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A Framework for Examining the Costs of Instructional Technology

高等教育における情報技術教育利用のコスト評価の枠組み

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A FRAMEWORK FOR EXAMINING THE COSTS OF INSTRUCTIONAL TECHNOLOGY

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INTRODUCTION

The purpose of this paper is to point out the need for research on the costs of instructional uses of communication technologies and to provide a framework for examining these costs. The term "instructional uses" is not tightly defined in this paper since technologies are used for a variety of purposes. This "jointness" of use is one of the complications involved in examining costs. For example, email can be used to teach a course, advise students, check library references, correspond with other academics, access administrative information and data, and keep track of one's friends. One of the challenges facing those who use, or seek to use, instructional technologies is to obtain clearer, more concise descriptions of: 1) technologies that are available and being developed, and 2) illustrations of the ways they can be used for instructional purposes.

Overall, the transition to employing information technology-based instruction has been erratic. Although institutions have reported steady increases since 1990, the number of colleges using instructional technology as a part of course work is still less than one-third and its use is highest in universities (Green, 1997, p. 1). Many of those advocating a more rapid expansion of instructional uses of technologies in colleges and universities claim that it will lead to substantial productivity increases, enable existing institutions to avoid being supplanted by newly emerging "for profit" and

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non-profit organizations, provide a means to reform ineffective current instructional practices, and increase students' access to instruction (DeLoughry, 1995). These proponents enthusiasm, frequently uncritical, for rapidly transforming higher education by increasing uses of instructional technology has assumed many aspects of past educational fads. The burden of proof is being placed on those who raise questions about the current state of technology applications, the cost implications of these innovations, and potentially negative pedagogical consequences of an uncritical, premature, rush for their adoption (Young, 1998).

As a consequence, those in the U.S. who question claims about the benefits of more rapid adoption of instructional technology frequently are criticized as resisting change for self-serving purposes or labeled as anti-technology "Luddites" (Neal, 1998). Obviously, new communications technologies are having, and will continue to have, a significant impact on higher education. However, many of the technologies are relatively new and there is very limited experience and research on their potential. Improvements and new developments are emerging rapidly, making those only a few years old obsolete. Additionally, the rapid introduction of new technologies in a competitive market place continues to create standardization problems for users.

Much of the research on the uses and costs of information technology by colleges and universities is anecdotal and does not focus on the full range of costs. Cost assessments typically are limited case studies of one component of the instructional technology system. The studies that have been done frequently ignore the costs of infrastructure, technical support, training, and related activities. The College of Engineering at the University of Idaho (1995b) describes several categories of the costs of using instructional technology and concludes that: "Although the costs of offering distance education courses may be high, there are high costs associated with offering conventional courses (p.3)." To date, Kenneth Green's annual survey is the only comprehensive look at the use of instructional technology.

TYPES OF COMMUNICATION TECHNOLOGIES AND MODES OF INSTRUCTION

There is no attempt in this paper to fully review and categorize the various types of communications technologies and how they can be employed for instructional purposes. However, to give some sense of the field, the categories suggested by a few authors are presented. Laurillard (1993) lists five types of technologies: audio-visual, hypermedia, interactive media, adaptive media, and discursive media:

Audio-visual Media. Audio and video cassettes and television.

Hypermedia. Hypertext [a "computer-based software system for organizing and storing information to be accessed non-sequentially and constructed collaboratively by authors and uses" (Jonassen, 1191, p. 83)] and multimedia resources such as information retrieval systems that include both text and visual materials.

Interactive Media. Computer-based simulations and modeling.

Adaptive Media. Tutorial programs and tutoring systems.

Discursive Media. Audio- and video-conferencing and computer-mediated conferencing.

Other authors have suggested additional categories:

Worldware. This is a general term applied to software that is not developed specifically for instructional purposes, but can contribute to instructional improvement when utilized. Worldware includes applications such as the Internet, E-mail, word-processing, and conferencing systems (Erhmann, 1995, p. 25). These applications are used for scheduling, course catalogs, course-based sites, and outside research. For example, the University of California at Los Angeles is aiming to have a WWW site established by 1999 for every course offered at the University. At a minimum, sites would include syllabus, assignments and course description. Other aims of a WWW course site are to create an environment for on-line communication such as a chat room or a listing of links to additional resources. Like E-mail, this technology allows students and faculty to work during whatever times fit into their schedules. Increasingly, courses are being designed to be taught using the capabilities of the World Wide Web.

