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ABSTRACT

With the advent of the computer revolution, major changes are underway in the ways campuses deal with computing and computers. One change is the gathering momentum of faculty members and administrators to become computer users. Another is the vast amount of individual and institutional effort invested in plans for integrating computing into the curriculum. Implementation issues that have presented problems for many institutions unwilling to learn from the experience of others are concerned with specific computer usage, faculty training, appropriate software, maintenance of equipment, cost effectiveness, and the actual process of integration. Today's campus leaders need to look at general classes of computing applications, such as their use for academic research, their role in instruction, and their ability to enhance productivity for faculty, staff, and students, and to integrate computing into the curriculum in ways that recognize all three of these dimensions and their interdependence. Although other issues such as computer equity, standardization, and industry support of campus development activities need to be addressed, it would be unwise for colleges to wait around for "ultimate answers." They would be better off pursuing an alternative that puts in place now broadly useful, affordable machines chosen for their ability to do identified work. Both campuses and the information-technology industry share the common goal of expanding the use of computing technology. To do this, all parties should acknowledge the cultural gap between academe and industry and listen to each other. (DJR)

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Inside this Issue:

Computers have moved into education in the same way that they have entered other areas: sometimes in small numbers so that they were hardly noticed, sometimes like a small army taking over an unprepared terrain. Colleges and universities have responded variously to the challenge of making the computer available to faculty and students. Some have let matters drift until the situation got out of hand and then have installed a central authority to gain the proper control; others have moved so warily that they found themselves far behind the state of the art. In this issue, an article by two observers examines some of the current problems that arise in bringing computing to higher education. Complementing, and sometimes contrasting with, the feature article, are commentaries by faculty and administrators at Harvard

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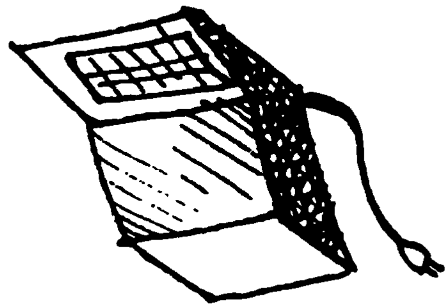


New computing in higher education

by Steven W. Gilbert and Kenneth C. Green

There is a "new computing" in higher education, dramatically different from educational computing of the past. The growing availability of computers is quickly approaching critical mass. This time, there's not one "revolution" but several afoot, presenting institutions and vendors with a new set of choices.

Between Fall 1982 and 1984, the proportion of entering college freshmen reporting that they "frequently" or "occasionally" wrote a computer program increased 85 percent, from 27.3 percent to 50.6 percent. This past fall, three of every five entering freshmen reported completing at least a half year of "computer science" in high school (Fig. 1). And almost a fourth of them report they used a personal computer "frequently" during the year prior to entering college (Fig. 2).

Are changes in college computing comparable? Are campuses and faculty prepared to build on the familiarity of these students with computers?

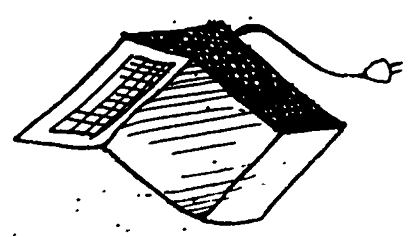
The preparation does seem underway. Data from a recently completed Higher Education Utilization Study (HEUS) suggest that some 300,000 microcomputers were in use in American colleges by 1985; other estimates put the number at 530,000. The HEUS report states that "about two-thirds of all colleges and universities were providing financial assistance (discount prices, loans, grants, group purchases) to students and/or faculty in buying computer hardware."

There may be uncertainty about the numbers, but not about the fact that major changes are underway in the ways campuses deal with computing and computers.

A gathering momentum

Thousands of faculty members and administrators have decided that 1986 is the year they will have a personal relationship with computing. Like their predecessors, most academics now getting started on computing are professionals who haven't been computer users before and who will never think of themselves as computer experts. What they realize is that they are embarking on a journey they can no longer delay.

Several forces drive this quest. Many academics are tired of being intimidated by an expertise they haven't till now understood nor been able to share with their professional associates, students, or even their school-aged children. They envy colleagues who report great (often undefined) "productivity gains." A few eye the developing market for academic software as a potential source of personal wealth. Still others will invest their time and money because they sense that the very nature of computing has finally changed, that the hardware and software of the late 1980's just might help them as educators realize the unfulfilled aspirations for the technology—for computing in the teaching-learning process.



For faculties as a whole and their academic leaders, the "microcomputer revolution" comes with forces that are hard to resist. The cost of the technology has declined dramatically: students routinely use (and many own) desktop systems more powerful than the most costly mainframe systems of the 1960s and early 1970s. Dramatic changes in the design of software—away from complex, mathematical programming languages to problem-oriented application programs—have made computers more accessible and attractive. Then there is the increasing access to computing in elementary and secondary schools, which means that many students arrive more "computer competent" than some of the professors they meet in the classrooms.

External forces decidedly affect this quest. Campuses can hardly ignore public concerns about issues of "educational quality," and the fact that computing technology, in the public mind, is viewed as a component of such quality, of how "up to date" a college is (although the public has scant evidence for such views). State authorities view the presence of technology on campus as an important aspect of higher education's ability to promote economic development and attract new industry. At an extreme, perhaps, there is a growing public concern that collegiate programs may be engaged in a kind of "educational malpractice" if their graduates are not prepared in certain software applications (e.g., word processing, spreadsheets, data base, graphics, and communications).

Implementation Issues

It is not surprising that, according to the HEUS study, "in 1984-85, about two-thirds of all institutions had a task force, study group, or individual administrator designated to look into the best uses and necessary technical facilities for use of audio, video, and computers for instructional purposes." Already, over the past four years, dozens of campuses have announced plans to "integrate" computing into the undergraduate curriculum. On hundreds more, budget committees have wrestled with ways to come up with the resources to provide "sufficient" computer access for students and faculty. We conservatively estimate that 300 institutions now have special "purchase agreements" that allow campuses to resell computers to students, faculty, and staff at a substantial discount. All the while, too, hardware manufacturers, software houses, even textbook publishers are assessing the viability of (and potential profits in) the higher education market for curriculum-oriented software.

In short, the "new computing" revolution in higher education would appear to be healthy and vibrant.

