Tomorrow's Campus

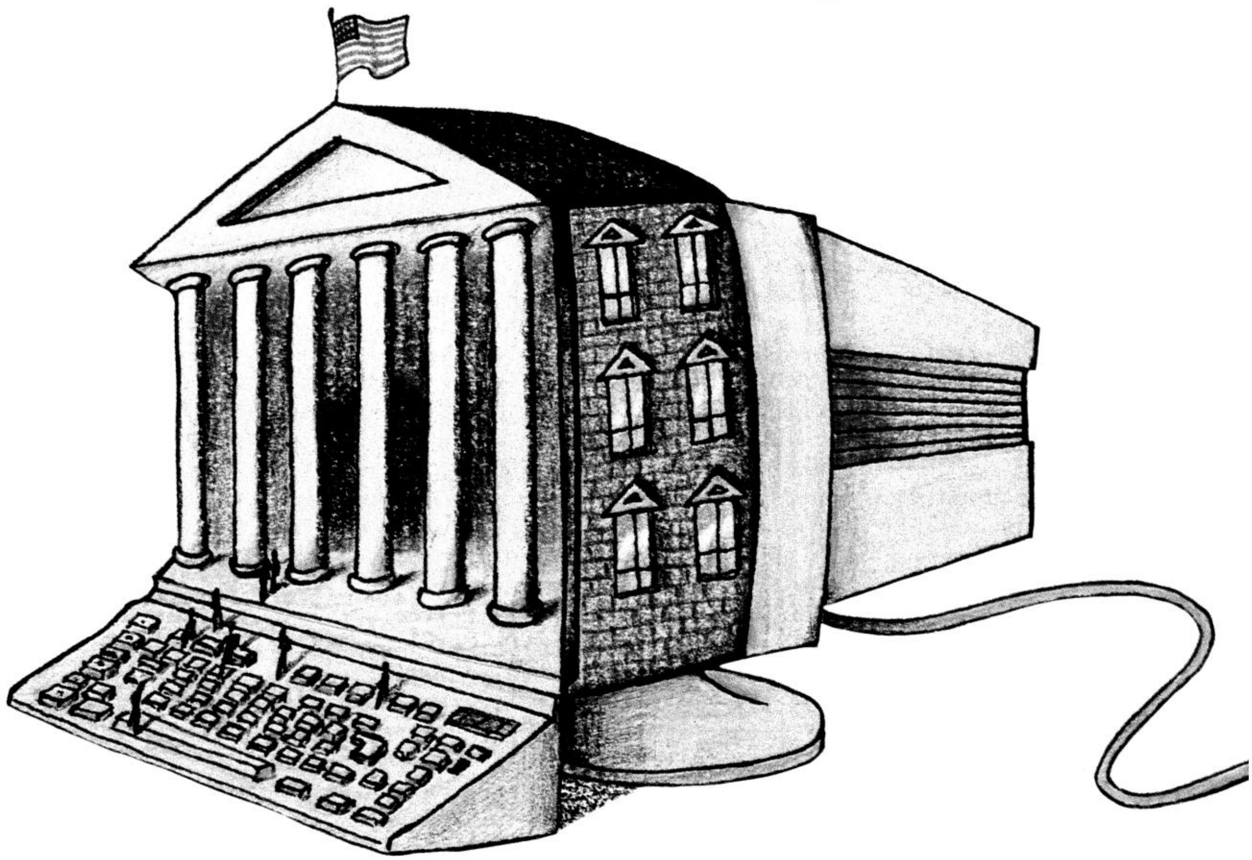

ILLUSTRATION ANA CICA

I am working on planning for a new campus of the California State University System, CSU Monterey Bay. CSUMB will open in 1995 on the site of a decommissioned military base,[1] and it is to be an experimental, forward-looking campus. Some of our goals are to invent new approaches to education and community building, serve the entire state (geographically and demographically), be global in outlook and practice, and innovate in the use of information processing (IP) technology.

Computing and communication technology are improving at an accelerating rate. Three developments with possibly profound implications for universities are: the growth of computer networks and the realization that computers are primarily communication devices, advances in portable computers of all shapes and sizes, and the low cost of processing new data types.

Little needs to be said about burgeoning computer networks. Computer-mediated communication networks will enable effortless communication within communities of common interest. The community might be a professor and the students in a class or colleagues around the world who share a common research interest. The networks also make it possible for individuals or groups to publish data and the results of their research.

I am writing this on a 2.9-pound portable computer while out of town at the beach. It is the first computer I have had that is so well-designed and powerful, I can carry it to a conference or lecture. I expect students to do the same on a routine basis.

