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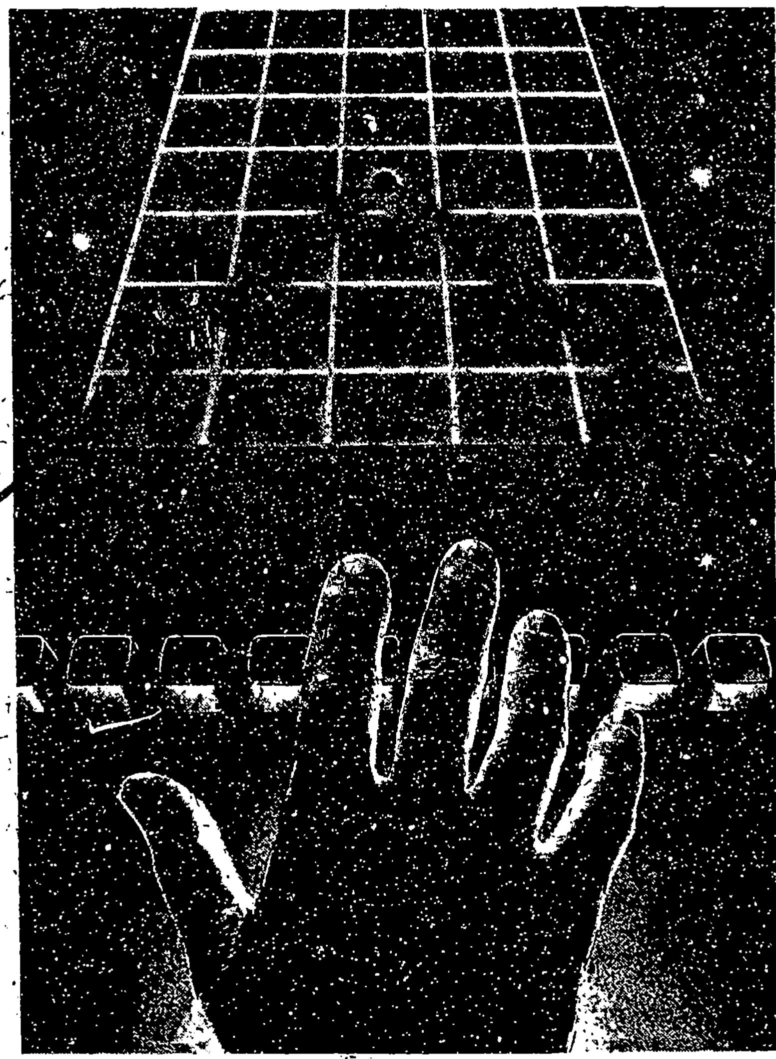
ABSTRACT

This report proposes a strategy of putting networked computing devices into the hands of all students at institutions of higher education. It outlines the rationale for such a strategy, the options for financing, the required institutional support structure needed, and various implementation approaches. The report concludes that the resultant optimal environment is a laptop computer for every student with sufficient network access points, on and off campus. The rationale for this environment looks at changes in models of education, the need for improved communication, rapid technology change, and the changing nature of students. Financing options suggested include redirection of existing funds and generating new income through student fees, bonding, faculty work reengineering, and product sales. Challenges and prerequisites to a universal student-access policy are addressed including changing the existing teaching/learning culture, involving faculty and students, and integrating technology with curricular change. Principles derived from institutions already implementing such a policy are identified noting different phasing schedules and various models such as straight purchase of computers by students, department-oriented requirements, and single vendor/machine sourcing. Needed infrastructure changes are also outlined, and policy issues concerning such issues as theft, insurance, replacement, repair, and part-time students are addressed. (Contains 15 references.) (NAV)

COMPUTERS FOR ALL STUDENTS



A STRATEGY FOR UNIVERSAL ACCESS TO INFORMATION RESOURCES

SHEEO

COMPUTERS FOR ALL STUDENTS:

A Strategy for Universal Access to Information Resources

by

Mark Resmer
James R. Mingle
and
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SHEEO

November 1995

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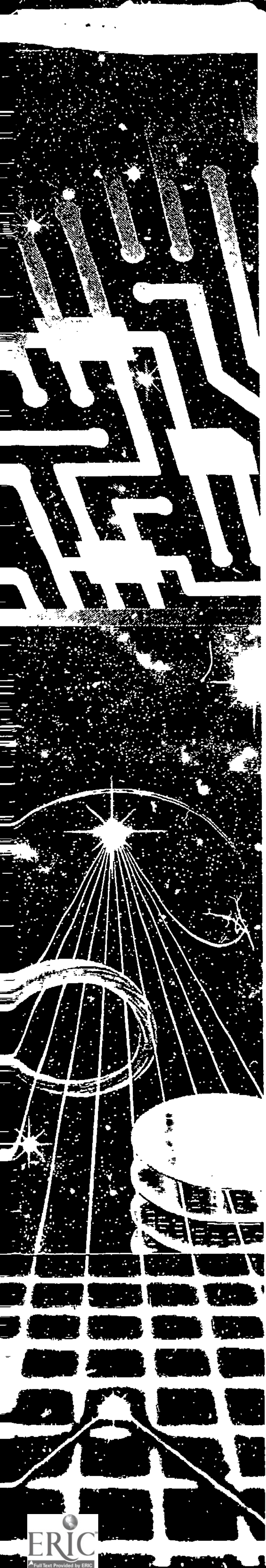

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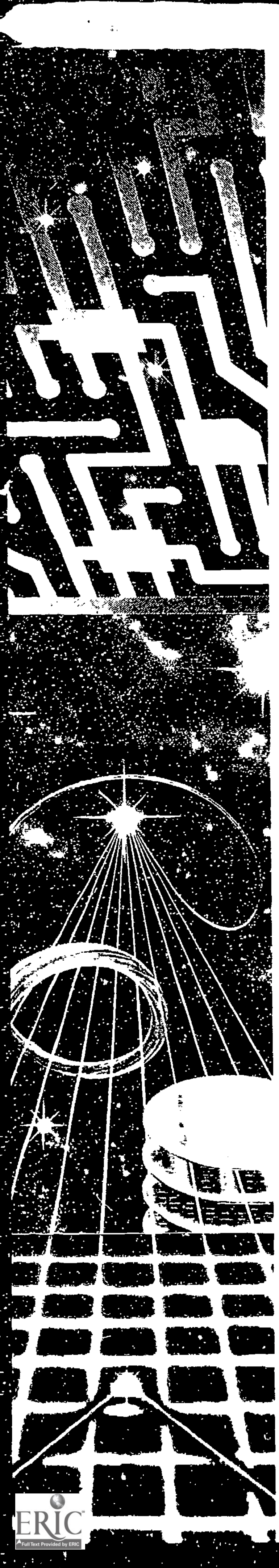

PREFACE

This paper on "universal access" to information technology is a joint effort of the State Higher Education Executive Officers (SHEEO) and the California State University System (CSU), under the auspices of Educom's National Learning Infrastructure Initiative (NLII). The NLII was designed to focus the attention of higher education on the opportunities presented by the emergence of global computing networks. The colleges and universities, public policy groups and corporations which make up the NLII believe that to meet the goals of improved quality and affordable access will require a major collaborative effort. At the heart of that effort is the creation of an infrastructure to facilitate technology-mediated learning and more cost-effective systems of access to postsecondary education.

Each year, a wide range of new technologies competes for limited investment dollars. Librarians, computer center directors, continuing education deans, instructional technology specialists, distance learning advocates, chief information officers, vendors, lobbyists and politicians all argue for their particular "technological" fix for the problems facing higher education. Funding these claims exceeds the ability of even the most well-endowed institution. As a result, the development of a coherent information technology investment strategy is a key priority in ensuring that higher education makes wise investments that realize fundamental educational objectives.

In assessing these information technology strategies, the fundamental criteria should be:

- Does the investment contribute to student learning?
- Does the investment contribute to faculty productivity?
- Does the investment contribute to greater student viability in the workplace?
- Is the investment cost effective?

We believe the strategy of putting networked computing devices in the hands of all students has the potential of making a contribution to each of these important objectives. The report which follows outlines the rationale for such a strategy, the options for financing, the required institutional support structure needed to assure success, and various implementation approaches.

In addition to those people noted in the acknowledgements, we would like to extend a special thank you to Robert Heterick and Carol Twigg of Educom and William Graves of the University of North Carolina for their leadership in establishing the NLII framework for this paper.