But is it? What will the educational consequences be of all this individual effort and institutional investment? Like many in the academic community, we have great hopes for and see great benefits from the "microcomputer revolution." Colleges may indeed be on the verge of realizing the much-discussed, long-awaited potential use of the computer to improve both instruction and learning (qualitatively different activities). Yet we also share the sentiment expressed by Harvard's Derek Bok in his 1983-84 president's report, that "experience should make us wary of dramatic claims for the impact of a new technology."

At a handful of pioneering institutions—generally elite, technologically sophisticated campuses such as Brown, Carnegie Mellon, Dartmouth, Delaware, Drexel, Stevens, Michigan, MIT, Stanford and others—implementation experiments are under way that should yield useful models for the decisions confronting more conventional (and less affluent) campuses.

Overall, however, we've seen more activity generated than answers. Across a broad spectrum of colleges, computing tends to be proposed as a "solution" to a broad array of ill-defined administrative and curricular "problems." Discussions about what kind of computing equipment campuses should buy tend to overshadow more important questions of what campuses should do with the equipment once it arrives. Feeling pressures to do something about the "computer revolution," campuses struggle to make important, costly, and long-term decisions about what are still immature technologies driven by great hopes.

Campus efforts to acquire and integrate technology raise complex issues at the heart of academic life. These efforts also involve significant costs. Given limited resources, most campuses opt for one-time, risk-aversive decisions—in part because they have no way to amortize the costs of these decisions over the appropriate time periods.

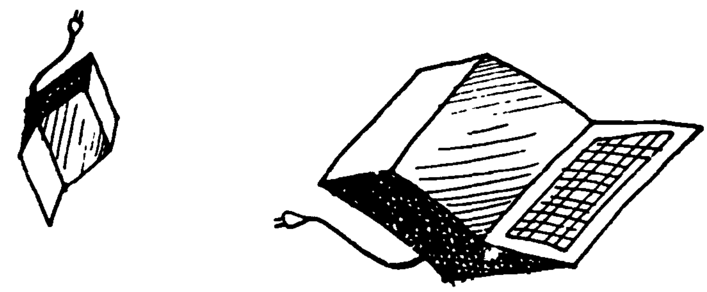
Unfortunately, many institutions seem destined—indeed willing—to repeat the mistakes made by "pioneers." The universities cited above and others that have attempted to promote campus use of new technology typically experience several "stages" in their implementation efforts:

1) Providing initial access to technology (terminals, microcomputers, "workstations") for students and faculty.

2) Providing training for the faculty.

3) Providing general utility (or generic) software for all.

4) Providing instructional soft-



ware to meet individual faculty needs.

5) Providing related support services.

These institutions passed through these (often overlapping) stages in about the same sequence. One would have expected that their experience would help next cohorts to anticipate potential problems. Unfortunately, that's seldom been the case. Insisting that their situation is unique ("This campus is so different"), they go it alone, spinning their wheels over what we label the "seven key implementation questions":

1) What do we do with the computers the day after the delivery truck leaves?

2) What do we do with the faculty after the introductory workshops are over?

3) What do we do when everyone requests (indeed demands) expensive commercial utility software (such as word processing, spreadsheets, graphics, and data base applications)?

4) What do we do when the faculty request (indeed demand) "good" software for all sorts of instructional purposes?

5) What do we do when we can't find, evaluate, or (even) afford the staff necessary to answer these questions, maintain our equipment, and help people use the software?

6) How do we decide how much to spend on academic computing?

7) And how do we "integrate computing into the curriculum"?

Computer implementation issues have become more complicated because the number of parties with a stake in the outcome rises dramatically with expanding access to microcomputers. In an era when the computer implementation issue involved mainframe systems, the computer center director and allied computer scientists (the much maligned "computer priesthood") dominated campus policy discussions. However, the growing availability of microcomputers creates a new type of expertise, one that is much more sensitive to differences within and across academic disciplines. On many campuses hundreds of faculty members with every

Discussions about what kind of computing equipment campuses should buy tend to overshadow more important questions of what campuses should do with the equipment once it arrives.

variety of discipline and machine allegiance now demand a role in campus decisions about computing. This shift in expertise has had important consequences: at a small, but influential number of campuses, the computer priests (*anointed* by their technological expertise) are being replaced (or at least supervised by) politically sensitive computing "czars" (*appointed* by administrative authorities). The czar's authority stems from an ability to manage implementation and academic politics as well as his or her technological skills. (For a provocative discussion of this and related ideas, see "Priesthood and Pedagogy: Examining Presuppositions," by Naomi S. Baron, *EDUCOM Bulletin*, Winter 1985, Vol. 20 No. 4, pp. 13-16).

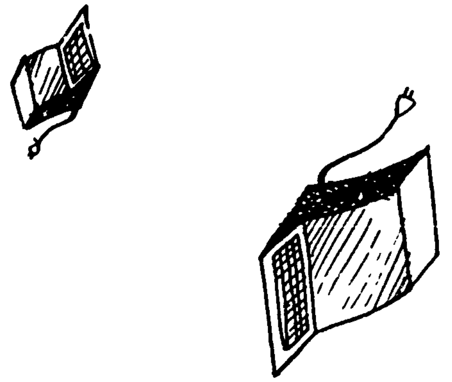
How does an institution new to the "computer revolution" sort out "key implementation steps"? The solution may be to see "the revolution" not as a single phenomenon but as several potential revolutions.

A choice of revolutions

Most people never noticed an "electricity revolution." What they experienced, as electricity and the products it powered became available, were several different "revolutions"—a lighting revolution, cooking and refrigeration revolutions, and so on. The analogy applies to computing, and it makes sense for campus leaders to look at general classes of computing applications rather than to regard "computing" as a single phenomenon.

What are those "general classes"? In higher education, we believe there are three. First, computers are critical tools in academic research (particularly mathematical modeling and statistical analysis); they assist in the acquisition and generation of information. Second, and this has been a dream for computing for at least twenty-five years, they have a role in instruction, in class and out, to help people learn. Third, there is their role in enhancing personal productivity, both of faculty and staff in their professional work and of students in their academic work and subsequent careers (see Figure).

Just to recite these categories should make it clear the campus computing experience over the last twenty years is relevant to today's decisions (a point that often escapes the new converts), yet, some models inherited from the mainframe era are no longer useful. For example, over the last twenty years, educators who thought about computers thought first about instruction and information, and last, if at all, about



productivity . . . and they thought about these functions as discrete activities. Links across the three dimensions were seldom considered (e.g., using the computer as a research tool to support instruction). Productivity (primarily word processing, telecommunications, and graphics) wasn't an issue because the earlier technology made such applications cumbersome and expensive.