The ENIAC, the first practical, programmable, electronic computer, operated on one type of data—numbers. Before the ENIAC was finished, its designers understood it would also be useful for alphanumeric data, and they began work on the UNIVAC, a machine to unify alphanumeric and numeric computation. When display technology improved, text processing became common. Today, processing of data types like audio, video, image, animation, ink, and knowledge is becoming economically feasible. This will alter university communications, and let us use multimedia presentation assets and courseware.

This article speculates on the impact of these changes for a 21st-century university such as CSUMB. We will begin with technology that may be ubiquitous—the ubiquistructure[2]—and then turn to possible curriculum changes.

Larry Press

[1]In the age of agriculture, "peace dividends" were characterized as the beating of swords into plowshares. In the information age, we convert swords to bits.

Information Processing Ubiquistructure

When the Macintosh was introduced in 1984, Drexel University required all students have one. Mandatory computer ownership for students has spread gradually, but I expect it to become the norm since the payoff increases as technology improves.

There are many objections—they cost too much, will be stolen and break, become obsolete, and students will use them to cheat on exams. We must address these concerns. A combination of loans, fees, and subsidies should cover the initial investment. Periodic software and peripheral upgrades (perhaps via PCMCIA cards) must be paid for as well. Encryption can insure privacy and reduce the likelihood of theft. Staff must be provided for maintenance and assistance, with the students shouldering an appropriate part of the cost. Changes in procedure, technology, and redefinition of "cheating" will be needed to handle electronic notes and communication during exams.

The benefits seem to me to outweigh the costs. With computers, student productivity will increase, and faculty will be able to assume everyone has certain capability in planning courses. Quantity discounts and subsidies will help poor students, and the cost of a computer is small compared to the direct and opportunity costs of education. The university will have offsetting cost savings in computer labs (though printers, scanners, and other servers will still be needed). Part of the university's capital will be in faculty, staff, and student homes.

There is the question of portable versus desktop machines. Desktop machines will always be cheaper and more robust for a given cost and level of capability, but much would be given up by leaving them at home. While the student machine of 1995 may resemble today's notebook computers, the student machine of 2005 will be very different [10]. In the long run, we will have many computers of different size and shape. [17]

Connectivity

Pioneering projects such as Athena [1, 5] at MIT anticipated campus internetworks, and even small campuses now have excellent internetworks [14]. Now we can extend the campus network to every office, classroom, meeting room, lab, residence, and study area.

We will want wireless connectivity for our portable computers. Diffused infrared may turn class and meeting rooms into LANs. The same may be true in larger spaces. The Infrared Data Association has defined a point-to-point standard for temporary connection to printers, scanners in the library, desktop computers, and other devices [7]. The standard allows for data rates up to 115.2kbps at distances of 1-3 meters using very cheap, low-power devices.

Off-campus connectivity cannot be separated from on-campus connectivity. Just as telecommuting and groupware have begun changing the nature and organization of industrial work, they are expanding options for the university. Faculty, staff, and students will need connectivity from their homes. Cost constraints may indicate a lower speed than on campus, but all the function of the campus infrastructure should be provided even if the user interface has to be different.[3]

Libraries, Bookstores, Presses, and Servers

It is clear that the university library should be centrally involved in all this. We are talking about information, and, as Willie Sutton might have said, the library is where they keep it.[4] Some feel print-based libraries will disappear, that all local information will be digitized and retrieved from a campus server, and other information will be retrieved from the wide-area network. While it is difficult to imagine that happening, librarians should plan for an ever-shifting mix of print and digital material. (We should also remember the role of the library as a study place.)

Rising costs require us to address publication as well as information retrieval. This is quite clear in scholarly publication, where professors write without pay for journals to which our libraries cannot afford subscriptions [4]. Faculty also write commercially published textbooks that are distributed through campus bookstores. This system is also fraying. Textbooks are expensive, the current distribution system fails courses using spontaneously decided readings, and high-cost multimedia material and distance education will require other outlets. One way to pay for the pedagogical and scholarly information needed by a university is to sell or barter other information. We must invent the digital university press, bookstore and marketplace, as well as the digital library.

There is a third requirement—the storage of the notes, teaching materials, messages, and other information created and retrieved by the members of the campus community. This is the university's community memory or dynabase [11, 13]. It must handle data of all types, and our goal should be to integrate it seamlessly with our portable computers and campus and wide-area networks.

University libraries have begun dabbling in digital information with subscriptions to on-line services and CD-ROMS. They are also experimenting with electronic publication using WAIS, Gopher, and World Wide Web servers on the Internet. The prehistoric ancestor of the dynabase is usually a 1970s-style timeshared computer running Unix in the computer center. These functions will have to be improved and integrated.