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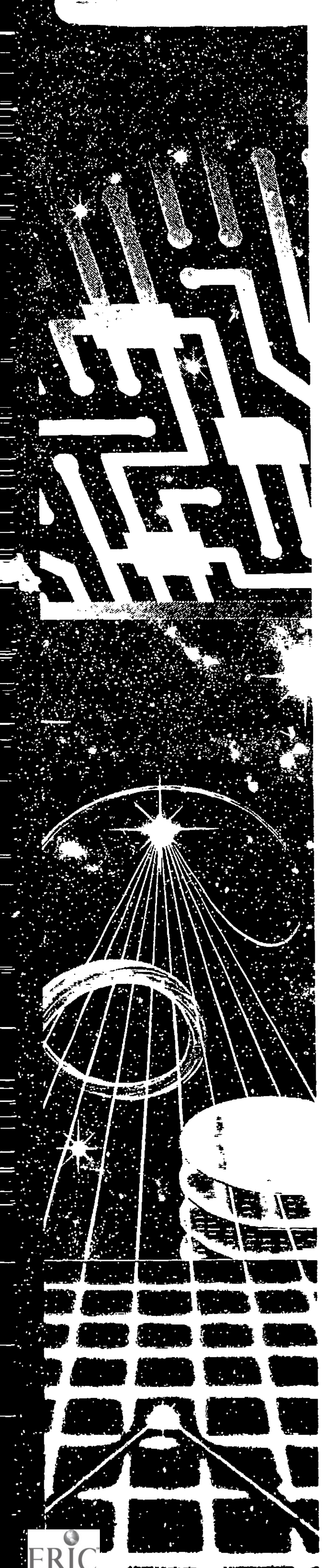

OVERVIEW

The purpose of a "universal access strategy"[1] is to make a laptop computer and access to the Internet available 24 hours a day to every student. Because networked information and communications is growing in importance, network connection is critical. Students must be able to access information resources that are integrated into their education experience. This strategy focuses on the student as the learner, as an independent producer of learning rather than a passive customer of teaching. The goal is "any time, any place" access to information resources.

Characteristics of optimal universal access include:

Twenty-four hour access. Twenty-four hour access to a computer and the Internet, along with any other networked resources that the student's institution makes available, is needed to realize the "any time" requirement of "any time, any place" access. Network connections are critical to extend the computer from a productivity tool/word processor

REMINDERS ABOUT UNIVERSAL ACCESS

- No single strategy is a panacea for the learning productivity challenge.
- The application of technology without a concurrent transformation in the teaching/learning process will be an add-on that will add only cost.
- Reengineering the learning environment will not occur without the development of a technology infrastructure, of which universal student access is a part.
- In some institutions, nearly 50% of students have their own personal computer. Our strategy extends this approach to all students and provides the necessary infrastructure to maximize the effectiveness of these tools for faculty and students.
- Establishing the personal computer as a foundation tool for all students is relevant to development in distance education. For example, video teleconferencing is emerging as a personal computer capability.
- Universal student access to information resources is equally relevant to community colleges, four-year institutions, research universities and K-12 schools.

[1] Given the many definitions of "access," it is important to note that in the context of this paper, "access" is defined as any means that permits students to use information resources and technology effectively to further education goals. "Access" should not be confused with "entitlement."

into a communications tool, and thus contribute to the centrality of the computer in the student's life.

Mobility. The computer should provide mobility to meet the "any place" requirement.[2] Mobility not only enables students to integrate the computer into everyday work but also fosters social interaction and peer learning. Leaders of institutions that have invested in laptop computers report it is common for students to gather around laptops over lunch or in the "quad" as they work together to solve problems.

> **WHAT'S WRONG WITH COMPUTER LABS?**
>
> *Computer labs are limited resources.* There is no guarantee students will find an available computer when or where they need one. Nationally, students have access to campus computers an average of 3.5 hours per week (Green, 1994).
>
> *Computer labs are not convenient.* When students use a computer lab, they must bring everything they need with them. Students who use labs as word processing centers must write their papers elsewhere, then go to the lab to type them.
>
> *Computer labs depersonalize the computer.* In a lab setting students cannot personalize a particular computer and establish a long-term trusted relationship with it. How many staff or faculty would be willing to use a shared lab computer instead of one on their own desk?

Possession. The strategy should allow students to possess a computer even if they do not own one, so that they can personalize it, expect that they will find it in the same condition as they last left it, and entrust their valued information to it. Possession is required to ensure 24-hour access.

Replacement cycles. Universal access should get the institution out of the equipment replacement business. No institutional budget is large enough to keep up with nine-month product cycles.

Space. Universal access should resolve some space problems associated with building computer labs. Institutions have too many competing needs to dedicate space to computer labs unless necess ;y.

Universality. The program should be universal and independent so that a base of functionality is provided to all students regardless of discipline, class standing, residential status or other characteristics.

Upgrading. Even though universality is a requirement, certain disciplines require higher levels of performance or greater network capability. Students should be able to avail themselves of these options if necessary.

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[2] Currently, laptop computers appear to be the best solution. But as Personal Digital Assistants (PDAs) mature, they may offer the possibility for even greater portability. Not only are PDAs more convenient than laptops, but they are also potentially less intrusive.

Guaranteed service. The program should provide access to shared resources (e.g., dial-up facilities and access ports) with constant, reliable service.

These criteria define the current optimal environment as a laptop computer in the possession of every student, with sufficient network access points, both on- and off-campus, to permit the student to have relatively uninterrupted access to the network at an adequate speed. As technology advances, new definitions of the optimal environment will emerge.[3]

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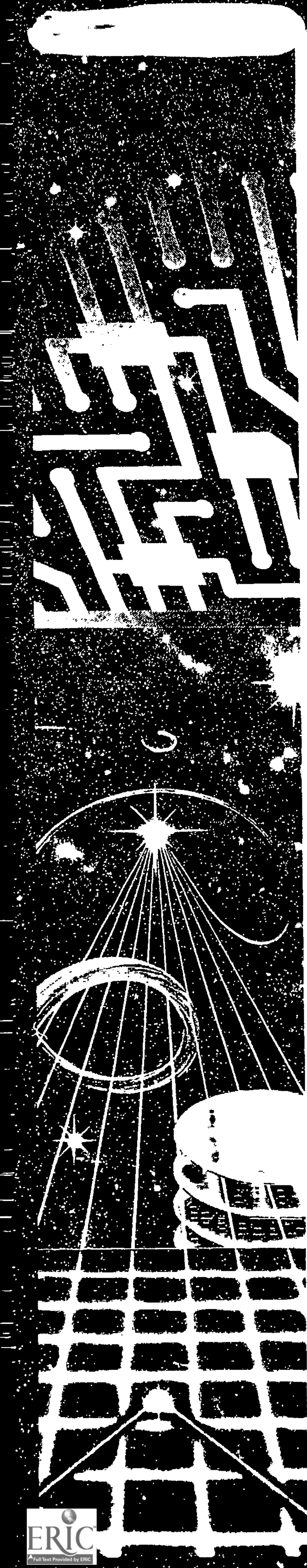
[3] Thomas W. West, assistant vice chancellor for information resources and technology at the California State University, has proposed the concept of a "PIRK" or Personal Information Resource Kit that evolves over time. A student's PIRK in the 1960s was the slide rule. Today, it may be a laptop computer, tomorrow a PDA or other device. This PIRK is the student's toolkit for interacting with the information domain.



RATIONALE

The rationale for universal access stems from the following factors:

- The increasing amount and dynamic nature of knowledge that students must absorb
- Changes in models of education
- A desire for improved communications
- The rapid pace of technological change
- The changing nature of students.

Information access

The body of recorded knowledge is growing at such a rapid rate that it is no longer possible for traditional tools to keep pace or for students to have sufficient access to the available information. Information is increasingly dynamic: It no longer can be captured solely on paper because of rapid change and the incorporation of elements beyond text and graphics. Direct access to the existing body of knowledge is an integral part of a comprehensive education experience in the 1990s.

To be effectively integrated into a student's education experience, such access needs to be available within the student's work environment, whether in the classroom, lab, library or home. As the availability of electronic information from libraries, museums and other sources increases, the amount of time that each student spends using a computer will increase. Personal, continuous access to computers and the network will enable a student to link information resources with other parts of his or her academic experience.