The conceptual model we propose is dynamic: the components continually change character to reflect changes in the underlying technology. For example, while the "information" dimension traditionally involved the generation of new knowledge, today's technology adds the component of affordable, local access to information via data banks and communications networks, access that can aid student learning and personal productivity. The trick for campuses in coming years, then, will be to integrate computing into the curriculum in ways that recognize all three dimensions and their interdependence, especially when it comes to the support of instruction and student learning (see Figure).

Costs and benefits

The problem with the usual cost-benefit approach is that it doesn't work when applied to today's campus computing. Far from being constant, the costs change rapidly, even plummet; the benefits are extremely hard to measu or even explain. Even so, the revolution marches on, constantly rewriting its own cost-benefit equations. It does so by making available newer, ever more-valued applications, and by changing the cost of the revolution itself.

Computing costs are low enough, and if the benefits are easy enough to observe, then expensive, elaborate evaluations become unnecessary for fundamental campus policy decisions. By the same token, if the potential cost of a single application of the technology is so low, and the benefit of that application is so great, formal evaluation may be unnecessary. The "new computing" in higher education presents both conditions: it offers potentially low costs and broad benefits, as well as one essential application available at a potentially acceptable price. These are unusual conditions—and they create unusual mandates for institutional action.

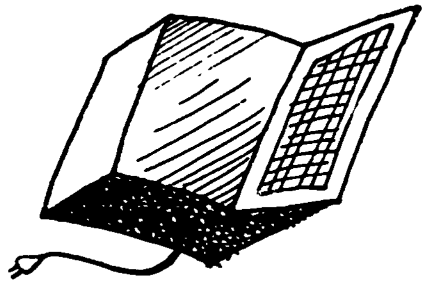
As the cost of machines continues to decline, word processing alone will soon justify computing capability for every student, faculty member, and most administrators.

Word processing

Word processing has extraordinary significance for higher education. The faculty member who becomes a proficient, comfortable writer on word processing equipment is usually willing to fight to maintain his or her access to it. Word processing helps faculty capture their most important resource—time. Just as corporate executives found that spreadsheets reduced the burden of computational tasks and let managers focus on the analytical issues in financial planning, budgeting, and forecasting, so those who write have found in word processing the tool they need to focus on the tasks of written expression rather than on the details of getting papers typed, corrected, and retyped again. (Think how many times you decided against making "one more" improvement in a paper because it wasn't "fair" (or affordable) to ask a typist to redo it "one last" time). Moreover, personal word processing provides faculty members with control over the details and final appearance of papers—something they felt they could never do when academic articles were produced via typewriters.

How useful is this tool? When word processing was added to the options on UCLA's mainframe some six years ago, faculty use of the computer for text processing in many departments quickly approached (and in some instances exceeded) the volume of "traditional" computing activity (e.g., research). Prior to the introduction of personal computers at Carnegie Mellon University, nearly three-fourths of all students used CMU's computer systems for word processing. Similar stories are told at other campuses. Few academic writers who are comfortable with a keyboard (a critical antecedent condition) would willingly give up the new technology once they have been introduced to it; word processing becomes flagrantly valuable to them.

Moreover, for many users, word processing provides an introduction to productivity tools. Experience, then mastery, encourages further exploration. Students, faculty, and administrators may then venture into other software applications (such as graphics, spreadsheets, and communications). The machines they acquired as writing tools assume additional tasks—at no significant cost increase.



Allocating Costs

The time will come when the costs of personal computers with word processing software will be so inexpensive that the acquisition of a personal computing system can be justified by the word processing power alone. Widespread access to computing in general will then become a reality throughout higher education. When that day arrives (networking costs aside), it will no longer be necessary to allocate any hardware costs for non-word processing uses of the same equipment. The allocation of costs across different uses of the same personal computer is always somewhat arbitrary, and becomes more so as the price goes down and the variety of uses goes up—trends that continue to accelerate As users become more devoted to word processing, it becomes reasonable to assign a major portion of system costs (as "sunk costs") toward processing alone and assign very small marginal costs to other applications run on the same equipment. This reduces the cost-benefit justification burden substantially for those other applications.

How, then, will campuses finance the new computing? They will find ways to capitalize computing costs across the institution (or to pass them through to students through tuition and/or special fees) rather than attempting to allocate them to "cost centers" (such as individual departments) that do not have budgets for academic computing. Alternatively, declining equipment costs will soon mean that individual departments can purchase their own computers, perhaps through tradeoffs from within their own budgets (e.g., forego travel money for one year to pay for a computer lab).

If our approach makes sense, then discussions about the ability of word processing to improve student writing, for example, become an ancillary issue. Yes, it is nice to agree that word processing does improve student (or faculty) writing. But formal evaluation to "prove" how much student writing improves isn't key to the underlying question: is providing access to word processing for all students really "worth it"? That question hinges as much on the cost of providing the access as it does on its effects—and the effects may be more difficult and costly to measure than is warranted by the declining costs of providing the service.

At some point, the number of individuals willing to spend their own money for a service is enough

If computing becomes inexpensive enough and/or assumes a basic academic role, it must be treated like the campus library—as essential.

of a measure of its value; that point is approaching very rapidly for word processing. Then the issue becomes political: who should bear the cost of providing the same service to how many others who cannot afford to provide it for themselves? There are real costs and benefits for moving quickly, and real savings and penalties for waiting. But fast movement involves accepting new kinds of costs as well as redefining the notion of campus responsibility for student access to computing. If computing becomes inexpensive enough and/or assumes a role that is essential for participation in the academic life of the college, it must be treated like the campus library—as an essential resource. Under these circumstances, the institutional obligation is clear (if not easily achievable): campuses must provide access to word processing for all—and access for other purposes then becomes extremely inexpensive.

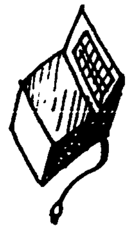
Curriculum Issues

For twenty years, innovators explored scientific and engineering applications, and statistical analysis moved to a new level of sophistication, but this work generally represented no major breakthrough of application or in computer access by new users.

A small, dedicated cadre has been working toward a dream of better instruction. Systems such as PLATO from Control Data and TICCIT provided advanced models of instructional software created by teams of skilled curriculum designers, discipline specialists, and programmers working on large mainframe systems. These resource-intensive (and expensive) instructional systems proved operational but impractical (for most campuses in the 1960s and 1970s) as an instructional solution.

We still do not have a broad body of cost-effective, curriculum-oriented software for higher education. Most K-12 software is only useful for remediation work at the postsecondary level. The instructional software expectations on college campuses are qualitatively different from those of elementary and secondary education—and remain largely unmet.

