future. These include such "institutions" as the Education Network of

[1] One of the most difficult concepts to apply to technology-based delivery systems, or for that matter any educational system, is the idea of "effectiveness." We have answered that question primarily through a diverse set of institutions with a wide range of goals from "workforce preparation" to "liberal education." Technology adds to this diversity but in ways that will hopefully add value. A. W. (Tony) Bates, in his excellent book (1995), discusses the advantages and limitations of various media. For example, he notes that the level of interactivity with both learning materials and with instructors vary according to media. In the case of computer-based pre-programmed instruction, for example, the level of interactivity with material is very good in comparison to other media, but poor on social dimensions. Computer conferencing (a more sophisticated form of e-mail), on the other hand, has a high level of "social" interactivity but only "average" interactivity with learning materials.

Maine, the Colorado Electronic Community College, the British Columbia Open Learning Agency, the National Technological University and private, proprietary providers such as the University of Phoenix. The interest in these electronic-based delivery systems and consortia was apparent at a recent meeting of the western governors (November 1995) who created a design team for a new "virtual university of the west" (see Mingle, 1995).

> **Institutions for the 21st Century**
> (Virtually Here!)
>
> - British Columbia Open Learning Agency
> - Education Network of Maine
> - Colorado Electronic Community College
> - National Technological University
> - University of Phoenix
> - Utah Education Network
> - Proposed Western Virtual University

More Intellectual Content or "Stuff". In 1994, Educom, the primary information technology organization in higher education, created the National Learning Infrastructure Initiative or NLII to capitalize on the national attention created by the Clinton/Gore proposals for an NII. Many of the conceptual underpinnings of this initiative emerged from Robert Heterick and Carol Twigg of Educom and William Graves, director of the Institute for Academic Technology at the University of North Carolina, Chapel Hill. Their beliefs and goals were that collectively higher education institutions could build a "learning infrastructure" that improved academic and learning productivity and cut costs to taxpayers and consumers. The structure of the NLII is essentially a public-private partnership with institutions, policymaking groups like SHEEO, and commercial publishers, software companies, and telecommunications companies joining forces. One of the first needs identified by members was the need for higher quality intellectual content that could easily be used and accessed in electronic forms. A learning infrastructure needs courses, modules, and tools in electronic forms that can easily be used by students and faculty and quickly updated and distributed through such vehicles as the World Wide Web.

Underlying the structure of the Educom initiative is the assumption that no single institution could undertake the standard-setting and content-developing activities needed to produce high quality, scalable software materials. Nor were publishers and software companies likely to rush to fill a market need that was highly individualized and diffused. Curriculum development for the most part remains "a cottage industry" in higher education, dominated by individual faculty members. Textbook and other print material publishing require only small amounts of up-front capital but high distribution costs. Digital publishing and software development, in contrast, are characterized by high up-front development costs and low distribution costs, suggesting consortial approaches and public-private partnerships to share risk and distribute the benefits of intellectual capital.

While much new content is now available through the Internet and can be increasingly accessed by individual students and faculty, Bill Graves, one of the founders of the NLII, is quick to note that "content does not a course make." Faculty and students need course management software to facilitate electronic delivery; and they need a wide variety of tool software and course modules with intellectual content from which they can choose. Much of this development has now focused on "object-oriented" programming, which combines the content with the software needed to read and interpret the object (say a multi-media presentation to teach foreign languages). Future users of computers will receive the content and the software needed to read and interpret the content bundled together and delivered "just in time" via the Internet (probably in a new enhanced version of the World Wide Web, which can handle larger blocks of multi-media). These object-oriented systems, according to a recent issue of *Business Week* (12/4/95), will replace the cumbersome marketing and distribution system of the current software industry.

The implications for higher education are these: much greater consortial development of course management and content and much closer partnership with the private sector for sharing the risks and benefits of intellectual capital.

Productivity Gains. It is not at all clear whether technology is part of the cost problem in higher education or part of the solution. Technology costs, primarily in infrastructure (wiring and switching technology) and end-user equipment (servers, workstations, computers, monitors) are consuming larger and larger portions of institutional budgets. In addition to these expenses are personnel costs in the computer center and instructional technology units, which proliferate from the campus to the college to the departmental level. Facilities to produce high quality video courses and the cost of instructional design teams can be major expenditures. Then there are licensing fees for software, ever-shorter life cycles on equipment, and line charges to pay the telecommunications carriers. To date, much of this technology enhancement has been "bolted on" an organizational structure, especially on the academic side, which is fundamentally unchanged.