Changing education models

As education models and approaches change from teacher-centered to learner-centered, technology serves as a catalyst for the development of learner-centered approaches to education. It is also a prerequisite for implementing such changes. Technology can free faculty and students from the constraints of the traditional classroom experience.

More active forms of learning may be encouraged when faculty and students can assume a high level of access to technology. At the University of Minnesota-Crookston, for example, universal student access has enabled faculty to use new approaches and cover more material than previously possible. With computers in hand, students can solve science, accounting, math and statistical problems on their own instead of watching the professor solve the problems on the blackboard. In English, students can engage in collaborative writing. In theater class, they can compare different performances under the professor's guidance. Classes can be structured so students learn by doing and by discovery instead of passively receiving information delivered by faculty.

Even within more conventional lecture/seminar models, institutions that have implemented universal access strategies show a much greater use of presentation tools by students. One of the best ways to learn is to teach. The enhanced focus on the students as presenters places them in the role of a "teacher." This approach also addresses a frequent faculty concern that faculty members will have to spend too much time preparing presentations for class. Although presentations have a place in the high-tech classroom, they are more likely to be the work of students than of faculty.

REENGINEERING INSTRUCTION THROUGH TECHNOLOGY

Faculty at Rensselaer Polytechnic Institute (RPI) in Troy, New York, have re-engineered physics and calculus courses using networked multimedia technology to engage learners. They not only have integrated technology, but also redesigned courses and classrooms.

The result is the "studio" model of instruction, an improved education environment for students that combines lecture, recitation and laboratory activities into a studio or workshop setting. This approach de-emphasizes lecture and intertwines the laboratory and problem-solving sessions into one team-based activity (DeLoughry, 1995). RPI faculty have cemented the relationship between the course and laboratory activities.

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

Communication

Communication among faculty and students also can be enhanced by access to networked computers (Roberts, 1995). For example, a student can post a question to the professor at the time the problem arises (often late at night), instead of taking class time or seeking the professor out during office hours. When questions have to wait for an answer, the student often forgets the question which then never gets asked or answered. Professors also can post significant questions and answers on the network so the entire class, not just a single student, can benefit from the interaction.

In spite of the obvious importance of communication, little effort is made in the average undergraduate course to develop students' communication skills. The instructional model at most institutions still features a teacher-centered environment which puts a premium on presentation skills for the teacher but requires little in the way of communication capability from the students. Success in many careers depends on communication, collaboration and cooperation, all of which potentially can be enhanced through the use of networked communications. Cooperative learning techniques also have shown success in encouraging the success of minority students (Wilson, 1994).

The utility of communications via the computer is directly proportional to the ubiquity of access points. A critical mass of users also is needed. With assured access by faculty, students and administrators, computer-mediated communications may replace less efficient media such as class handouts or hallway postings.

Technological change

Technology changes rapidly. New products enter the market on six- to nine-month cycles. Education institutions cannot keep pace with these changes. Institutions with universal access strategies are better able to match the pace of technological development with technology deployment. At the University of Minnesota-Crookston, for example, computers are "refreshed" annually through leasing arrangements with the vendor.

Changing student needs

Existing institutional policies were developed for a student population that entered after high school graduation, attended college full time and graduated in approximately four years. These "traditional students" are now in the minority. Non-traditional students work part or full time, are motivated by career or work-related factors and require different support. Many are adult learners with family commitments. For these students, it may be impossible to use computer labs during open hours. For example, working mothers find it difficult to gain access to resources designed to serve single, residential students. Universal access programs may be the only means of providing non-traditional populations with access to learning resources.

For any off-campus student, computer labs present a challenge. In many areas, returning to campus to use labs at night is a safety concern. Associate Professor Dennis Lieu of the University of California-Berkeley writes, "Prior to the due date of homework assignments or projects, it is not unusual for students to be present in the engineering graphics laboratory for the entire night, many of whom admit that they are simply afraid to walk home after completing their assignments late at night." If each student has his or her own computer, such issues of accessibility and safety are resolved. Students residing off-campus are able to use the computer at home, at work, while commuting or whenever and wherever it is convenient.

Responding to the needs of nontraditional students may be crucial to the survival of many institutions. Nontraditional students exert their "buying power" by gravitating toward institutions that provide them with the educational "product" they are seeking. Unless colleges and universities can offer education in a form that fits their needs, students will look for alternatives outside the traditional arena. New types of institutions may emerge to cater to those needs.

Both public and private college and university leaders report that employers are driving much of the technology change in their institutions. They expect graduates to come prepared to work in a technology-rich environment. Students, parents and boards expect higher education will produce graduates who are competitive with these employers and in these environments.

Educational impact

Evidence showing that the use of computers can have a positive impact on teaching and learning is increasing (Baker, 1994; Berge and Collins, 1995; Cartwright, 1993; Ehrmann, 1995; Green, 1995; Tynan, 1993). Universal access can help improve education in four areas:

- Maximizing learning by creating an ideal learning environment
- Promoting student adaptability and encouraging lifelong learning
- Increasing the relevance of higher education to students and society
- Enhancing equity of access to information and education.

Maximizing learning. Maximizing learning is the single greatest benefit universal access seeks to facilitate. Universal access to information technology can enhance learning in several ways.

Pacing. "The computer makes it possible for the learner to make choices that determine both the kind of material presented and the rate of information flow. Hypertext or hypermedia documents open up the ability to follow relationships among ideas. The timely access to relevant information is intellectually arousing for the student and assists in "discovery" learning. The interactive format makes it possible for the presentation of information to occur under natural conditions of inquiry, that is, when the learner has framed a question and is receptive to the answer" (Noblitt, 1995).

Retention. "Many have noticed improved retention from interactive instruction. Students seem to remember when they are actively involved in absorbing data, and it appears that a combination of media, including visual and audio cues, tends to make a stronger impression" (Tynan, 1993).

"The productivity gains occur in both retention, more efficient use of the student's time, easy access to groups studying over networks, better feedback to faculty and organized self-assessment and self-pacing" (Baker and Gloster, 1994).

Changing the focus from teaching to learning also should change the criteria used to measure educational effectiveness. Instead of measuring faculty productivity, teaching loads, student-faculty ratios and similar inputs, assessments should concentrate on student outcomes. Universal access to information technology is a prerequisite for many of the techniques that permit this change to take place.

Promoting student adaptability. Many observers would describe what happens in education today as "pouring in content" or "distributing information." But, as Berge and Collins (1994) said: "We need to develop motivated, skillful, lifelong learners. As knowledge in many fields increases exponentially, we cannot hope to fill up students as if they were passive, empty vessels."

For many disciplines, it is estimated that the volume of information doubles every five years or in about the amount of time it takes to complete a degree (Molnar, 1990). As a result, it is becoming more important for students to develop the processes for acquiring information, thinking critically and making decisions, and less important for them to memorize facts. The expectation that professionals will change careers several times during their lifetime also makes the memorization of facts less important and mastering processes more valuable. Without the aid of digital technology, it is unlikely any student will be able to acquire the information needed as a professional. Information must remain extremely accessible.

> "The important thing in education is to distinguish between what the student must internalize and what may be safely relegated to storage in information technology" (Noblitt, 1995).

Increasing the relevance of higher education. If one views higher education as an industry, then students, parents, employers and governing bodies are its primary "customers." These customers expect higher education to provide them with the tools, techniques and knowledge needed for productive careers. Among those expectations is that students will understand and be able to use information technology, regardless of their academic specialization or intended career.