Just as there are three categories of computing applications in higher education (instruction, information, and productivity), so too are there three distinct types of curricular or instructional software: commercial utility or general applications software, derivative



applications (generally templates that work with commercial utility or general applications products), and purely instructional software. Note that two of these three categories—commercial software and derivative applications—are new dimensions in educational computing, not readily available in the 1960s.

The HEUS report tells us that ". . . instructional use of general-purpose applications software was reported by substantially greater numbers of schools as the fastest growing student and faculty use of computers than was hands-on use in learning about computers. Perhaps even more notable is the fact that only about 10 percent of the institutions named programmed exercises/tutorials as the fastest growing student use."

This finding reflects a real shift of focus in instructional technology. As recently as five years ago the discussion still emphasized large-system technologies and instructional software that was not much more sophisticated—from a design perspective—than that envisioned in the 1960s. The few commercial products that found their way onto campuses (onto mainframe computers) were technical products—programming languages, mathematical modeling packages, and statistical or financial analysis tools. Derivative applications (or "templates") were generally unknown.

The movement to desktop systems has created entirely new demands for "academic software" or, more generally, for software useful in regular courses. The use base demanding such products continues to grow; institutional, department, faculty, and vendor interest is strong. Indeed, one of the most common information requests at EDUCOM over the past three years has come from faculty asking "for a list of good instructional software for my machine, in my discipline, and information about how I can obtain it quickly and inexpensively." (The new EDUCOM Software Initiative will address some of those issues.)

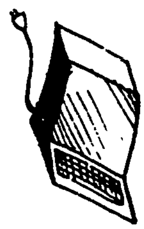
Higher education has a computer equity problem: access to computing resources is severely restricted among students at less affluent institutions.

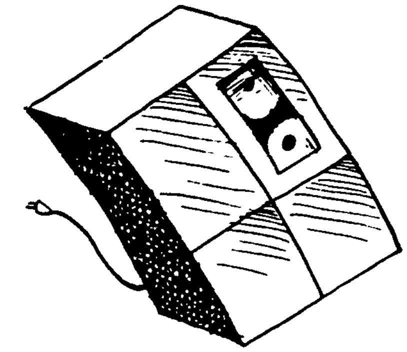
Despite rising demand, we sense that really good, really accessible specially tailored curricular-oriented software is still a faraway dream. The most often cited development model is textbooks, but the publishing industry is standing back from software development for the campus market, at least for now; major publishers experimented in that market during the past five year and got "burned" in the process. Several now sell disks along with standard textbooks; some are experimenting with site-licensing agreements; still others offer combinations of introductory workbooks with limited-function versions of popular commercial software products.

Book publishers, software developers, and individual faculty—the three most likely sources of curricular software—all confront strong disincentives to invest time and resources in academic software development. Publishers and developers are not convinced they can recover their investment, given both the half-life of software and the potential risks of software piracy on campus. Faculty know that promotion and tenure requirements reward the hour invested in scholarly research (or, on some campuses, straight instruction) over any time invested in writing instructional programs or developing templates.

By default, much if not most of the current support for academic software comes from computer manufacturers. They recognize the importance of software as a critical factor affecting efforts to sell their products to campus users. The larger vendors—Apple, AT&T, Burroughs, Control Data, Data General, Digital Equipment, Epson, Hewlett-Packard, IBM, Prime, Texas Instruments, Tandy and others—pursue a variety of approaches. A common one entails equipment grants (and/or cash support) that provide incentives to faculty to create templates or develop software addressed to curricular (i.e., instructional) needs in individual disciplines. An interesting exception to this curriculum-support strategy is Zenith; recognizing that access to commercial software may be more important than the development of new instructional software, Zenith's proposals to campuses often include a software collection of key generic products.

Beyond software development, several companies recognize the need for "courseware" dissemination as a second phase of their efforts. IBM





and Carnegie Mellon have worked together in a four-year partnership to develop hardware and software products specifically for the campus environment. IBM has also worked with the University of North Carolina to offer a series of seminars and the beginning of an effort to disseminate campus-developed software for the IBM PC. Earlier this year Apple announced an arrangement with Kinko's Graphics to distribute faculty-developed, Macintosh-oriented curriculum tools. Digital Equipment Corporation has provided support for Iowa State University to develop a distribution system for computer-based education software for its VAX line of computers.

Under present conditions, however, we suspect that the long-pursued goal of wide use of "good" instructional software will not be realized. We hope conditions will soon change, but barriers to implementation and institutionalization of instructional applications of computing that were identified in the early 1970s by Ernest Anastasio writing in the *EDUCOM Bulletin* still remain (see Figure 3). Development costs are too high, the returns too uncertain. As things stand now, only a small number of faculty members, publishers, and commercial software developers will be in the game of producing products for campus instruction.

What will happen in the near future, we suspect, is more of what is happening now: faculty will adapt commercial software products for use in the classroom, to assist instruction but not to replace it (see recent research on faculty preferences by Ray Lewis). We can expect, too, lots of derivative applications, like spreadsheet templates. Indeed, the latter are already common in engineering and business programs, and are slowly appearing in other disciplines as well. To busy faculty, relatively "easy" instructional opportunities seem apparent in commercial software and templates; the development of widely accessible more sophisticated highly interactive learning systems may have to wait for another day—when important obstacles have been overcome.

To draw an analogy between the automobile industry and the computer industry, the computer industry may not yet have passed beyond the stage of the Ford Model T.

While the instructional dream of widespread availability of a range of superb material tailored to student self-directed learning has not yet been realized, advancing technology has added a new dimension. Given the increasing availability and use of productivity software, the development of instructional applications built on commercial productivity products can provide students with "real world" skills as a by-product of a particular course—one that outlives the "half-life" of the course content, which is all too often through the end of the course or the final exam.

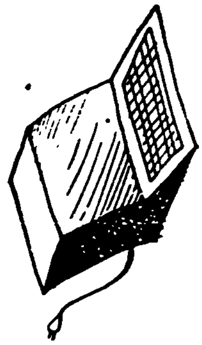
Industry Relationships

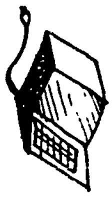
The new computing forever changed the way the information industry deals with campuses. Gone are the days when a vendor's contacts were limited to a small cadre of elite users. Gone, too, are the days when only prestigious research universities could obtain free or deeply discounted equipment from manufacturers.