Courseware. This term refers to a software package or application designed for a specific course (Twigg, 1996).

Video Networking and Interactive Video. Satellite television networks are the premier medium of distance learning programs. Traditionally, distance learning degree programs have used television to deliver advanced professional degrees such as a master's of business administration. Interactive video supports two-way video and audio communication between multiple locations (College of Engineering, University of Idaho, 1995a).

Multimedia/CD-ROM. CD-ROM's are developed and used as instructional aides, usually for student use outside of class. However, according to Twigg (1996, p. 14) most CD-ROMs developed to date do little to "add value" to the level of instruction and simply provide a few supplemental examples or resources to what is already available.

Electronic Mail. Faculty and students use this application as a personal communication device, and as an instructional tool called "computer conferencing." For example, faculty can use email to transform the function of out-of-class assignments. At the University of Arizona, a

conversational Spanish course required students to communicate via email in order to practice their skills, and students could participate at anytime (Erhmann, 1995, p. 25). This type of assignment may replace other out-class-assignments that would require students to accommodate conflicting schedules in order to complete group projects. Email even may be capable of shortening the length of traditional lectures and discussions if such information is posted to a class ListServ, which allows students to respond at their own convenience.

COMMON ASSUMPTIONS ABOUT THE USE OF INSTRUCTIONAL TECHNOLOGIES

The Growing Use of Communication Technology

The development and use of communications technologies are expanding at unprecedented rates across modern societies with significant and unforeseen consequences. The most visible examples are the vast systems for collecting and transmitting data employed by businesses and public agencies, the rapid development of the internet and World-Wide-Web (WWW), facsimile transmission, cellular telephones, interactive video systems, and global position devices. Twigg and Hetrick (1997, p. 4) report that 83 percent of today's college students use the Internet and 40 percent use it every day. Looking into the future, they envision a "...global learning infrastructure" - a student-centric, virtual, global web of educational services - as the foundation for achieving society's learning goals" in contrast to the "...bricks-and-mortar, campus-centric university of today" (p. 7). A recent survey of 400 high school seniors who planned to attend college in Fall 1998 (Chronicle of Higher Education, 1997, p. A25) revealed that two-thirds had computers at home that were capable of browsing the World-Wide-Web, 72 percent had some form of access to the Internet, and nearly 40 percent rated themselves as being proficient with computers.

Waterman (1998) describes how an Arctic explorer is employing a notebook computer, a digital camera, a cell telephone, and a solar battery charger to present and discuss his discoveries in classrooms, by means of a satellite, while he is experiencing them hundreds of miles from the nearest wired communication facility. However, Lewis and Wall (1988) point out that, although the pace of technological activity increased between 1978 and 1988 (and changes have come even faster in the current decade), "technology advocates and skeptics alike can point to almost 40 years of obvious discrepancies between promises and practices."

The Effects of Technology on Productivity

The national effects of technological developments on productivity have engaged the attention of economists and were the subject of a recent U.S. Department of Commerce report. The report concluded that:

> The key question is whether all the investment in information-processing equipment is making the economy more productive. As the report ["The Emerging Digital Economy", U.S. Commerce Department, April 15, 1998] candidly acknowledges, some economists think it is giving a major boost to productivity while others "remain skeptical. ...As yet, there is limited direct evidence in government data that investments in information technology have substantially raised productivity in many non-information technology industries. (John M. Berry." Not All Figures Compute in a Digital Economy", *The Washington Post.* p. E1, April 16, 1998.