Ubiquity

While the university needs specialized equipment for research and advanced classes, ubiquitous technology will determine culture, curriculum,

[2] I considered using the world "infrastructure," but for many people that denotes conduits, cables, wiring closets, and perhaps routers. The world "ubiquistructure" is meant to include active elements such as servers and software (as much as heating and plumbing include pumps and furnaces), and to denote pervasive deployment. Unfortunately, it is an ugly world—please suggest a better one.

[3] Today's options—ISDN, modems, and perhaps cable TV—are relatively slow, but in the long run, this may not be an issue. If ATM over fiber to homes becomes pervasive, we may have equal bandwidth everywhere (of course no one knows what our campus net will look like then). It is interesting to note that industry is experimenting with ATM to homes for entertainment, but not education.

[4] Of course computer-mediated communication reminds us that most of the information we need is in other people's heads.

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and pedagogy. Imagine the changes if blackboards and clocks had not been invented. Blackboards are powerful lecture and discussion tools, and without them we would rely more heavily on independent reading and study.[5] Without clocks, we would have to alter our rigid class schedules and unit-based graduation requirements and resource allocation. While revolutionary, blackboards and clocks are always there—used when appropriate, and otherwise ignored.

Each instructional room still needs a clock and blackboard, and suitable projection and lighting systems, but we must carefully consider what else it needs. Does it need a wireless LAN, connectivity to the campus network, a file server, sound recording equipment, or a liveboard? If these are everywhere, and all students have computers, it may change the way we teach.

We must not forget ubiquitous software. Ubiquistructure extends beyond conduits and wiring closets—it includes file, print, fax, directory, email, conferencing, and other services. For example, an organization that decided to deploy Lotus Notes would have to provide client software, training, and support to all members of the campus community. Only then could Notes disappear into the ubiquistructure.

Equity also follows from ubiquity. Today, affluent students have computers and modems, giving them a significant advantage over poorer students. Appropriate subsidy of student-owned computers and connectivity will help redress this imbalance.

Charging policies are another ubiquistructure element. If a professor's account was charged for every class session in which the blackboard was used, his or her attitude toward blackboards would be changed. To be taken for granted, to be part of the ubiquistructure, a resource must also be part of the accounting overhead.

[5]I was a Docent at a Swedish University in the early-1970s, and a course consisted of a 3,000-page reading list, four lectures, and an exam. Students were said to "read" a subject.

Organization Chart

Qualitative technological change allows us to reconsider organization structure.[6] How might information processing be organized in the university of the future? It should be what Drucker [2] calls an information-based organization—not a group of hierarchically organized administrators, but a collection of professionals who do things. In addition to operating their area, they would be expected to innovate and seek funds and partnerships. They would also have teaching roles either as instructors or more likely supervising internships and apprenticeships.

The CIO would be responsible for vision articulation, tracking research and industrial development, interaction with the university, vendors, funding agencies and other partners, and support and coordination of directors for the following areas:

- *Ubiquistructure*—providing the hardware and software that makes up the IP ubiquistructure.
- *Interactive Instruction*—providing tools and people with production, storytelling (audio and video), and user interface and instruction design skills; finding ways to capture the special knowledge and presentation skills of expert lecturers; and combining technical and creative skills to become the D. W. Griffith of interactive instruction.
- *Curricular integration*—assuring the integration of IP technology in the curriculum and teaching process, tracking, and conducting educational research.
- *External community*—developing telementoring and other programs in support of local schools, libraries, cooperating institutions, feeder high schools, applicants for admission, and so forth.
- *Library/publication*—acquiring and publishing information used and created by the university community and supporting individual and community dynabases.
- *Administrative IP*—supporting routine and *ad-hoc* administration functions and providing workflow and groupware tools.

[6]The effect of computing technology on organization structure dates back at least to a landmark article by Leavitt and Whisler [8]. While some of their predictions appear to have come true, the causes have not always been the ones they expected. Still, Leavitt and Whisler kicked off a wide field of study.

IP Curriculum

Many feel we are in transition from an industrial to an information age. Concepts like "bit" may seem as fundamental and important in 100 years as "force" or "energy" do today. There is massive reorganization and convergence in IP industries, and we should consider a corresponding shift in university organization.

Universities are typically organized as departments within schools. Every school has departments centered on IP. Some, such as computer science, electrical engineering, cybernetic/systems science, computer engineering, and cognitive science are directly concerned with the enabling theory and technology for the information age. Art, design, film, radio and television production, journalism, and educational technology are concerned with the generation of information—they are the storytellers who use the technology. Other departments such as communication studies, information systems, and library science bridge the gap, studying the technology and its application.