Vendors recognize that the new computing increases the strategic importance of the campus market. No longer do institutions purchase only one (large system) computer; now even an "obscure" campus may purchase hundreds or even thousands of units in a given year. Colleges, unlike computer stores or corporations, have an annual supply of potential new purchasers in their successive cohorts of entering students. Campus markets are stable compared to the volatile retail market, the mysterious home market, and the ebb and flow of corporate sales.

Certain universities have always been strategic targets for the nation's computer companies. Campuses such as Berkeley, Cornell, Delaware, MIT, Michigan, Stanford, and UCLA have had long relationships with companies that design and manufacture computers. Their campus users offer an expertise the industry needs, and an implicit product endorsement important to vendors in their approach of corporate clients (which explains the steady flow of equipment, graduate fellowships, and ancillary support from vendors to these certain institutions and strategic departments). The new computing potentially extends the possibilities for strategic endorsements to lesser-known campuses: product adoption at the "college up the street" can be an important halo for computer sales in smaller cities.

The new computing has changed the shape of industry support for campus development activities. Carnegie Mellon's pioneering 1982 agreement with IBM, for joint product development of a "scholar's workstation," marked a new form of campus-corporate relationship in





support of computing: CMU would assist IBM's development efforts, IBM would own the patents, while CMU would reap tremendous research and computing capacity benefits.

The Apple University Consortium (AUC) program, announced in January 1984, provides another new model for campus-industry partnerships. Whereas the CMU-IBM agreement emphasizes product development, Apple's program focuses on market development.

The AUC arrangement provides a way for students to purchase computers at dramatic discounts, but it is more than this. As Stanford's Michael Carter has pointed out to us, the AUC contract was an historic breakthrough, permitting universities to make a commitment without incurring intimidating legal or financial obligations. The nature of the "contract" recognized the nature of universities and allowed university leaders to decide to participate without feeling overextended. AUC agreements provide incentives, not actual contractual penalties. They are a "good faith" arrangement that recognizes higher education as an important but unique marketplace.

Software development was a secondary goal of the consortium, one supported more by the participating institutions than by Apple. Over time, though, curriculum development at AUC and on other campuses doing business with Apple did lead to "products" that consequently now support Apple's marketing efforts.

Equity Issues

Most people are aware by now of a "computer equity" issue in elementary and secondary education, that low-income students in city school districts haven't the same level and quality of computer access as their counterparts in suburban and private schools.

Higher education has its own computer equity issue, one less recognized but essentially similar to the problem in elementary/secondary education: access to computers and computing. The nation's public and private research universities have always offered more computing resources to their students than could most smaller institutions. However, when computers were primarily a tool for students and faculty in the sciences, the inequities in access, while not trivial, affected smaller populations.

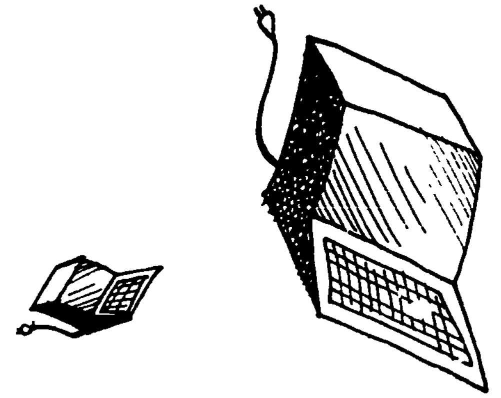
Sometimes a new technology can become useful more quickly and practically through a less-than-perfect implementation at a lesser price.

But the new computing has changed both user demand and user needs. More students from more departments have more—and qualitatively different—uses for computing. Vendor attention (and gifts) generally favor elite private and large public institutions. State and community colleges are often viewed as less important and certainly less wealthy customers. These institutions have fewer institutional resources to allocate to computer purchases; their student profile is also less affluent than that of the private colleges and research universities. The HEUS report confirms the degree to which computing resources are concentrated in larger colleges and universities: some 1,500 institutions—regional public colleges and community colleges, plus historically black colleges and less selective private colleges—report fewer than 50 microcomputers in use on each of their campuses.

Vendor relationships often play a critical role in access to computing, too. Unfortunately, the institutions that serve the largest numbers of students—state colleges and community colleges—often have less freedom to negotiate than their private counterparts or flagship state universities. State regulations can make it difficult for them to enter into resale agreements (selling computers to students) or to develop an ambitious implementation plan in cooperation with only one vendor. Cal State San Luis Obispo made a last-minute decision not to join the Apple University Consortium because state regulations seemed to prohibit the resale agreement. Campus officials sometimes worry that local computer stores will view the institution's resale arrangement as unfair competition. Many public institutions have developed privately chartered bookstore or foundations to coordinate resale arrangements, but the generalization remains that they still have far less autonomy—and leverage—in these situations.

Many smaller campuses confront an antecedent resource problem even before they begin their planning: they simply don't have the human resources to make informed decisions about computers, computing strategies, and vendor negotiations. That threshold problem causes them to delay, make mistakes and miss opportunities—placing their students at increasing disadvantage.

The previous several paragraphs focused on equity issues across campuses. However, there are two



internal dimensions to the equity problem that are too often ignored. The first concerns access to computers across disciplines. As the quest for desktop resources advances, more departments and academic units attempt to initiate individual negotiations with vendors. Departmentally negotiated "gift" agreements began in engineering and computer science programs, soon spread to business programs, and soon will beckon the less computer-intensive disciplines. The vendor interest is obvious: a donated lab to X department means another strategic alliance with a prominent program. But these arrangements impose a territoriality among faculty and students, providing computer access to some solely on the basis of major or degree program, but tending also to provide less access for "pure humanities" students and faculty.

A second internal dimension involves faculty. We hear stories of and have witnessed instances where junior faculty view the personal computer as a "resource equalizer." Confronted with excessive publication demands, often without the student assistance and secretarial support available to older, tenured colleagues, many junior faculty invest their own money in a personal compu to capture productivity gains . .d get control over their writing and research. The senior faculty, in other words, get it for free, the junior faculty out of their own pocket.

Standardization

Increasing the "installed base" of computing systems that can accept a new application will increase the size of its potential market—and its potential profitability. Increasing the installed base of systems suitable for a new instructional application can be achieved by selling mo. e of a certain kind of machine or by getting a variety of machines to work with an agreed-upon operating system and user interface. In other words, sell more computing "workstations" of a certain type or get more of the workstations already being sold to standardize on certain important criteria.

But which criteria? Set by whom? How soon? And who really would benefit?