Many claim that educational applications of communications technologies will help overcome limits to productivity in higher education resulting from its labor intensive nature (Twigg & Hetrick, 1997; Twigg, 19965). Massy and Zemsky (1995, p. 8) argue that: (1) "given the differential growth rates of labor and technology, one can expect positive long-term returns on investment even when returns are negligible during the first few years; and (2) "technology-based solutions also tend to be more scalable than labor-intensive ones... one should expect that additional students could be accommodated at lower cost with technology than with traditional teaching methods." The University System of Maryland central administration, for example, predicted that its initiatives to increase the use of communication technology could increase the productivity of the System's 11 institutions by 20 percent (University of Maryland System Administration, 1996). The Western Governor's University is being created to use communications technology for delivering courses across the Western states (Blumenstyk, 1998a). Twenty-one colleges and corporations in 16 states and Guam will provide courses that students take via computers or through other technology. The new institution will employ professors from existing institutions to provide its courses. This initiative is based on an assumption that this means of instruction will cost less than expanding existing institutions, or adding new ones, to meet the needs of an increasing number of students. In addition to the presumed cost savings, it also would create access for students who lack the means to attend classes at a conventional institution.

The Effects of Technology on Instructional Quality

Many critics maintain that U.S. college and university officials, and professors in particular, are

resisting taking advantage of the capabilities emerging technologies offer for saving resources and improving instruction. Many of these critics predict that institutions who do not rapidly take advantage of these technologies will have their students lured away by competitors who do employ them. These competitors will include new providers of education such as commercial technology firms and enterprises like the rapidly expanding profit-making University of Phoenix. A typical example of such apocalyptic views is one offered at a recent conference:

> "I think 25 per cent of higher education institutions in this country will be out of business in 20 years," because they won't adapt to technology fast enough." (Douglas S. Gale, Assistant Vice President for Information Systems and Services, George Washington University)

Those rapidly adopting communications technologies for instruction and other academic purposes presumably will be delivering education more efficiently and more effectively than those relying on more traditional forms and methods of education. Massy and Zemsky (1995, p. 2) argue that information technology has the potential to offer mass customization, which allows faculty to accommodate individual differences while providing "improved convenience" for both students and faculty. The research dealing with these questions has been inconclusive.[1] The University of Idaho's College of Engineering reports that:

> "...the instructional format itself (e.g., interactive video vs. videotape vs. "live" instructor) has little effect on student achievement as long as the delivery technology is appropriate to the content being offered and all participants have access to the same technology." (1995b, p. 1)

Another benefit claimed for these technologies is that their use will permit instruction to become more accessible and better tailored to students' individual educational objectives. New theories of learning, such as concepts of "active learning" and "constructive learning," will be facilitated by the use of technology. Denning (1998), in reporting on a seminar series, asserts that:

> "A new set of learning practices is taking shape in the incubator of the Internet. Some order is beginning to emerge from the swirl of buzz words -- words like distance education, just-in-time learning, self-pacing, proficiency-basing, certification of competence, virtual classrooms. We have given the name hyperlearning to this new organism. Hyperlearning means learning in a

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[1] For those interested in distance education technology research the 4th edition of "the 'No Significant Difference' Phenomenon is Reported in 248 Research Reports, Summaries, and Papers" is available from: tom_russell@ncsu.edu

richly interconnected, decentralized environment -- where the individual must take responsibility for what is learned and cannot rely on direction from a central authority."

Some predict that books will become passe and libraries will be radically transformed. Another participant in the conference noted above predicted that:

"Novels for the couch, the beach, and bus will remain,... [but] ...print-and-paper technology would be supplanted as a means of storing information, as a medium of scholarship, and as the focus of education." (Eli M. Noam, Professor of Finance and Economics, Columbia University)

Reactions to Current Assumptions

A number of observers, however, are suggesting that, while communication technologies have had, and will have, a significant impact on higher education, the current enthusiasm is excessive and is becoming the latest "fad" to sweep through higher education. Neal, reacting to pundits' assertions that new institutions are going to "steal our students" and lead to the demise of current institutions, says that "Faculty members sense that this hysteria has little basis in reality, and the evidence suggests that they are correct" (1998, p. B5). The current uncritical advocacy of technology recalls a similar enthusiasm for technology in the late 1960s that fell far short of its proponents' extravagant promises. Once again predictions, both about the speed of adoption and the pedagogical effectiveness of the new technologies, are lacking sufficient critical scrutiny and appear overstated. These circumstances raise concerns about claims regarding the extent to which proposed uses of technologies will increase productivity and reduce costs, at least in the short-term. Reflecting these concerns, Christopher Oberg (Young, 1998) describes technology as:

"...often an open pit into which institutions shovel money. Most universities do not even have ways to measure how much they spend on information technology. We are loath to find out I.T. costs because we fear the answers would make us look silly." (p. A30)

Massy and Zemsky are quoted in an article by DeLoughry (1995, p. A17) as predicting that institutions that "...keep their labor-intensive methods will lose students to less-expensive, for-profit companies that will enter the education market." They conclude that:

"...technology has not made the instruction more efficient--because computers generally have raised costs, not reduced them." "...but technology can, and must, increase the productivity of instructors if colleges are to curb labor costs, hold down tuition, and compete with profit-making

companies that will become bigger player in education in the future." (p. A17)

Heterick (1991, p. 12) believes that "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." Pepi and Scheurman (1996, quoted in Nash, 1998) argue, paraphrasing Emerson, that "Computer technology is in the saddle and it is riding us" (p. 229). They liken the ascendancy of computer technology within colleges of education to Hans Christian Andersen's tale, "The Emperor's New Clothes." Nash lists a number of critical questions about technology that need to be raised and concludes that "...the delivery system should be a secondary consideration to the pedagogical strategy."

The Effects of Technology on Student Access

A third claim is that instructional technologies will greatly increase student access to an affordable education. They will be able to have a broader selection of subjects and majors, be able to schedule their involvement in ways that accommodate their varying commitments, and will be able to draw on the resources of multiple institutions.

There is no doubt that significant increases in distance, or off-campus, learning capabilities are occurring. However, important questions need to be answered about who will benefit most from such programs and about the economics of the enterprise. For example, will it replace a portion of current residential undergraduate and graduate instruction or will it be largely serve place bound, older, self-motivated, adults? Will distance education have economic advantages over residential programs if similar instructional quality is maintained? Many untested assumptions currently are being made about the answers to these questions. No doubt, time and experience will provide the answers but more systematic research could reduce the time and costs associated with typical trial and error methods of improving education.

COSTS ASSOCIATED WITH THE USE OF INSTRUCTIONAL TECHNOLOGIES

National Infrastructure Costs

Many of the uses of instructional technology are supported by a vast national and international system of computers and other communications devices linked by cable and by ground and satellite

transmitters; the "information superhighway." This system obviously is extremely costly to create and maintain. These costs, however, are supported by a number of governmental and private parties and, consequently, typically are viewed as "givens" and, typically, are not factored into institutional decisions on instructional technology. These costs are similar in some ways to those incurred by one buying an automobile. Automobile ownership entails supporting the national highway system, traffic police and the extensive system of automobile related facilities and services. These are real costs of ownership but typically have a marginal effect on individuals' automobile purchase and use decisions. Rapidly growing world-wide communications systems support the needs of nearly all sectors of society and, therefore, discussions of their costs generally are more salient in national than in institutional decision making. Nevertheless, someone has to pay the pro-rated portion of these costs that relate to education and, therefore, they should be considered when analyzing the productivity of instructional technology.

Institutional Infrastructure Costs

Institutions require a communications network and associated equipment to link classrooms, buildings, and dormitories together. Campus networking requires a major institutional commitment and a significant share of total institutional resources. The University of Maryland, College Park spent $25 million installing its fiber optic network, of which $5 million was for the equipment (Rood, 1998). This network replaced a system that contained wires dating back into the 1920s with a type of paper insulation that, when wet, occasionally allowed wires to touch, creating static and error messages. Part of the costs were attributable to having to put cable in old buildings with poured concrete walls that were not designed for such installations. In addition, the older buildings had few electrical outlets, limiting classroom use of computers with out significant expenditures. Rood reports that students are now requesting that the university provide wireless access to the internet.

Larger institutions in the U.S. now generally have high speed networks. However, costs of these systems have delayed their installation at many smaller institutions. Elmira College, a small, private, liberal-arts college with about 1,150 students, currently estimates that it will cost about $800 thousand to install a fiber optic network at its campus, funds it cannot easily obtain. Despite this cost, they believe making this investment soon will be necessary if they are to compete with other institutions. In some cases states such as Texas have created regional networks to link their institutions (Ferrante, Hayman, Carlson and Phillips, 1988).