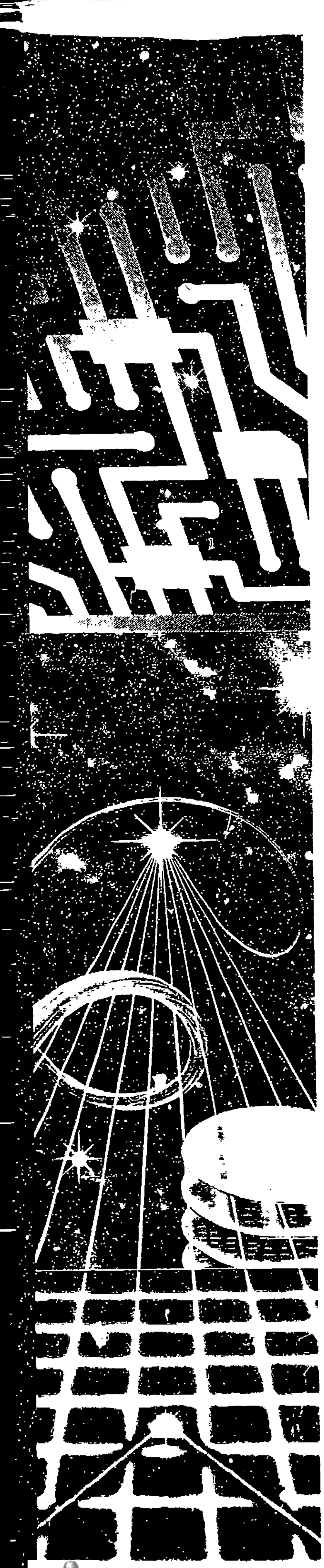
> **WORKFORCE PREPARATION**
>
> "There is no question that technology skills will be essential in ever-increasing portions of the labor market of the 21st century; the use of computer and other information technologies is becoming prevalent across all fields and occupations" (Green and Gilbert, 1995).
>
> "Students and those already a part of today's workforce need knowledge about technology and skills in its use to remain productive and valued. Among these essential student skills are a basic familiarity and understanding of the role and functions of technology in our present world. Students require a mastery of technological applications germane to their professions and disciplines. They need a working knowledge of personal computers and common software tools. They require the ability to search, retrieve, analyze and use electronic information. Finally, students must develop the capability to use technology independently and collaboratively in their work" (Hall, 1995).

Institutions that have announced universal access programs have elicited enthusiasm and support from both employers and the media. The perception is that such programs are highly relevant to the needs of the institutions' "customers" and make colleges and universities more responsive to the real world. Students, who are increasingly motivated by career considerations, see universal access programs as having direct relevance for them. Institutions that have implemented such programs have realized an increase in the number of applicants for admission and transfer.

Enhancing equity. Because technology is becoming more and more central to the education process, the disadvantaged student must be assured of having the same access that the more affluent student can afford. Without an institutional commitment to universal access to information technology, the risk of building a society of haves and have-nots continues to rise. Evidence shows this situation already is occurring. Students with the means to purchase computers are doing so (national estimates are around 40%).

These students have a significant advantage over students who must rely on computer labs. These labs often have outdated equipment, are open during limited hours and are often crowded. As demand for access to technology grows, this situation can only get worse. While some observers consider it unfair to impose the additional burden of computer purchases on students with limited means, it is these individuals who will be disenfranchised if they do not have access to computers. If a universal access strategy is implemented with attention to equity issues, it can help bridge the existing gap between the haves and have-nots.

Such a strategy also can extend learning opportunities to others. For example, there are indications that when students own computers, they introduce information technology into their family and community. Students with computers use them for many purposes other than academic work — running small businesses, preparing tax returns, helping children with their homework, etc. Students serve as local "evangelists," introducing technology from the "inside," reducing inequity on a broader, societal scale.



OPTIONS FOR FINANCING A UNIVERSAL ACCESS PROGRAM

Colleges and universities face enormous financial pressures. Dwindling support and rising costs combined with continued pressure for more services mean that strategies such as universal access to a networked computer must make good sense, educationally and financially.

Tuition and fee charges that do not contribute directly to students' learning productivity — i.e., students' ability to gain the knowledge and skills needed to succeed in a competitive world economy — will be difficult to justify to either public policymakers or the students. Putting networked computers in the hands of all students, we believe, can be justified when compared to other uses of funds.

GOALS OF FINANCING STRATEGIES

- Maximize benefits that can be derived from technology
- Share the financial burden among the stakeholders
- Take advantage of increasing performance of the technology
- Develop a rapid replacement cycle.

We believe costs of this strategy should be borne jointly by the student and the institution. Universal student access presupposes that a mix of funding sources will enable students to acquire the necessary technology. Dividing the costs between the institution and the individual reduces the financial burden to both. In examining the financial aspects of universal access, it is important to consider the program costs within the overall context of educational cost: Expenditures in this area may have consequences in other areas.

Funding sources

Specific sources of funding for universal access programs identified by the NLII working group ranged from redirecting funds to generating new income.

- *Administrative restructuring.* Any savings resulting from reengineering business processes or other administrative streamlining can be a source of funds for new technology initiatives such as universal access.

- *Redirection of existing technology funds.* Over time, funds spent on computer labs and support can be reassigned to universal access programs. Indirect savings from the reuse of lab space also represent an indirect source of funding.

- *Tuition/fees.* Imposition of dedicated fees for technology access may support the cost of universal access programs. Alternatively, some or all of the costs of such programs may be incorporated in standard tuition costs.

- *Direct expenditures by students.* Students purchase their own computers. This expenditure represents a direct investment in a universal access program.

- *Bonding.* Traditional capital budget funding strategies may be appropriate in the case of large infrastructure projects associated with universal access programs.

- *Reengineering of faculty work.* While not the primary subject of this report, we suspect that technology including universal access programs will continue to reshape how faculty spend their time. Part of the savings which were used to pay for the studio courses at Renneselaer were generated by reductions in faculty contact hours. As more self-directed and nonmediated learning takes place with the aid of computers, we would expect additional enrollments to be accommodated without adding faculty. An institution, for example, may be able to increase the number of hours generated in independent study through a universal access strategy. We would also expect such approaches to allow a more "modular" approach to teaching and learning so that student productivity would rise.

- *Product sales.* Institutions can become vendors of technology products and services, generating revenue to support universal access programs. While this is an attractive means of converting some of the institution's intellectual capital into funds, such efforts frequently are stymied by lack of venture capital. In the case of public institutions, limitations on competition with the private sector may be an impediment.

The above list is not intended to be exhaustive, but does offer some indication of the scope and range of financial resources that can be considered when implementing a universal access program.

Funding models

While there are as many different funding models for universal access programs as there are institutions implementing them, the two major components are student ownership and technology fees.

Student Ownership. The details vary, but this approach requires the student to possess a computer. Each institution must decide whether students will be required to *purchase* computers or not. One option is to lend students machines that the institution has leased. Another option is to have students make some type of personal financial investment in a computer, whether it be through outright purchase, a monthly fee or a work-study commitment.

Transferring part of the cost burden onto the student may be the only realistic option in the absence of other funding sources. There are other advantages as well: Students who have made a tangible investment in the technological component of their education tend to make good use of it.

While student ownership increases the cost of a student's education, it is not disproportionate with other expenses accepted as reasonable education costs. Students typically spend around $200 per semester on textbooks. Purchasing a $1,600 computer, paid for over four years, represents a similar level of investment. The potential benefits are at least as great. However, adding a cost of this magnitude to other education expenses may price some students out of the market. For this reason, any universal access policy must recognize and provide for the special needs of these individuals.

Technology fees. Many institutions assess a student technology fee to support the additional infrastructure needed to link students to a technology base. These fees already exist at institutions without universal access programs: Technology fees support conventional technology infrastructures. Computer purchase requirements, however, increase the need for a substantial infrastructure to support technology. It may make sense for institutions to levy a fee, using it to build up the institutional infrastructure, before requiring students to have their own computers. In this way, the institutional infrastructure is prepared for the additional demands of hundreds or thousands of computers coming on line.

Fees generally range from under $50 per semester to more than $300 and cover widely different levels of service — from basic connections and computer labs at one extreme to provision of loaner laptop computers at the other. Some institutions have elected to embed the technology fee in their tuition, others assess a separate fee. The University of Minnesota at Crookston and Sonoma State University both have elected to keep tuition constant and impose technology fees, as well as have universal access policies. Wake Forest University will increase tuition to include the cost of a computer with a two-year replacement cycle. Drexel University has not implemented a fee or raised its tuition to explicitly cover technology costs. The University of Iowa levies an information technology fee, but has no universal access policy in place.

An issue that inevitably comes up around technology fees is the perception that such fees may not be used for their intended purposes. Establishing the credibility of such fees requires colleges and universities to be accountable to students and their parents in their management of the fees. Two approaches help ensure that students feel their money is being appropriately spent.

- *Create a student oversight group.* Placing funds from a technology fee in a separate account with expenditures overseen by a student-appointed group addresses concern that funds might be used for inappropriate purposes.

- *Track both deliverables and total expenditures.* A combination of public release of financial statements showing the total spending on information technology, together with a clear identification of all deliverables purchased with a fee (e.g., through the use of stickers on equipment) can assuage student fears in this area.