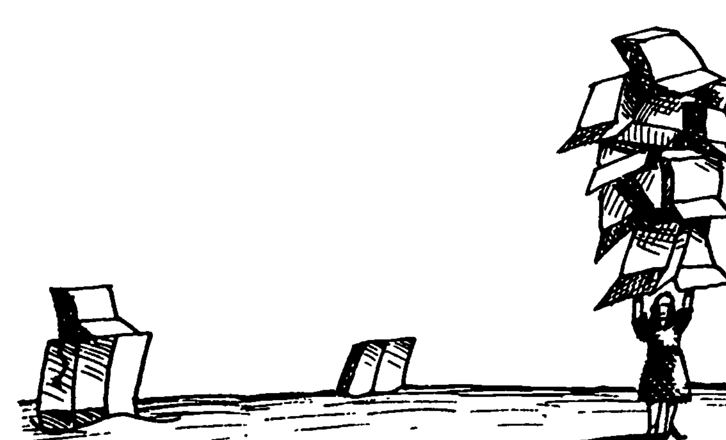
Recent writers have developed analogies between the automobile and the computer to try to discover the proper role for "computer literacy." For our purposes, it may be more useful to draw analogies between the automobile industry and the computer industry.

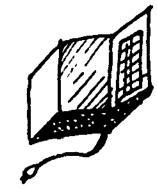
In our view, the computer industry has not yet passed beyond the Ford Model-T stage. Perhaps the Apple II or less expensive IBM PC clones are the industry's Model-T: they offer basic capability at a price affordable by middle-class families. But the Model-T for computing may not have arrived yet! It still seems possible that a major breakthrough in user-interface/operating-system combinations may emerge, and that such a development could give new definition to the "basic model."

Development of a common operating system and a common workstation structure is certainly a goal that, if achieved, would solve many important problems for higher education computing. However, the competitive nature of the industry, the rapid, unpredictable changes characteristic of the technology, and the difficulty of getting a large number of faculties or universities to agree on almost anything (including a desired set of workstation functions), all suggest that standardization of academic workstations will be difficult to achieve at all, let alone in the next year or two.

Nor, perhaps, to follow our logic, should standardization be an immediate goal. A standard set too soon may preclude a next breakthrough. It may be better to focus on an intermediate goal beneficial for large numbers of people than on an ultimate goal that will only change as we approach it.

The relative merits of UNIX as a standard operating system aren't the issues here. (UNIX is an operating system that is widely used on many campus minicomputers and main-





frames. It is "migrating down" to microcomputers and has been proposed as the "standard" for a new—some say next—generation of computers frequently referred to as "scholars' workstations." While UNIX may be an important feature to sophisticated users and programmers, we suspect that most users care more about the quality of word processing software than the features of an operating system.) The majority of microcomputers currently purchased by students, faculty, and institutions—IBM PC and PC-compatibles—are bought in spite of their operating systems. (The Macintosh is a somewhat different situation.) University software developers may endorse UNIX, but consumers are more likely to respond to qualities that provide comfortable usage (such as good word processing) than to characteristics of the underlying operating system.

The market being addressed is extremely varied: the majority of individual students and faculty at the majority of colleges and universities are a long way from wanting or needing a full, high-powered academic workstation that meets the minimum requirements of the (very important) minority of individuals at a minority of institutions who are extending the frontiers of academic computing. Full standardization based on advanced workstations will have to wait; the more immediate implementation issue confronting higher education is to provide access for individuals who are clamoring for "personal productivity" computing at low prices—now.

A pragmatic alternative

Some leading research universities—Brown, Carnegie Mellon, MIT—are now engaged in projects to develop and find effective uses for powerful "academic workstations." Expectations for these machines are high; as Carnegie Mellon's John Crecine described them recently in *Science:*

> The next generation of personal computers will provide the most advanced professional design aids, document and graphics design tools, and knowledge-based systems (artificial intelligence programs, expert systems, and intelligent tutors) for $5,000 to $6,000 . . . . Given their likely price in late 1986 or early 1987—roughly $6,000 but closer to $3,000 with educational or quantity discounts—the new workstations can serve as a vehicle for revolutionizing education (with higher education leading the way), as well as for providing the powerful professional tools needed in engineering, science, and the world of design and commerce.

Undoubtedly, it will be a long time before every faculty member, student and administrator has access to one of these marvelous systems. Meanwhile, even as vendor and campus interests boost the "academic workstation" approach, several studies are underway to assess just what more modest list of features are most important and useful to faculty who are not interested in computer technology for its own sake.

Even if powerful workstations were readily available tomorrow, $3,000 is much too high a price tag to permit their widespread adoption, at least for the next several years. A good (old) used car costs $3,000 now and is not as "accessible" to students as we would like the computer to be (and a car's usefulness at the price is a lot clearer to students than the computer's). By comparison, the $200-700 price range—that for audio or video equipment—seems within reach of most individuals we'd hope to provide with computing power (and assuming we provide adequate functionalities in return for such fees).

It is risky to predict price ranges that will result in universal sales for a product when its demonstrable benefits and the situations under which its use would be essential are not yet established. But we claim that any amount greater than $1,000 per system precludes universal access (let alone widespread individual access) within higher education.

Consequently, we propose a pragmatic—an immediate—goal: the universal availability of academic-oriented microcomputers that may be considerably less powerful and flexible than state-of-the-art technology permits, but at prices considerably below state-of-the-market. The machines we have in mind would be quite capable of solving problems (instruction, productivity) and of providing access to information; they would less useful for certain kinds of knowledge-generation activities. The following characteristics define our proposed system:

1. *Personal productivity:* Word processing of reasonable quality for academic purposes is essential. Basic "utility" functions such as graphics, spreadsheets, and database management are almost as important. Statistical packages for the social and hard sciences should be available. Full compatibility with other machines is not essential.

2. *Access to information:* Telecommunications capabilities and network access for: a) Interactive use of online databases and information utilities such as BRS, DIALOG, Compuserve, ERIC, etc. b) Sending and receiving files—including "electronic mail," research papers or even computer programs

3. *Access to instruction:* Telecommunications capabilities and network access to software packages for: a) Downloading (parts of)

instructional software packages for (temporary) usage. b) Direct interactive online use of instructional software maintained on central computer systems.