Productivity gains have been made, however. Our admissions and registration systems are more efficient; our payroll, accounting, and auditing functions more effective; our libraries more expansive and easier to use; and the access of distant learners to our resources substantially improved. In states like Maine and Utah, with isolated populations, we have brought the best of our universities to isolated communities in a manner that simply would not have been feasible any other way. George Connick of the Education Network of Maine notes that the costs of building his network, which currently serves 5,000 students, is less than the cost of a single 700-student high school!

Some of the benefits of technology are, of course, very difficult to quantify, but unquestionable in their value. World-wide computer networks have dramatically reduced dissemination time for new knowledge. Whether it is developments in AIDS research or "best practices" in organizational processes, information now travels at nearly instantaneous speeds around the world. The value of all this networking is apparent in its use.

The current interest in productivity centers on the comparative costs of different delivery systems. These costs are dictated by a complex mix of capital and operating costs and of technology and human labor costs. They also are in continuous flux as the market changes. In a perceptive analysis of open learning and distance education, A.W. (Tony) Bates has analyzed the comparative costs of different media, both one-way and two-way (see box on "Technology and Costs"). Technology's impact on productivity, however, depends as much on effectiveness as it does on costs, a complex subject for which precious little evaluation research exists.

**Technology and Costs**

| Media | Costs | |
|---|---|---|
| *One-way* | *Large No's* | *Small No's* |
| Print | Good | Average |
| Radio | Good | Poor |
| Audio Cassette | Good | Average |
| Broadcast T.V. | Poor | Poor |
| Pre-recorded T.V. | Good | Poor |
| Video Cassettes | Average | Poor |
| Computer-based | Poor | Poor |
| Multi-media | Poor | Poor |
| *Two-way* | | |
| Audio conferencing | Poor | Good |
| Live Interactive T.V. | Poor | Poor |
| Video Conferencing | Poor | Average |
| Comp Conferencing | Average | Good |

**Note of Caution:** Costs can vary dramatically in different settings and are in flux as technologies evolve.

Source: A.W. (Tony) Bates, *Technology, Open Learning and Distance Education.* New York and London: Routledge, 1995.

In a thoughtful analysis, William Massy and Robert Zemsky (1995) discuss the issue of academic productivity and technology. In short, they ask, what are the comparative advantages of technology versus faculty? They argue that information technology offers both economies of scale and "mass customization." Taking advantage of economies of scale means large initial investments but the "usage per incremental student is apt to be low" (p. 2). Mass customization refers to the potential of faculty accommodating individual differences while extending convenience on an "anytime, anyplace" basis.

Massy and Zemsky note a number of barriers to the adoption of information technology, the most important of which are "established institutional norms relating to teaching methods, faculty autonomy, and notions of productivity" (p. 6).

It is the essence of faculty work that is the fundamental cost and productivity issue, whether that is in a traditional or technology-based system. While Bates and others note the cost differences of various media, it is the labor component that most dramatically affects costs.

On page 22 is a draft matrix developed by the NLII working group on costs that allows policymakers and planners to analyze costs of different technology-based delivery systems. By disaggregating the various functions of the instructional process (the horizontal axis) against the objects of expenditure (the vertical axis) such as faculty, equipment, licensing fees, and transmission costs, we may be able to better understand the cost advantages of one approach over another.

In a traditional delivery mode, the overwhelming majority of costs can be found in the faculty lines, with often a single individual carrying out all of the functions across the horizontal axis (planning, production, distribution, etc.). In technology-based systems, two dynamics occur. First, different individuals may be involved in different processes — some in course production, others in mentoring, for example. And costs shift from labor to capital to some degree (e.g., from faculty engaged in production and maintenance of courses to purchasing/licensing agreements for content).