Ultimately, as with many concerns about universal access programs, the issue of appropriate use of funds may turn out to be part of the start-up phenomena associated with these programs. These concerns may cease to be significant once students see program benefits.

Student financing models

Universal access programs that involve student investment must recognize the needs of students who would be taken out of the market for higher education if they have to pay almost any additional fees. Among the ideas suggested for dealing with this issue are:

Federal financial aid. By making the acquisition of a computer a requirement, students become eligible to include such costs as an education expense for purposes of financial aid. But such an approach is no panacea. In practice, the amount of grant dollars at most institutions is finite and already fully used; additional financial aid often is available only through the Stafford loan programs. Depending on a student's individual circumstances, financial aid may:

1. Become available in the form of a subsidized loan to a student who otherwise would not qualify for a loan, if the cost of the student's education becomes greater than the expected family contribution (EFC).

2. Increase the amount of subsidized loan funds available to the student, again by increasing the differential between the cost of education and the EFC. This would be the case if a student was eligible for financial aid, but had not reached the limit on the amount available through the loan program.

3. Permit the student to take out an unsubsidized Stafford loan if the EFC is so high that the student does not qualify for a subsidized one. The difference between the two is that in the unsubsidized loan, interest becomes payable immediately, while it is deferred in the case of the subsidized loan.

4. Do nothing if the student is already at the limit of the available loan funding. This typically would be the case in instances in which the EFC is nil or very low and the student already is fully using his or her financial aid. In these cases, institutions will have to identify other means of funding the computer acquisition.

Loans. Loan programs typically are available from finance companies that work closely with computer vendors. The programs offer reasonable interest rates and are heavily used by students to finance computer purchases at many institutions. The programs generally require a minimum income of at least $15,000 per annum, either on the part of the student or a co-signer. Principal repayment generally is deferred until the student graduates, thus reducing the initial monthly payments even further.

Institutional leasing. Programs such as the one implemented at the University of Minnesota at Crockston rely on the institution's leasing computers from a vendor and then providing the machines to students for a fee. In this way, students do not need to qualify for financing and, since the machines are never owned by either the student or the institution, the problem of computers becoming obsolete is eliminated. This approach, however, does increase institutional exposure to risk associated with loss of machines.

Student employment. In principle, there is no reason campus jobs should not be used to finance the purchase of a computer rather than provide cash income. The attraction of such a program is that the student could receive the computer at the beginning of the semester and "work it off" during the remainder of the academic year. Such a program eliminates minimum loan qualifications required by commercial lenders, which tend to disqualify students who most need assistance.

> **FINANCING UNIVERSAL ACCESS AT UM — CROOKSTON**
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> The University of Minnesota at Crookston (UMC) has operated under a universal access strategy since the fall of 1993. Under this policy, UMC issues each student a notebook computer for the academic term in which they are registered. Students pay a mandatory "fee" of $260 per quarter, which avails them 24-hour use of the notebook computer, unlimited access to e-mail, unlimited use of printers located throughout the campus, dial-in access from remote locations and network connections in classrooms, libraries, and dormitories. Students also receive a suite of Microsoft Office software, communications software and other specialized software that may be required in certain courses. Through a lease arrangement between the university and IBM Corporation, the computers are replaced with newer models each academic year.

Equipment loans. Even with the options outlined above, it is possible that a student may be so poor and have so little available time that he or she does not qualify for any of the above options. In these cases, institutions will need to establish some form of last-resort equipment loan provision to ensure that no student is unable to participate fully in the universal access program. Such programs are analogous to limited circulating collections of textbooks held by some libraries as a means of assisting students who cannot afford to buy textbooks.

Infrastructure funding

Institutions and systems bear responsibility for providing the fundamental infrastructure to support technology. Infrastructure expenses are comparable to capital costs normally associated with building construction. Expenditures of this magnitude present a problem: While the size of the expenditure suggests that technology infrastructure is a capital item, the actual costs usually fall into operating budgets.

This capital-cost/operating-cost dilemma for technology remains unresolved. Potential solutions include trading space for technology in capital budget proposals (i.e., giving up some building construction and using the funding for creating electronic infrastructure) and forming innovative partnerships with commercial entities to jointly create the infrastructure and profit from it.

CHALLENGES AND PREREQUISITES FOR SUCCESS

Introduction of a universal student-access policy represents a major shift in the ways that an institution operates. Institutions that have implemented such programs report it was much more complex than they anticipated. Universal access affects many aspects of institutional culture, requiring significant planning and institutional deliberation before such a program can be successfully implemented. This section of the document examines a number of the challenges such programs present, as well as prerequisites for success.

Extensive conversation with the student body, faculty, administration, executive management and governing bodies is necessary. These constituencies also may need significant education to obtain their support. Without the active engagement and support of all these constituencies, implementation of a universal access program may fail. Even worse, this failure may be damaging to the introduction of curricular innovations and technologically mediated learning.

Changing the teaching/learning culture

Extensive student and faculty use of information technology will require a dramatic cultural shift for many institutions. Organizations experience change as a disruption, particularly when the organization must change its habits to implement technology (Hodas, 1993). In the case of academia, where many of these habits date back hundreds of years, such change can be seen as particularly threatening to the status quo.

Specifically, when technology is incorporated into the curriculum, the following "habits" of the institution will need to change.

> "The microcomputer is a symbol of a new way of life. It represents the 'disconnect' many educators feel between their background and training and the current needs of society. The digital medium redefines the conditions of psychological and economic well-being for our students and therefore the dynamics of teaching and learning" (Noblitt, 1995).

- *Student workload.* Traditional pedagogy has the faculty working hard while the students act as passive recipients of information. What we need is just the opposite. Personal computers in the hands of all students puts the burden of learning productivity where it belongs — primarily with students. This approach will change faculty roles as well to one that is more a "coach" or a "mentor" and less the guardian of information.

- *Amount of preparation time and the nature of the preparation required for class.* As faculty incorporate technology into their courses, they will need additional time for class preparation. Through the start-up phase of a universal access policy, the institution may need to recognize in policy the impact on faculty workload. Successful institutions will do so by providing release time or funding to faculty engaged in such developmental efforts. Over time, however, we would expect the introduction of technology to add to faculty productivity and not detract from it; thus, such incentives probably can be phased out eventually.

- *Degree of control in class.* Active learning environments cause faculty to relinquish a degree of control to the students. Many faculty members have become used to being seen as a "performer." For some of them, becoming a manager of learning instead of the all-knowing sage represents a loss of power. Incentives and recruitment practices need to be developed to ensure faculty have realistic expectations about their role in a learner-centered environment.

- *Skills required by faculty members.* With the advent of technology in the classroom, many faculty no longer will be able to limit their role to that of content expert or pedagogue. To capitalize on the educational potential of technology, three additiona! skills are required beyond the content expertise of existing faculty: instructional design, application design and technical implementation. These skills need to be supplied by institutional support systems or by the faculty themselves. Faculty training will be critical in helping faculty members develop these skills because most faculty have not needed these capabilities previously.

- *Student passivity.* We see computers and information resources as a means for overcoming the student passivity that characterizes much of the instruction currently used in postsecondary education. If students have constant access to all the potential benefits offered by the use of information technology, internal motivation will drive most of them to become more active learners. Computers alone will not change the model, however. A new approach to learning is required in which students take an active role in constructing knowledge.

- *Traditional forms of faculty/student interaction.* Technology promises to facilitate a wide variety of asynchronous (independent time and location) interactions between faculty and students that can enhance the level of communication. Simultaneously, it threatens faculty ability to compartmentalize and separate their interactions with students from research and personal time. Institutions that rely on computer-mediated conferencing report that cultural norms make this communication socially acceptable.

  Technology also permits academic traditions, such as note-taking in class, to be re-evaluated. Instead of students spending much of their class time taking notes, ubiquitous access to technology permits the professor to distribute notes ahead of time in electronic form. Students simply annotate the notes with personal observations, rather than having to capture the full substance of what the professor said. This approach offers benefits in terms of increased attention in traditional lectures, but might also be equally applicable in a more learner-centered environment, where the process of developing notes could be a collaborative one between the faculty member and the students.

In many ways, the challenges associated with communications are some of the most interesting ones from a cultural perspective, since they go to the heart of one of the processes by which cultures are originally formed. As with any cultural change, the evolutionary process in all these areas will be a gradual one.