4. *Price:* Significantly less than $1,000 each for a fully configured system (computer, including storage capacity, display, operating system, basic software, etc.) adequate to perform the above tasks

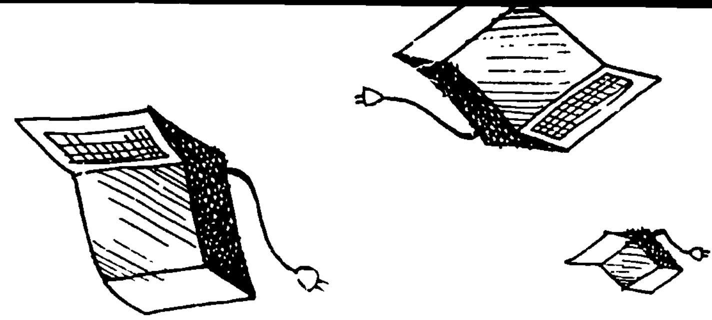
Even casual observers of the "new computing" will recognize that the system we describe exists today, except for two remaining barriers: price and ease of use. There are capable machines that sell at discount for about $1,000, but their posted price hides the cost as a fully configured system as described above. But the price and ease of use barriers will be overcome, soon, and as that happens institutions should look to the configuration we propose as a viable, intermediate-goal route to universal access to personal computing.

Towards "perfect" computing?

We must beware of what Peter Keen of MIT has called the "counter-implementation strategy" of "Yes, but let's do it right." That is, one way to postpone indefinitely the widespread use of a new technology is to support it enthusiastically while insisting it must be embraced only when its every detail is complete as part of a comprehensive, integrated plan. Sometimes a new technology can become useful more quickly and practically through a less-than-perfect implementation at a lesser price.

If we are to wait for the "perfect system," we will wait forever. The horizon keeps moving farther away

	Instruction	Information	Productivity
Issue	Using technology to enhance/improve instruction. Focus on learning, outcomes, instructional productivity, and faculty productivity issues.	Access to information via computer networks. Move beyond individual desktop computing to contact with other users and data resources.	Access to/utilization of tools to help people in academic environments work better, smarter, and maybe even faster. Defined in context of individual fields and disciplines.
Assisting Technology	Initially mainframe and minicomputer, increasing microcomputer.	Decidedly microcomputer, with links to large systems and office networks.	Mainframe for some technology disciplines, increasing movement to desktop systems across all fields.
Primary Clients/Users	Students, both in and out of classrooms.	Faculty and administrators, often department bound. May include students	*EVERYBODY!*
Barriers to Implementation & Institutionalization	• Cost (of both hardware & software, even in era of desktop computing). • Academic rewards for faculty investment in instruction. • Design issues which require both subject area and technical expertise • Need for authoring system accessible to typical faculty member. • Student access to systems with common operating system.	• Incompatibility of competing networking technologies. • Access to networks. • Networking, especially electronic mail, is least understood "basic" computing application to most new users.	• Cost of hardware and software. • Training for new users and support for all users. • Different needs within/across disciplines. • Patterns of campus decision making.



	Instructional	Commercial	Derivative Applications
Application	Intended strictly for classroom, lab, or individual instruction. Realizes some of the long-pursued poorly defined instructional goals for computing.	Commercial products that, not by original design, facilitate class-room/course learning goals Generic or professional products.	Instructional applications that depend on commercial products (e.g., spreadsheets, data bases, statistical packages).
Created by	Developed by faculty, work-groups of curriculum specialists, and/or book/software companies.	Created by software developers for broad commercial use Instructional applications are a secondary market (at best).	Adaptations developed by individual faculty to support instruction in their classes. (Analogy: special readings selected for a course).
Useful Life	Generally short, like a textbook. May be a single learning module in a longer course, could also cover a complete term Generally little use beyond classroom.	Long, depending on market response. Use by students extends beyond boundaries of classroom and course experience, into routine activities.	Generally short, like a textbook. May be a single learning module in a longer course, or could cover entire term. Generally little use beyond classroom
Cost	Unknown. Depends on who develops it, and for what purposes. Likely that faculty-developed products will be less expensive, especially if development costs are underwritten by grants and/or campus support.	Generally expensive—at retail price Campus resale/discount agreements sometimes reduce prices by upwards of 50 percent. Textbook bundles may provide software along with key textbooks.	Small. Compares to lab equipment fees in the sciences. May be distributed at no cost to students as part of class materials or reprints. Development may also be supported by campus funds.
Implementation Issues	Support for development, incentives for faculty; publisher awareness of market opportunities; access to equipment.	Fear of illicit copying. Faculty familiarity with and use of technology; support for innovative teaching and curricular adaptation/implementation.	Support for faculty development; access to equipment; access to distribution channels; faculty incentives.

as we approach it. Our expectations will grow, machine capabilities will grow, but the price for "full function," "state of the art" systems will decline only slowly.

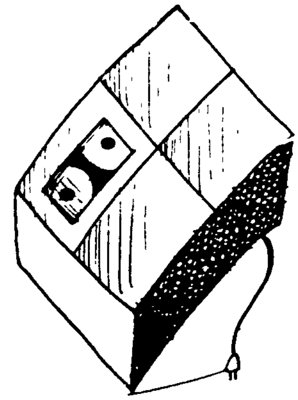
We have a sense of *déjà vu*. The current trend toward "distributed systems" on campuses is really just another phase of a recurring cycle. As the power of microcomputers increases, new users feel they can get by with access only to their own machines. Meanwhile, the power of larger-than-micro machines grows and new applications emerge on them that are unavailable on the micro. We then rediscover remote access computing, and insist on ways for micro users to gain access to the more powerful computer.

When new, even more powerful "micros" become available, those who first acquire them find themselves doing what was possible before only on bigger machines, access to the latter is no longer desired. Then new applications emerge on the ever-more-powerful big machines, and the workstation owner rediscovers the advantages of access to bigger systems. And so it goes

This cycle will continue, because the computer industry keeps offering rapid increases in machine capacity and decreases in machine cost (per whatever unit you like), and software developers continue to invent attractive new applications that require more computing power than the micro of the day can supply.

Arguments about what is a "micro," "mini," "mainframe," or "super" computer are irrelevant. Those definitions automatically shift as the technology gets faster, cheaper, bigger, etc. What really does matter is that both bigger, more powerful, faster *centralized* computers and smaller, more powerful, faster *personalized* computers will become available.

This brings us back to where we



began: it will be unwise for colleges to wait around for an "ultimate micro" or a "final answer" to the networking question. Most colleges will be better off pursuing an intermediate but immediate alternative that puts in place now broadly useful, affordable machines chosen for their ability to do identified work, especially word processing (be it information, instruction, or personal productivity). Cost-benefits are maximized when machines are deployed for purposes they serve best and when their linkage is done on an "as needed" basis to accomplish identified work.