Hardware Costs

The costs of computers, printers and other peripherals have declined at a remarkable rate. However, usage, with virtually every faculty member and student possessing a computer at some institutions (Resmer, Oblinger & Mingle, 1995), probably has not lessened the total investment institutions are making in equipment. Additionally, the incredible rate at which the technology is progressing is resulting in personal computers becoming outdated within two to three years. For example, in 1997 the 18 community colleges in Maryland conducted a study of the investment required to up-grade their computers to accommodate contemporary software and the World-Wide-Web. The estimated cost was approximately $95 million. The "Year 2000" problem also will force institutions to replace some of their older computers. Hawkins (1991) observed that all too often institutional investments and commitments have been in the form of:

> "...one-time expenditures on capital acquisitions. Microcomputers have not been viewed as capitalized assets needing replacement or renewal. This issue of capital replacement of equipment is one of the most serious facing academic computing on virtually every campus in the country." (p. 29)

There is very little evidence this situation has changed much since he made this observation.

Software Costs

The general purpose software employed in computer related instructional technology applications typically is up-graded every two or three years and must be replaced or enhanced to maintain currency and compatibility. Some software also will have to be up-graded, or new software acquired or developed, to deal with the "Year 2000" problem. Software used for instructional purposes is costly and the frequent up-grades require a good deal of user relearning, temporarily reducing productivity, even though new software is becoming increasingly "user friendly" and requires less learning time than earlier versions. However, user friendliness is coming at the price of larger, more complex programs that require larger, faster computers. The costs resulting from the regular up-grading of software must be factored into examinations of the productivity of instructional technology.

Technical Support Costs

Green (1996) found that providing technical support is a priority issue facing about one-fourth of

the campuses surveyed. However, information about costs for computer support services is typically illusive because of the complexities in accounting for salaries, purchases, maintenance, unexpected repairs, upgrades and the use of outsourcing to provide additional support (Guernsey, 1998). Institutions typically have instructional technology support offices that provide general assistance for technology users and some have specialized facilities, such as rooms equipped for interactive video instruction and conferencing, that have technicians assigned. Faculty while using a technology, such as interactive video, may require a full-time technician to operate equipment. In many circumstances rapid repair service is necessary in order to avoid costly delays during instruction. A few institutions are now "outsourcing" their technology services. East Tennessee State University has signed a five-year $7.9 million contract to provide technology experts, a "help desk", World-Wide-Web sites, assistance with "Year 2000" problems and related services. The private company will assign from six to 14 employees to the University (Blumenstyk, 1998b).

The University of Maryland at College Park, as an example, maintains a number of technical support units and a few classrooms especially equipped for employing instructional technology. The largest units support students, faculty and staff for all campus-wide computing labs and networks, as well as computing in the residence halls. The current cost to maintain two of these units is roughly $450,000 and $150,000 per year respectively. The bulk of the budget, like other costs associated with higher education, is for staff salaries. One can only speculate about the extent to which any savings in faculty and clerical staff salaries, resulting from using instructional technology, is offset by the costs of these technical support staffs.

Faculty Training and "Opportunity" Costs

The extent to which faculty are trained to utilize newer instructional technologies appears to vary according by discipline and the age of the faculty member. Faculty in fields such as physics and engineering were the pioneers in developing many of the current technologies. Their technical training often provides them with the skills needed to utilize technology with a minimum of training. Similarly, younger faculty who have "grown up" with technology and received training or experience during their educational years may require less training. Nevertheless, for most faculty, considerable training will be required, especially for those who feel challenged by technology in general. The cost of this training is significant. Some institutions, such as the University of Maryland, have a faculty training unit with staff assigned.

Other forms of training include sabbatical leaves to learn instructional applications of technology and gain experience using them, reduced course loads for training, and sending faculty for specialized

training. Some institutions provide faculty with small grants to learn about and develop use of technology. Ehrmann (1994, p. 33) urges institutions to provide faculty more opportunities for development in computing. He recommends courses in both the summer and winter for both groups and individuals, creating reward systems for faculty who utilize technology to improve teaching and learning, and creating opportunities for faculty computing advocates.