Faculty involvement

Although the under ying assumption behind this report (and behind the NLII) is that education should be learner-centered, faculty are responsible for the academic governance of our institutions. Universal student access to technology is an institutional academic initiative. As such, its success depends on the faculty having a high level of commitment and ownership.

A critical mass of faculty adopters of the plan is also critical. If students have computers, but only a few faculty members use the computer's capabilities, a universal access initiative would fall short of its potential or result in a backlash against the adoption of technology that would do more harm than good to the institution and students involved.

A number of factors can influence the level of faculty support for universal access and, ultimately, its feasibility. These factors include extensive consultation, support for faculty development, reflection of the importance of curricular innovation in tenure decisions, development of other effective reward and recognition mechanisms, and, most important, development of clear education goals for the program.

Consultation. While the initial impetus for a universal access strategy may originate outside the faculty, it is important that the faculty take ownership of the project. Faculty members should be engaged in discussion of the issues as early and as extensively as possible. Faculty sentiment may be hostile initially, but extensive discussion generally leads to a high degree of support once all the major issues have been identified and resolved. Some predictable concerns include motives, depersonalization of instruction, affordability and magnitude of change. Others include:

- *Concern about making a "radical" decision.* Many faculty see this approach as unproven and on the "bleeding-edge" of institutional policymaking options. However, as the level of interest in universal access programs grows, and the number of institutions adopting such programs grow, this concern should fade gradually.

  Discussion of the educational implications of the programs also has helped inform faculties and overcome initial negative reactions. Semantics can be very important here. Replacing the concept of "mandatory purchase," for example, with "required access" can make a significant difference in the way programs are perceived. Ensuring that faculty have a strong presence throughout the planning and implementation process is also essential in ensuring faculty support for a program.

  Media coverage also can disrupt the consultative process. There is considerable risk that faculty members will learn about the program through media articles before they have a chance to get the information through normal processes. One of the biggest challenges associated with managing a discussion of this magnitude is ensuring that views are not formed in response to incomplete information. Keeping the discussion out of the press is probably desirable, though not necessarily practical. Once the media are involved, the university will need to carry out an extensive informational campaign to respond to any concerns or misconceptions.

- *Concern about faculty jobs.* Many faculty members are concerned that the real motivation for universal access programs is to save money by making the faculty redundant. The concept of using technology to replace faculty is particularly threatening if initial suggestions for a universal access program originate from administrative sources. Matters are not made better by pronouncements from senior executives, usually intended for the ears of trustees and/or legislators, which imply that if only enough technology were deployed, many more students could be taught by fewer faculty. Administrators and other advocates of technology should be careful with these types of assertions. Technology may be a way of accommodating additional student demand with the same faculty complement. Faculty need to understand that "learning productivity" has the potential to improve student outcomes — greater retention, less attrition, higher graduation rates and improved knowledge acquisition. Most important, the incorporation of technology into the institution may be an institutional survival issue — a way of saving jobs by making the institution more competitive. The ultimate impact of technology use in higher education may be to expand demand, not restrict it.

- *Concern about depersonalizing education.* Many faculty members see education as a personal relationship between teacher and student, and the introduction of technology alters this relationship. Ensuring that faculty both understand and accept the concept of learner-centered education, and that they perceive and internalize the opportunities that technology offers for enhanced communication and personalized instruction can assuage these concerns. (Ironically, one of the complaints of faculty using e-mail is that their contact goes up, sometimes more than they can handle.) Some faculty will continue to feel that technology offers no opportunities to enhance their teaching, and some who teach in specialized areas cannot use technology in any effective way. Such cases are likely to be rare, however, and should not detract from the more general utility of a universal access program.

- *Concern about losing equity and costs.* This issue tends to arise in faculty discussion from well-meaning concern for students' welfare. Faculty may have a principled commitment to providing a low-cost education for the masses, and anything seen as potentially interfering with that mission, however beneficial, is rejected out of hand. Building student support is one way of overcoming faculty anxieties. A universal access approach can be viewed as a "direct investment" in student learning with immediate pay-offs. Even when students carry the majority of the cost burden, initial negative reactions can be, and have been, overcome. (As noted earlier, including charges for computers and technology support into a designated fee that can be tracked by students and faculty may help.) In constrast, little debate takes place on campuses over the extraordinary costs imposed on students for the purchase of textbooks and other materials whose long-term utility is questionable compared to a computer. If all else fails, administrators can note that charges and other financial decisions are not usually part of faculty governance prerogatives.

Faculty development

One of the most frequent causes for faculty dissension comes from a feeling that universal access programs will force faculty into areas where they are not comfortable with their level of knowledge or skills. This is particularly true for faculty who do not use information technology in their own studies. While creating an expectation for ongoing development among senior faculty is a desirable policy objective, it can result in significant opposition from a powerful constituency.

Tenure criteria. A promising approach to faculty development centers on recognizing innovative pedagogy as a valid evaluation criterion in retention, tenure and promotion. To date, the perceived professional risks of such work have been major obstacles. Attempts to reform the retention, tenure and promotion process have been notably unsuccessful. Almost every institution with a strong commitment to technology can relate anecdotal evidence of faculty who have failed to gain tenure because of their work in the technical arena. Some institutions are beginning to recognize technology accomplishments in promotion. The University of Michigan, for example, appointed Perry Samson to a named professorial chair in recognition of his work in creating the Weather Underground, a project aimed primarily at reforming pedagogy in the sciences. Such actions are becoming more common.

Unless the general retention, tenure and promotion process can evolve to recognize both changing education models and the significance of technology, colleges and universities will face increasing competition from other educational entities. Some of these institutions can make rapid changes, in part, because they do not have tenured faculty. There is increasing public pressure for the abolition of tenure, and if colleges and universities wish to preserve tenure, it needs to evolve so as not to present an insurmountable obstacle to ongoing development and quality enhancement in higher education.

Recognition mechanisms. In addition to formal reward structures associated with retention, tenure and promotion, institutions have other opportunities to recognize exceptional pedagogical applications of technology. Such mechanisms may range from "Outstanding Professor" awards to internal grants for curricular innovation to opportunities for showcasing the exceptional projects of faculty. In general, faculty are motivated by a sense that what they are doing is important. Actions that underscore the importance of curricular reform and incorporation of technology into the student learning experience can build faculty commitment.

Educational focus. Building an educational rationale and focus for the implementation of universal student access to technology is critical to gaining faculty and institution-wide commitment. In designing formal programs for faculty development in technology, it is important for universities to avoid those that focus primarily on technical skills development (i.e., computer literacy), rather than educational reform. Faculty first must understand why a set of skills is important to their work before learning the skills themselves. Skills need to be learned in context — ideally in the context of the faculty workplace. For this reason, approaches to faculty development that encourage faculty to build on their interests, work with their peers and leverage the ability of the self-motivated adopters of technology, are often much more successful than those that do not and also help ensure that the focus of universal access programs remains educational.

Student involvement

Student support is even more important than faculty buy-in to the success of universal access programs. Students ultimately bear much of the cost of such programs, and they are affected more than anyone else. Unfortunately, processes to consult with students often are less well developed than they are for faculty. This situation contributes to the difficulty of ensuring adequate consultation, as does the low level of student interest in student government.

Thus, the primary challenges center on creating effective forums in which discussion occurs and in ensuring a sufficiently high level of student awareness, so that decisions are not made on the basis of incomplete or inaccurate information. Fortunately, students typically are receptive to new ideas. A telling anecdote in this area concerns the students at Humboldt State University. When they initially learned their campus was considering participation in a universal access pilot project spearheaded by Sonoma State University, students censured the Sonoma president for having the temerity to propose such a plan. After some significant campus discussion, students voted 60-40 in a campus referendum six months later to proceed with the first steps of the plan.

While some student concerns are the same as those of the faculty (e.g., affordability, educational justification and skills development), students respond to the issues differently. Faculty concerns usually are personal and relate to their particular situation. Students, on the other hand, worry much more about their peers than themselves. For example, a student who has invested in a computer and feels that investment is worthwhile may argue that it would be unfair to ask his or her peers to make a similar investment.

The factor that has convinced students that universal access programs are in their best interests is a perception that exposure to technology applications will give them a competitive advantage upon graduation. Students believe having a universal access program significantly adds to the market value of their degree.

Most student concern about universal access programs usually occurs before a program is implemented. Institutions that have implemented such programs report students are strongly supportive and take pride in attending an institution with a high degree of emphasis on technology.