Campuses and the information-technology industry share a common goal: to expand the use of computing technology. How, then, can these parties best realize that goal? Here are our suggestions.

For colleges and universities

First, the academic community must make it easier for companies in the information-technology industry to enter and stay in the higher-education market. A way to dissuade that entry is to treat company representatives as if all faculty members inherently deserve free or deeply discounted product pricing. A way to help is to encourage all members of the college or university community to respect the legal, economic, and ethical basis for a successful higher education market—especially for software.

Second, assess priorities for information technology within your college or university. Which among the "new computing revolutions" (personal productivity, information, or instruction) is an appropriate first target for your institution? Establish reasonable goals for a level of accessibility to computer technology (especially word processing) for your students and faculty, for the quality and variety of software to be provided, and for pricing structure, plus a timetable to achieve these objectives (what proportion, if any, of your faculty and students are unlikely ever to embrace word processing?). Consider developing an organizational arrangement that serves these goals; be cautious about assuming your ability to hire quickly a "computer czar" with the experience and skill to fulfill this demanding role.

Third, campus officials should plan ahead to avoid "disastrous successes." Don't get faculty and students prematurely excited about the introduction of microcomputers before having in place adequate access to hardware, software acquisition procedures, supporting staff, and organizational structures.

Finally, all parties should acknowledge the cultural gap between academe and industry. Listen to each other.

Fourth, institutions (and state agencies) must revise budgeting systems to reflect the need to: a) "invest" in faculty members; b) replace microcomputers every 2 or 3 years (even though they will still be functioning quite well at the end of such a period); and c) fund software and user-support services.

Fifth, consider the incentives your institution can provide for faculty to develop instructional applications for computing or to adapt and use applications developed by others. Establish formal institutional policies that enhance these incentives. Evaluate the economics of institutional support for software development and distribution, including the subsidy of software development as an aspect of a scholar's professional growth.

Sixth, we encourage institutions and individuals to participate in associations and consortia that provide information about implementation and permit one to avoid the mistakes of predecessor institutions.

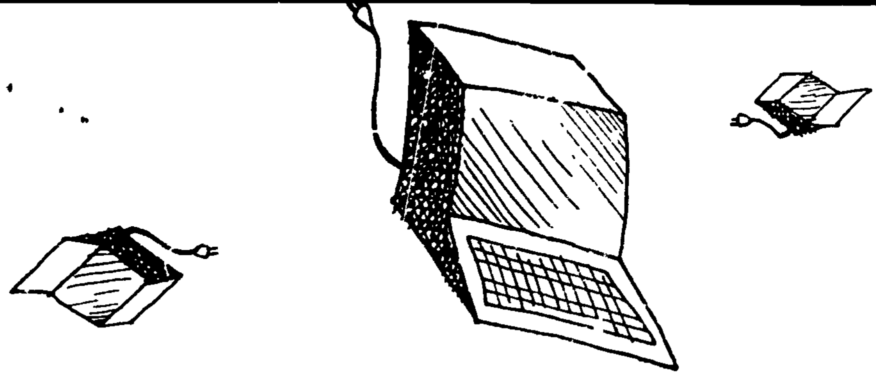
Seventh, we recommend the "Checklist of Issues in Strategic Planning for Information Technology," by James C. Emery (*EDUCOM Bulletin*, Fall 1984) and the book, *Campus Computing Strategies*, edited by John W. McCredie.

For the industry

First, identify which among the "new computing revolutions" (personal productivity, information, instruction) is the most appropriate for your company to address when approaching higher education as a market.

Second, recognize that as the (marginal) cost of producing a technology declines, its price can be lowered without sacrificing profitability. Demand for information technology in higher education is price sensitive; your gross profit will increase as prices are lowered and sales volumes grow. Remember this basic premise of microeconomics: *focusing on maximizing average unit price will usually not maximize net profit*, an idea suggested by Professor James C. Emery, chairman of the Department of Decision Sciences at the University of Pennsylvania's Wharton School in February 1986.

Third, reducing costs for marketing to higher education will



increase profitability. Don't waste time and money on conventional marketing approaches when less expensive, more effective alternatives are available. Use public relations and other promotional activities to deliver your messages, especially through professional associations. Treat people in higher education as colleagues; never refer to your campus contacts as "customers." Nurture "campus champions" for your products; let them do the talking for you.

Fourth, recognize that the elementary/secondary market is very different from the higher education market. Don't expect the approaches that work for the K-12 market to work on college campuses: it may be a selling point in K-12 that some colleges or universities are using a particular product, but the reverse will not be true.

Fifth, watch (indeed search) for emerging, less costly patterns for distributing products on campus, for example to students through campus stores. Note that distribution may not always involve resale, particularly in the case of software. Help colleges and universities develop effective mechanisms for passing through to students some of the costs of integrating information technology more thoroughly into the curriculum.

Sixth, you can benefit from "market segmentation" in higher education: learn to use certain associations to reach the right decision makers for the right category of college or university. (In some institutions department chairs are critically important in computer-related purchasing decisions; in others, quite the opposite is true.) Learn which decisions are more influenced by peers in a discipline than by the hierarchy within an individual college or university. Learn that purchasing decision cycles and budget cycles can vary significantly by class of institution.

Seventh, be very selective in your use of advertising.

Eighth, watch for the emergence of new (electronic, less expensive, more reliable) mechanisms for delivering software and related products to higher education.

Ninth, do not try to negotiate tightly restrictive contracts. Avoid punitive clauses. Don't expect colleges and universities to accept the same form of institutional liability that corporations can accept—colleges and universities simply do not have the same kind of control over the actions of students and faculty members that corporations have over employees and managers.

Tenth, recognize pricing realities. Strive for low prices for "basic" systems.

Recommendations for both higher education and industry

First, develop more centrally available, cost-effective mechanisms for the marketing delivery, and maintenance of computer-related products for higher education.

Second, watch the growing and increasingly important role of computer networking, both local and inter-institutional.

Finally, all parties should acknowledge the cultural gap between academe and industry. Listen to each other. Assume that the other party is intelligent and well-intentioned—until proven otherwise. And, even then, give the other party a second chance!

Steven W. Gilbert is managing director of corporate relations and of the software initiative at EDUCOM, and executive secretary of the FIPSE Technology Study Group He also directed EDUCOM's Computer Literacy Project. Kenneth C. Green is associate director of UCLA's Higher Education Research Institute and associate director of the American Council on Education/UCLA Cooperative Institutional Research Program.