Faculty engage in a variety of activities related to their scholarly, research, instructional, and public service responsibilities. They must curtail some of these activities if they are to make a significant commitment to use instructional technology. What often is viewed as resistance to change is rational calculations of the relative importance of engaging in the use of educational technology as compared with the value of their current engagements. Neal (1998, p. B5) observes, however, that: "Most faculty members are slow to adopt new technology simply because they are not convinced that using it will improve their students' learning." "...teachers have a right to ask if their investment of time and effort in learning how to use the technology will produce significant benefits for their students." He reports that "The fundamental error in the experiment with instructional television was that, typically, no one asked faculty members how this technology might serve their instructional methods or contribute to better learning by their students; teachers were simply told to get on the bandwagon."

Student Access and Training Costs

Students incur a variety of costs related to their use of instructional technologies. McCarthy (1998) observes that little has been written regarding information technology's biggest end-user: the college student. She notes that a great deal of attention has been given to rising tuition levels but little to the fees students are charged to pay for improved computer labs, software and Internet access. Kenneth Green (1997) found that an increasing number of U.S. colleges and universities are relying on user fees as a way to underwrite the cost of using information technology on campus. In the National Survey of Information Technology in Higher Education, he notes that the use of mandatory student fees at four-year public institutions has risen over 15 percent in just three years, hovering around a 59 percent usage rate. Students attending such universities pay on average $140 in information technology user fees (Green, 1997, p. 3). McCarthy speculates that institutions may seek to impose "course fees" on students taking courses that involve costly technology, similar to the laboratory fees frequently charged for science classes.

Other costs passed on to students include software purchases and the cost to print documents at campus computer labs. Some institutions require incoming students to purchase their own computer. In fact, nine percent of the institutions Green (1996, p.9) surveyed "require or strongly recommend"

the purchase of a personal computer. For example, the University of Florida now is requiring all incoming first year students to have their own personal computer at an average cost of $1000 per student (McCollum, 1998, p. A21). Some staff members and students are criticizing a University of North Carolina plan to require students to own P.C.'s beginning in 2000 (Young, 1998). Another phenomenon revealed in Green's (1997) study is the advent of "computer competency" requirements for undergraduates, which is imposed by a growing number of institutions, including 46.5 percent of all public four-year colleges. Institutions are becoming concerned about the types of uses student make of computers and how proper usage can be assured without monitoring (which would raise constitutional issues). Some institutions are formulating user codes of conduct.

McCarthy (1998) suggests one consequence of the high costs of instructional technology could be limits on institutional choice and access for students with lower incomes. The 30 million people in this country who have access to the Internet are better educated and have a higher income than the average American (Barnard, 1997, p. 30). This population clearly does not include the majority of students who are at risk of not attending a higher education institution because of financial constraints or fear of debt. Requirements for purchasing computers, technology users' fees, and computer competency requirements will pose a barrier for many of these students.

Course Design and Development Costs

The design and development of courses that make proper use of technology are generally expensive. Twigg (1996, p. 20) reports that development cost estimates for courseware are roughly $50,000 per instruction hour, or about $3 million per course. However, some believe such costs can be offset by savings. For example, at Rensselaer Polytechnic Institute, "studio classes" for introductory physics courses have replaced traditional lecture-style formats. This new format reduced class size to about 50, down from 345, and employs computers as a key part of instruction. Campus administrators' report the courses actually save the university money, but reveal little concrete evidence as to how, other than on personnel expenses saved by utilizing fewer teaching assistants (DeLoughry, 1995, p. A19).

Courses typically are designed by the faculty member that will be teaching them. However, some institutions, particularly those engaged in distance learning, employ course designers who supply and train faculty how to teach courses using technology. Commercial firms also are designing "courseware" for use in college and university classrooms. Some funds for courseware development are supplied by Federal and foundation granting agencies. However, the cost and availability of validated courseware appears likely to constrain expanded use of instructional technology unless the

Federal government makes a major commitment to provide support.