External constituencies

While students and faculty are the two key internal constituencies, it would be a mistake to underestimate the influence of external forces in the decision-making process for universal access programs. These groups range from senior-level policymakers to community organizations, employers, technology vendors and alumni. Any of these groups can serve as the impetus for action, a source of ideas, a contributor of support or, alternatively, a staunch opponent of the program. Fortunately, these groups usually are more supportive of universal access programs than students and faculty, so the key objective is to ensure they are offered opportunities for engagement and feel they have a stake in the program's outcome.

The perspective of legislators, board members and state-level policymakers will vary, depending on the fiscal climate and public attitudes about student costs. Populist legislators and board members may be especially concerned about any policy initiative that adds to students' costs. Tuition and fee increases often are highly visible through the press and legislative discussions. In order to overcome initial opposition, institutional advocates will need to emphasize the expected gains in "learning productivity" and gain support from student board members. A financial plan that shows institutional commitment to infrastructure development can help put student charges in perspective. And a universal access strategy which is part of a larger "reform agenda" for undergraduate education also is likely to gain legislative and board support.

Community organizations and employers generally see universal access programs as opportunities to bring academic and work environments closer together. They also tend to encourage the programs because of their perceived benefits in creating a stronger workforce and enhancing the community's economic vitality.

Technology vendors have a clear stake in supporting universal access programs since they greatly extend their market. This commercial opportunity offers the possibility of creating win/win partnerships between vendors and institutions, in which vendors increase sales and, as a result, are in a position to support the programs in various ways. In particular, the size of the market represented by universal access programs may provide the academic community with opportunities to influence the design of machines intended for this specific market and may also affect the price of entry-level machines.

Alumni might seem a relatively peripheral constituency in this context, but, in fact, universal access programs offer some significant opportunities for alumni involvement. Alumni have an interest in the institution's quality as reflected in its graduates because anything that improves the perceived quality of the institution reflects on the value of the degree(s) alumni hold. Another way in which alumni can play a part in the implementation of universal access programs is through directed giving in support of such programs. Given the level of interest and support in the community for programs of this type, and the perception that they serve students in a direct way, universal access programs constitute a good opportunity for institutions to solicit funds from new sources.

The synergy of technology and curricular reform

One can legitimately ask the question: "Which comes first — curricular reform or technology?" Should curriculum determine the application and choice of technology or is it the other way around? Based on our experience to date, we believe that the two can, and must, proceed simultaneously. The best strategy for implementing universal access programs consists of a combination of "field of dreams" approaches in which creating technological resources spawns innovative ways of using them, and program-based approaches that define educational objectives that analyze what technology needs to be in place to achieve them.

In an ideal world, technology might be viewed as only a means to an end, but in the real world, the acquisition of computers, and especially access by all students, can help drive change in an institution (the versatility of the computer as a tool certainly adds to this dynamic). We believe there is a synergy between the computer and the curriculum, especially when all students have access to their own personal computer. At the same time, the results will be directly proportional to the time, energy and resources devoted to curricular innovation. In this sense, the universal access strategy is a means to an end — a catalytic device to energize instructional reform.

IMPLEMENTATION APPROACHES

Various approaches to implementing a universal access program have been tried by members of the task group. This sections summarizes some of those approaches. Given the relatively few institutions that so far have implemented universal access, much remains to be learned. Nonetheless, we hope these observations can assist others who may be considering implementation of a universal access plan.

Phasing

When initially implementing a universal access program, institutions typically have selected one of two approaches. Either, as in the case of University of Minnesota at Crookston, they have elected to bring all students on board at the same time or, as in the case of Sonoma State University and Wake Forest University, they have opted to start with incoming freshmen and phase the program in gradually as additional classes enter the university. Both approaches have some merits and some failings.

Specifically, implementing the requirement for all students at the same time creates a homogenous environment in which faculty can count on all students having the same capability. This approach enables a much faster introduction of advanced instructional techniques that rely on universal access and ensures there are no "haves and have-nots" after the introduction of the program. This approach, however, also presents current students with a change in the "rules of the game" after they already are enrolled in the university and therefore might be seen as a breach of the implicit contract they entered into with the university.

From a practical viewpoint, one-step implementation also means that in the initial year of the program, demand for support resources and other facilities may be four times higher than they ever will be again. Designing for such peaks may be expensive.

Conversely, phasing in implementation permits support resources and infrastructure to be gradually increased over a four-year period and ensures that no student feels the institution has broken commitments made at the time of enrollment. The downside of a phased implementation is that during the initial years, the combination of students with and without computers makes it difficult to plan effective instructional programs that make optimal use of the technology.

Models

To date, universal access programs fit into one of three appoaches or models:

> **ASSURED ACCESS MODEL AT SONOMA STATE UNIVERSITY**
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> The textbook model is used at Sonoma State University, where the program is called an "assured access" requirement, as opposed to a mandatory purchase requirement, even though, in practice, most students choose to purchase their own computers. Just as with textbooks, this model recognizes that while instructors can expect students to have access to required textbooks, they cannot enforce the recommendation. It is up to the student to decide how he or she wishes to meet the textbook requirement (e.g., by borrowing a friend's book, buying a used book, or checking a book out from the library).
>
> By analogy, students may purchase their computer, share a computer with their housemates, use a computer belonging to their parents, or otherwise meet the access requirement without necessarily having to buy a computer. The expectation for computer access is set by faculty in the context of their courses, and there is no "computer police" to monitor compliance with the requirement.

Textbook model. In this model, the computer purchase is treated like a textbook purchase. The institution or instructor makes a recommendation, but it is up to the student to make the business decisions associated with the purchase, i.e., exactly what to obtain, where to buy it and even whether to buy it. This model, however, offers students the greatest degree of flexibility. It resolves any issues associated with mandated purchases yet may create a heterogeneous technological environment that can cause major support problems.

Department-oriented, multi-level model. In this model, computer configurations and models are based on departmental requirements rather than institutional ones. Not all departments may require the use of a computer at the outset of the program. Cal Poly San Luis Obispo uses this approach. While such approaches may represent a pragmatic compromise between student-based funding approaches and traditional lab models, we believe they do not constitute true universal access since they do not fundamentally change the educational infrastructure of an entire institution.

While a department-based approach can result in a very good fit between recommended systems and their applications, it also may eliminate the possibility of interdisciplinary synergy and increase the cost of support. It also ignores the importance of general education as a forum for innovative learning models.

Single vendor/machine model. This model involves the institution making a commitment to a single vendor and a single model of computer, requiring all students to have the same machine. This model is currently in use at the University of Minnesota at Crookston. The operational advantages of this approach are obvious — having a single machine greatly reduces support costs and facilitates the kinds of synergy the other approaches fail to do. This approach can be expected to raise issues surrounding the freedom of students and faculty to choose the optimal computing resource for their work and does not recognize that some discipli .s may need different computing resources. It can be argued, however, that we do not let students select their textbooks, so why should we allow them to choose their computer? One other limitation of this model is that it does not accommodate the student who already owns a machine that provides equivalent functions to the mandated model. While this might appear to be a significant problem, the University of Minnesota at Crookston reports remarkably little student or parental resistance on this issue.

Infrastructure requirements. In order to realize the full benefits of a universal student access program, significant enhancements to an institution's infrastructure almost certainly will be needed. The following areas likely will have to be addressed.

- Expanded network capacity
- Extension of the network to all buildings and classrooms
- Provision of network connections in convenient student locations (e.g., library, student union)
- Addition of dial-in ports for remote access
- Enhancement of e-mail, file-serving and other centralized services
- Development of net 'orked classrooms that can accommodate students' computers
- Provision of printing facilities and definition of how printing will be funded
- Creation of a software library
- Determination of the supported operating system(s)
- Determination of a standard application suite
- Implementation of a virus protection scheme
- Enhancement of network security to reflect the greater possibilities of hacking from student-owned machines.

Infrastructure development is likely to be significant in networks, classrooms, software, support, training, administration and information resources.

SINGLE VENDOR/MACHINE MODEL AT UM — CROOKSTON

Because all students use the same make and model of machine at UMC, the university is able to provide comprehensive maintenance and support for the notebook computers. Students have access to a help-desk to solve both mechanical and educational problems they may need help with. The university is an authorized service center for IBM, which means students are not burdened with warranty processing or repairs.