Financing/Regulatory Reform. The full productivity potential of technology, many believe, depends upon a restructuring of the financing and regulatory environment in postsecondary education. There are both short-term and long-term issues here. An immediate concern of many public institutions in the distance learning business is the ability to operate outside of their territory and the appropriate revenue-sharing policies between send and receive sites. Ironically, many public institutions are finding it easier to deliver courses out of state (which tends to be unregulated) than they are in state, which is often highly regulated (through role and mission and geographic service area policies). Given current funding policies, the motivation of "receive" sites to be hosts for sending institutions also is not high, especially if the send site is receiving all of the state support and tuition revenue. While many such policies have been negotiated bilaterally, some systems (e.g., Georgia) are exploring a variety of revenue-sharing schemes.

The problems of revenue sharing will only grow more complicated in the future. Imagine the complexity of funding in the scenarios outlined earlier. The state in partnership with major employers has established a series of work-based learning centers. Students and workers come to these centers to take live interactive video courses, to connect via computers to on-line asynchronous courses or modules, and to receive face-to-face counseling and advising or to use computerized data bases. (They also access these courses from their desktop at work and from their home.) In any given term, the individual student may be using course materials, intellectual property, and other services from literally dozens of providers. In this circumstance can the state provide funding for such instruction primarily through institutions? Probably not.

One alternative may be to create "education trust accounts" in the names of individuals, with credits from a variety of sources including the state entitlements (based on residency), financial aid (based on need), employer contributions, and even individual savings programs. Debits would be made automatically by the student passing his "smart card" through the computer. Various providers would price their intellectual property as they see fit, creating a more effective marketplace for instructional activity.

A Matrix for Examining the Components of Direct Costs*

| | Planning | Course Production | Course Maintenance | Delivery/Distribution of Information | Mediating/ Tutoring | Student Assessment |
|---|---|---|---|---|---|---|
| Personnel | | | | | | |
| Full-time Faculty | | | | | | |
| Adjunct Faculty | | | | | | |
| Graduate Asst | | | | | | |
| Undergrad Asst | | | | | | |
| Technical | | | | | | |
| Clerical | | | | | | |
| Facilities | | | | | | |
| Equipment | | | | | | |
| Purchase/Licensing of Instructional Materials | | | | | | |
| Broadcast/"Connect" Costs | | | | | | |
| Other Costs | | | | | | |

*Developed by Dennis Jones, NCHEMS and Frank Jewett, California State University System

Such a "voucher-type" financing system does not end the necessity for public sector investment but rather changes its nature. Investments in infrastructure, connectivity and curricular content (i.e., applications) will be substantial, and public institutions that serve public purposes will continue to need institutional grants to cover many operating and infrastructure costs. (They also will need grants from the state to sustain their research and service functions.)

The question of what contributions will made by the private sector (i.e., the telecommunications, public utilities, and cable providers) to provide widespread access through broad-band digital networks is currently the subject of extensive debate. On the one hand, many believe that deregulation of the industry will drive down costs and extend services, through competitive mechanisms, to virtually the entire population. Others believe that public entities, especially state public utility commissions, should assure "universal access" to rural providers and subsidize line charges to special-purpose institutions such as educational institutions. Critics of the free-market approach note that the private sector's primary interest in networking is in the area of entertainment and merchandising through vehicles such as home shopping, not in educational offerings that tend to lose money for private providers and need public subsidy.

The problem of providing a "broad-band" connection to virtually every home, institution, and place of business is often referred to as "the last mile" problem. Mike Roberts, Vice President of Educom, argues that this last mile should be built as a "public asset" in order to reduce governmental regulation (ironically, multiple providers building systems to our doorsteps will add to the regulatory labyrinth). "Making the bitway a public asset assures that all users are treated fairly and that standards for bit transport are openly developed and provide a level playing field for private sector companies both large and small" (*Educom Review*, November/December 1995, p. 50). The real economic value, Roberts notes, is not in the highway, but in the "content" and applications. By gaining public investment to the last mile, private sector investments can be freed up to concentrate on the most expensive parts of the information infrastructure: the computer applications and their electronic contents.