Massy and Zemsky (1995) argue that classes that stand to gain the most from the use of information technology applications are those "subjects that have a high volume of students, a standardized curriculum, and over whose content faculty are less possessive." Altering the "teaching" enterprise to the "learning" enterprise via information technology occurs in those courses where knowledge is "codified and algorithmic" not those subjects "concerned with questions of meaning and value, of culture and philosophy." They point to such classes as remedial mathematics and writing composition in which work is self-paced rather than the "batch-processing and episodic assessment" experienced by students in traditional college courses (pp.3,4).

Administrative and Legal Costs

Although planning, time, and a lack of funding appear to be immediate barriers to utilizing instructional technology, copyright hurdles also present problems. Software to record, track and distribute payments for the use and posting of electronic journals and books is in preliminary stages. However, some libraries already use a preliminary form of the tracking software since so many disciplines are simultaneously preparing articles for print and World-Wide-Web distribution (Barnard, 1997, p. 33). The issue of on-line copyrights has pitted university librarians against the publishing industry. In general, university librarians are pushing for "fair use" of electronic products, which allows them to avoid the cost of copyright. Publishers are pushing for the passage of federal legislation to carve-out electronic documents from this rule (Guernsey, 1998, p. A27).

Steinbach and Lupo (1998) describe "hidden legal traps" that have cost implications for distance learning programs. These include obtaining approvals from accrediting agencies and state higher education boards, complying with intellectual property laws, and obtaining user agreement for use of materials. They recommend that institutions establish policies that specify who owns materials produced by faculty and staff, how the materials should be used to comply with U.S. copyright law, and how to ensure that those intercepting the programs or materials understand that they cannot be used without authorization.

Less Tangible Costs

In addition to the costs of employing instructional technology that have been described earlier, there are a number of less tangible factors. Some persons express concern about the lack of human contact and interaction that could result from people spending larger portions of their time

communicating by means of technology. The limited availability of qualified staff to engage in and support instructional technology also imposes costs. Having marginally qualified staff decreases productivity and raises the salaries of qualified persons who are in high demand.

Another threat to productivity is what one might term "Internet addiction". There are numerous reports of both students and faculty "surfing" the Internet for long periods of time while neglecting their other responsibilities. In addition there is the well know hazard of "solitaire" and other games that come "loaded" on most computers. A Dilbert cartoon suggested that solitaire was God's response to humans attempting, through use of technology, to increase the universal limits on how much productive work a person habitually accomplishes in one day!

A further concern is the potentially negative effects of information overload. Email, voice mail message recording, facsimile transmission, pagers, and cell telephones are tremendously increasing the access people have to one another. Unless ways are discovered to manage this avalanche of information, people will have to sort through huge quantities of information to find that which is relevant and requires attention. Upon arriving at work, a considerable portion of one's day can be consumed by the time taken to listen to voice mail, collect and read FAXs, check Email, and finally attend to traditional "hard copy" mail. This problem can be compounded by inclusion on "listserves" and the growing problem of "SPAM" (unsolicited mail from strangers).

CONCLUSIONS

Technology Investment Planning Needed

Higher education's conventional planning and budgeting cycles frequently do not accommodate the rapid product development cycles of information technology. Twigg & Heterick (1997, pp. 171-19) recommend institutions' and states' oversight boards focus on: 1) developing a "consortia of partners" for providing technologies; 2) making a long-term investment in computer networks for instructional programming, rather than video networks; and 3) creating partnerships with software/courseware providers for high enrollment courses. Only 28 percent of respondents in Kenneth Green's 1997 survey reported the use of some functional financial plan for information technology. Green urges college and university administrators to resist "the temptation" to use student fees to quell budget woes, mostly because such actions do little to address the underlying needs for a long-range information technology infrastructure and plan (Green, 1997, p. 3).

Steve Gilbert (1994, p. 21) of the TLT Group (an affiliate of the American Association for Higher Education) urges institutions to consider the following questions when devising strategic information technology plans: 1) is a new committee or task force needed to develop policies and plans?, 2) which "educational tasks" are better served by the use of information technology?, and 3) how do we develop a plan to fund the role of information technology? The recommendations of the National Commission on the Cost of Higher Education (1998) expressly state that college and university leaders should articulate the results of "self-reviews" to the "campus community and institutional constituents" with information on a variety of expenditures including technology (Goodling, 1998, p.1). The Commission's recommendations also instruct colleges and universities to seek out different kinds of "partnerships" in order to effectively curb costs (p. 2).