Students also serve an important support function at UMC. According to Bruce Brorson, senior technology associate at UMC, since universal access has been implemented, "There has been a dramatic change in the teaching and learning environment. Students are taking more responsibility for their learning, and they also help each other." UMC Chancellor Donald Sargeant noted that through universal access, "learning is individualized and accessible, communication is much higher, and students are communicating in different ways."

Network. Given the importance of networking to the universal access strategy, this is an area that usually needs much work. As well as extending the network to reach all academic building and classrooms on campus, institutions also have committed to provide at least one Ethernet connection per bed in every residential unit. A closely related provision is the development of "docking stations" that permit students to connect to the network from campus locations. Specific locations vary, but popular sites are libraries, student centers, departmental lounges and other spaces where students typically congregate or study.

> **DOCKING STATIONS**
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> While specifications of docking stations vary widely, Sonoma State University has developed a taxonomy of different levels of functions. These levels are classified as:
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> - Level 1: a 10BaseT Ethernet jack, with an associated easily-accessible power outlet
> - Level 2: same as level 1, but with either an attached printer or a cluster printer associated with a set of level 1 docking stations
> - Level 3: same as level 2, but with the addition of CD-ROM, scanner, large color monitor or other specialized peripherals. Unlike levels 1 and 2, these docking stations are machine- and model-specific, although, to the degree this is feasible, they are constructed to work with as many laptops as possible.

In networking, the issue of dial-up connections comes up. One of the first implications of extensive student ownership of computers is that demand for dial-up services skyrockets. This demand is for high-speed network connections through such protocols as PPP, rather than for traditional low-speed asynchronous connections. Dial-up services can be a black hole into which the institution invests significant funds without ever creating adequate levels of service. For this reason, a number of institutions are looking for ways to "outsource" this problem, i.e., develop partnerships with telecommunications vendors, on-line services and network access providers. California State University has entered into an agreement with Sprint to provide dial-up network services; other institutions are taking similar action. As a result of these activities, effective models will be developed that can address this area in the near future.

Printing. The other perpetual challenge to campus computing organizations is how to manage and charge for student printing. In general, moving from a lab model to a student-ownership model does not significantly alter the volume of printing. It does, however, distribute machines more widely, presenting more opportunities for technical incompatibility with printers. The advent of high-quality, low-cost portable printers suggests this may be a short-term problem, since student ownership of computers makes it much more likely that students will also purchase printers and cease to use campus-based facilities.

Labs/classrooms. While there is no longer a need for traditional computer labs once every student has his or her own computer, computer labs will survive in at least two highly modified forms. Computerless labs serve as places where students can bring their computers and work collaboratively. Computer classrooms accommodate computers in lecture halls. In both cases, the physical infrastructure must include such items as:

- Power outlets and networking jacks
- Different sizes and shapes of desks
- Projection facilities.

The other form in which labs will survive is as high-end specialized facilities serving particular disciplines. Indications are that however much the price of computers drops, there always will be a new class of machine that remains out of the economic reach of the average student and yet provides some special capability that particular disciplines require.

Software library. Just as there always will be computers that are costlier than a student can be expected to afford, there also will be software packages that the institution cannot expect the student to purchase. In general, software can be divided into two categories: the generic packages that every student is expected to have and those discipline-specific packages that may be needed only for a particular course. Unless the cost of these specialized packages is low, it seems appropriate for institutions to buy such software to make available to students who need temporary access.

Course catalog with software/RAM/textbook requirements. As more and more courses require the use of computers, the schedule of classes or the course catalog of the future will contain not only the course information, but also details of software and equipment requirements. In this way, unless the institution has selected a single model for all student machines, students will be able to predict the technical requirements of courses they plan to take and plan accordingly. The University of Minnesota at Crookston already includes information about technology use for each of its courses in the university catalog.

Training. A prerequisite to implementing universal student access successfully is the provision of training for faculty, staff and students. In most cases, training is provided to each group independently. For example, if the expectation is that faculty will use technology in classes, faculty training may need to precede student access to machines. Note that faculty training often goes well beyond hardware/software use to include pedagogy and learning theory. Institutional models for student training range from those in which all students are required to take an information competency course, to those in which all technology instruction is integrated into other areas of the curriculum. An institutional policy should be established for several variables, such as whether student training is mandatory or voluntary, credit-bearing or not-for-credit and the topics included.

TRAINING AT SONOMA STATE UNIVERSITY

One of the greatest challenges associated with implementing the assured access strategy at Sonoma State University (SSU) was to ensure that all the incoming freshmen would learn to use the technology effectively during their first year at the university. The Freshman Seminar course presented an opportunity to integrate use of technology into the students' overall introduction to university resources. Additionally, the library offered credit-bearing courses in information competency within broad discipline areas, such as business, or natural sciences. Finally, and perhaps most importantly, many faculty teaching courses aimed primarily at freshmen made an effort to integrate the use of technology into their classes, and to work with their students to ensure that they knew how to use the required technical resources.

SSU thus has leaned toward an approach that stresses integration of information technology training into the broader curriculum, rather than demanding that all students take a particular course in this area.

Support mechanisms. Few campuses indicate their current support for technology is adequate. Universal student access will increase demands for support, both from faculty and students. Support functions needed range from a help desk to training for faculty and students to classroom assistance or repairs. To maximize the value of the infrastructure and information available, an adequate support structure must be in place.

Administrative systems. As technology penetrates the curriculum, there is likely to be pressure to re-engineer administrative systems as well. Students may be provided with electronic access to course catalogs, schedules, their own academic or financial records, etc.

Information resources. The success of universal student access is contingent on having access to valuable sources of information. Among those sources, an institution might consider library access, access to the Internet and World Wide Web, access to administrative systems, e-mail, course syllabi, class notes, etc.

Computers and networks are the tools that allow faculty and students to gain access to worldwide sources of information and expertise. Students who have access to primary sources (real data) will be better prepared as professionals. Helping individuals find valuable sources of information is an important support function. Access to information also implies sharing of resources within and among institutions.

Policy issues

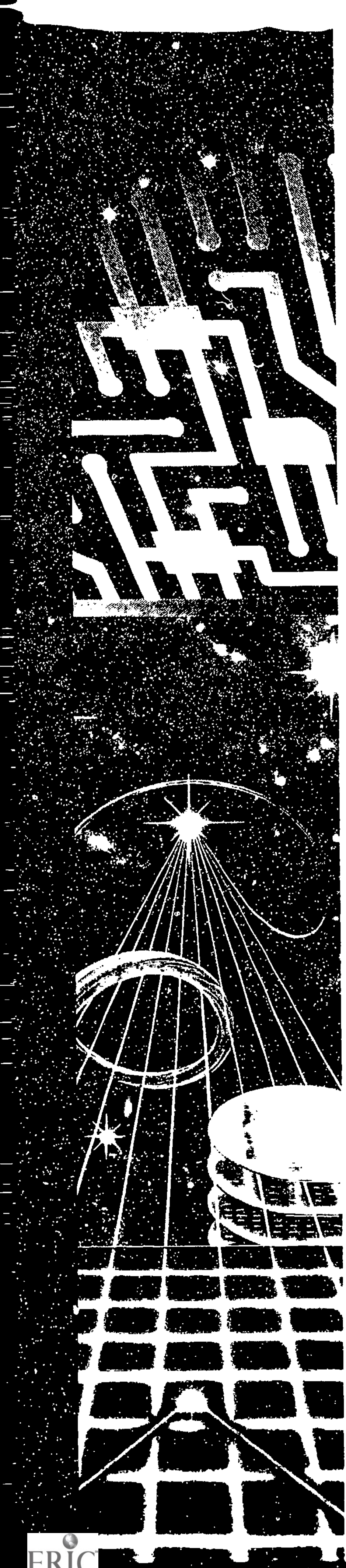
Institutions must develop and establish clear policy statements regarding universal student access. The policies that need to be considered are:

- Theft
- Insurance
- Replacement machines
- Costs for repair, replacement

- Eligibility for loan machines
- Inventory control
- Drop outs; non-payment

Part-time students

Part-time students represent a particular challenge for universal access programs. With needs just as great as those of full-time students, their overall financial investment in their education is less. Thus the information technology component may represent an unacceptably high proportion of the total cost. The problem is especially acute in the community college sector, where the majority of students may be part-time. While no definitive solutions have been iden‘ified, it appears that some form of voluntary purchase incentives (rather than a requirement), coupled with a loan or check-out program, is acceptable. At the University of Minnesota at Crookston, many part-time students elect to pay the full fee so they can have a computer full time.



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