**State Investment Strategies for the 21st Century**

If coordinating boards, system heads, and other policymakers are feeling somewhat seasick from all of the extraordinary developments in technology, it is understandable. The implications for underlying "value-systems" and for specific policies are potentially enormous. (See "Ten Questions for Coordinating Boards/Policymakers" on page 25.) As a guide, let me suggest the follow "rules of thumb" for coordinating boards:

<u>Think about goals before delivery systems</u>. Many coordinating boards have not fully clarified the goals for the use of the technology. In this sense, technology and its use is seen as

an end rather than a medium. At best many believe that technology can be a "change agent" to shake up the existing institutions that may be complacent about their responsibilities. But technology-based delivery systems have dramatically different cost structures and levels of interactivity and effectiveness, depending upon the target group and purpose of the system. Goals will have both a general statement (e.g., increase access) as well as a specific application (e.g., provide science/math professional development programs to rural high school teachers). State boards also should think about goals and the application of technology in this context: What priorities need public or system investment because they are being neglected by the marketplace?

Invest Strategically. There is no end to the requests for new networks, new levels of connectivity, new equipment upgrades, new programs for faculty development and training. The question for state boards is this: Where can we make our investments to have the biggest impact on the largest number of students? What are the big access problems in this state (rural areas or under-served populations in metropolitan areas)? Where are the big learning problems (lower division undergraduate courses in science and math or graduate professional development programs)?

Don't Forget About Equity. Many problems in providing access to technology may be solved by private providers and by the self-financing of individuals. Others will not. If 80% of the students in your selective research university are coming with personal computers and only 20% of those in open-door institutions, it may mean the need to intervene with public incentives for the latter.

Focus on the Learner. State boards have historically played an important role in "consumer protection." What better way to protect consumers than to ensure that state investments serve student needs. George Connick at the Education Network of Maine created the mythical "Amy" to tell the story of countless adult learners whose needs are not being well

**Ten Questions for Coordinating Boards/Policymakers**

1. What educational objectives will be served by the technology solution proposed? What are best practices in this arena?

2. Do the technology investments serve important public purposes? What new or underserved markets can be reached? What are the most cost-effective solutions to reach that market?

3. What accountability mechanisms are needed? More consumer information? Strengthened accreditation?

4. What is the current state of infrastructure and connectivity on campuses? Across campuses? Across sectors? What is the level of utilization.

5. What are the short-term and medium-term plans of the telecommunications providers in your state? How can the board capitalize on these initiatives?

6. What inequities exist in the system in access to information technology resources? Who are the "have-nots"?

7. What changes are needed in regulatory policies that govern eligible providers (e.g., role and mission, service areas, eligibility of private and out-of-state providers)?

8. Are new or strengthened coordinating mechanisms needed to establish investment priorities? For operational priorities?

9. What changes are needed in financing policies to support technology-based delivery? Have fundamental questions of "Who pays?" been determined?

10. What is the feasibility of multi-institutional and/or multi-state collaboration and partnering? What cost and quality advantages might be obtained? Are new institutions and/or consortia needed?

met by the traditional delivery systems. Many faculty have historically held paternal attitudes toward students. Technology and choice force a change in attitude — they allow students to get what they want, when and where they want it — an important factor for working adults whose "customer satisfaction" standards are driven by the high standards of the private sector, not the predetermined requirements of faculty. Every investment, whether directly in students (e.g., Internet connectivity in the library and dorms) or indirectly through institutions (in faculty development and infrastructure), should be evaluated against this standard: How does it serve the goal of increased learning by students?

Press for Partnerships and Collaboration. Clearly, it will be difficult for individual institutions or uncoordinated systems to operate in this new environment. Consortia will be needed to pool resources and partnerships with the private sector. Old criteria for determining the franchise based on geographic location will need to be set aside in preference to evaluations of capacity and quality. It is highly unlikely that individual institutions will be able to create such quality alone in the future.

## Conclusion

Ultimately, technology is not about access, although increased access to programs and to information may be the result of our network building. In the end, if technology investments are not about educational effectiveness — about learning — they will be wasted investments. Technology's application to teaching and learning cannot be "just as good." The needs of society demand that new technology-based delivery systems be a great deal better. But that is the exciting revelation that comes quickly to astute observers. When properly used, instructional technology mixed with the right amount and kind of faculty mediation can be a whole lot better than traditional modes of delivery. Anyone who has listened to Professor Stan Smith at the University of Illinois or Jack Wilson at Renneselaer talk about their chemistry and physics courses is struck first by their extraordinary commitment to the craft of teaching. And when one listens to the testimonials of students who have taken Professor Ray's Internet course at Virginia Tech, one can sense their extraordinary level of engagement and wonder about learning.

These are not compromises. This is teaching and learning at its best.

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