Research on Instructional Costs Needed

The principal impediment to implementing such recommendations is the serious lack of research and policy analysis on the nature and full range of the costs involved in instructional technology. Most policy discussions of instructional technology take place at far too high a level of generality. The planning called for, until more research has been done, is likely to rest on far too many untested and inaccurate assumptions. The planning will be driven by the frequently false hopes of savings. Without in-depth research, there will continue to be a tendency to invest too large a proportion of available funds in technologies and far too little into the other costs noted above; particularly course development, training, and technical support.

One means to address the gap in our understanding of the costs of instructional technology would be for a Federal government agency to fund an Institute for the Study of Instructional Technology. Such an agency could provide resources for the cost studies and policy research that are badly needed to guide the millions of dollars being expended in this area.

Prospects for Institutional Adaptation and Change Based on Technology Applications

A good deal is being written in the U.S. on the need, and desirability, of "transformative change" in education. These calls for major, rather than incremental, changes in higher education fail to recognize the fundamental nature of institutional changes processes. Jones (1995) notes that:

> "After numerous encounters with this paradox--the maintenance of the status quo in the face of compelling arguments for change and reform--it has become increasingly apparent to us that institutions are in fact behaving rationally. They are responding directly to the incentives and

constraints that actually exist around them. Devising change strategies that are likely to work therefore requires much more conscious recognition of the relationships between institutions and their external environments than has been typical in the past." (Jones, 1995)

Institutions operate in the cybernetic ways described by Birnbaum (1988). Staff and faculty at various levels, in various roles, attempt to balance off a variety of competing demands. If instructional technology applications are perceived to produce values that exceed those of other competing investments of resources and time, then faculty and staff will adopt them.

In this environment, given the costs and ambiguities surrounding the use of instructional technology, it is not surprising that institutions are not comprehensively adopting these innovations. Doing so entails great risks as well as potential rewards. There is a need for a few institutions and faculty to take the large risks of developing and experimenting with new instructional technologies. However, not all institutions need to be pioneers. A less risky strategy for most is to examine the results of the "lead institutions" efforts and then adopt only those applications that are found to be effective. Most institutions will profit from a mildly skeptical posture given the hyperbole currently associated with technology. This is not to imply that technology is not currently having, and will not continue to have, a profound effect on the way education operates; it will. But developments typically will not be predictable and there will be many surprises and notable failures along the way. More research would help reduce the number of these surprises.

Sources of New Students for Technology-Based Instruction

The predictions that new technology-based institutions will eliminate or greatly reduce the students enrolled in traditional institutions assumes a redistribution of current enrollments. Over time, the use of instructional technologies undoubtedly will modify some aspects of pedagogy at traditional institutions. This will help them retain students who prefer to reside at an institution. The more extreme views, that new and highly innovative institutions or profit-making organizations using these technologies are likely to displace traditional institutions, do not appear warranted.

What appears more likely to happen is that new, highly flexible and entrepreneurial institutions will emerge along side of the traditional institutions. These new institutions will compete most vigorously with the continuing education units of traditional institutions, who themselves will be leaders in employing instructional technology. They also may compete for students with the two-year community colleges. However, a considerable portion of these new competitor's students will come from developing new markets; mostly older and "place bound" persons who, in the past, would not have engaged in postsecondary education. A past example of new institutions emerging to meet

newly perceived needs was the creation of community colleges in the United States in the 1950s and 1960s.

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【要旨】

高等教育における情報技術教育利用のコスト評価の枠組み

フランク・シュミットライン*
サリー・マッカーシイ**援助

本論文は，1998年7月30日に学位授与機構（東京連絡所）において実施された研究会における講演のために準備したものである。

本論文では，大学の授業における情報技術の教育利用のコストに関する研究の必要性を指摘し，コスト評価のための枠組みを提示している。そのため，まず情報技術及び教授法のタイプ分けを行い，教授技術の共通前提を検討し，その利用に伴うコストを明らかにし，技術投資計画とコスト研究の必要性を指摘し，大学の構造転換と新しい学生層の出現を予測している。

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