A school that combined these disci-

One possible organization for the introductory course would be around types of information and operations such as record/encode, transmit, display, convert type, transform, and buy and sell.

plines would have a fruitful mix of people who tell stories and communicate, and those who build and study the enabling systems. Alternatively, we could encourage joint appointments combining IP and other disciplines. We need an organization that reflects contemporary reality and can accommodate Steven Spielberg, a computer scientist (Jurassic Park) and a storyteller (Schindler's List).

Regardless of the organization, integrating a campus will require increasing effort since communication technology tends to erode local collaboration. We work with colleagues in other organizations and nations, not those down the hall. If we want our storytellers and technologists to work together, we need appropriate reward systems, hiring practices, and other culture-shaping policies.

If we are entering an information age, where IP technology will be taken for granted on campus, a mandatory first course in IP is crucial. (This idea dates back at least to Dartmouth College in the early-1960s [6].) The course has two broad goals: presenting an IP-centered worldview and teaching skills with the systems the students will use while in school.

An introductory course should make a few high-level concepts part of the student's worldview. In looking back at my undergraduate courses, I recall only course organizations and key concepts. For example, my Western Civilization course was organized around politics, religion, art, and technology and economics, but I do not recall many details. I spent two semesters practicing integration, and although I can no longer integrate many functions, I do know what an integral is. Similarly, our introductory students will only retain the "big picture," therefore, we must organize this course carefully.

Newton gave us concepts such as "energy" and "force" which were esoteric at first, but became commonplace during the industrial age. Our students should learn appropriate vocabulary for an information age. One possible organization for the introductory course (suggested by [9]) would be around types of information and operations such as record/encode, transmit, display, convert type, transform, and buy and sell [13].

This would be one way to organize the conceptual portion of the first course, and others should be considered. Regardless of organization, it should be closely tied to hands-on training with the IP technology on campus. For example, discussion of text as a data type would be tied to instruction on the use of word processing and email. Skill training provides concrete examples to illustrate the conceptual portion of a course, and prepares students to use IP tools throughout their school years.

Interns and Apprentices

I am a big believer in apprenticeship because I learned that way. In my first job, I was assigned to assist an accomplished system programmer who asked me to code small subroutines. After a few months I understood a lot about modularity, reentrant code, computer/memory tradeoffs, and so forth, and he and I were soon a productive team. Ben Shneiderman also reports creative and positive experiences with IP internship [15, 16].

It would be terrific if we could give our students similar experience. A campus has professionals involved in all aspects of IP, and students could be expected to work with them on real projects—programming, system building, multimedia production, courseware design, decision support, and so forth. The line between instructor and administrator or staff member would be blurred, but that is perhaps appropriate.

Students could also assist faculty with their teaching, research and consulting. As undergraduates, we saw our professors teach, but how many of us knew what they did out of the classroom? A student assisting a professor for a period of time would learn how the professor used his or her time, what skills were needed, how the research world was organized and what its values were, in addition to the details of specific projects.

There would not be enough projects and faculty on campus to provide apprenticeship experience for all students, but part of the university mission is service, and projects could be found in the surrounding community. For example, Vice President Gore has called for connectivity in every classroom, library, hospital, and clinic[7] [3]. Working toward that goal could provide internships. After course work in technology, organizational dynamics, applications, and time on a support hotline, student teams would be assigned to organizations. A team assigned to a school might include students interested in engineering, education, and behavioral science or business. They could install a LAN, router, and software, show faculty educational applications, and student teach.

Internship would include explicit time for reflection and evaluation of the experience, and would be a bridge between the university and employment. It could be integrated into and funded as part of a state or federal service program. Similar opportunities exist in nongovernmental organizations operating in developing nations around the world, a "hi-tech peace corps." [3].

[7]During this talk and the question and answer session which followed, Gore set a goal of attaining this connectivity at video data rates in five years. He must either be a very optimistic man or a politician.

Textbook Evolution

New technology gives us the opportunity to rethink textbooks. An obvious extension is suggested by the term "text" book. We are free to go beyond text to audio recordings of lectures and discussions, dramatic readings, video and animation sequences, simulations, and other data types.[8] (I do not mean to downplay the value of text—that would be particularly inappropriate at this moment.)

Module length may also vary. A conventional text contains material for a 3-unit semester or 4-unit quarter, and a chapter can be covered in a single class meeting or a class week. My intuition says we want small, focused presentation objects that can easily be combined and cross-indexed. Textbooks may become object-oriented databases, with one of the jobs of a professor being the creation of new objects. This implies developing new tools, and providing support expertise.

Communication technology allows further tampering with the notion of a textbook. When one adopts a text today, the bookstore orders copies, the instructor gets some supporting materials, and the transaction is complete. In a networked world, we can envision adopting a set of course-related presentation objects as including both access to those assets and entry into a conversation among people who are interested in the same material. Students and faculty adopting the material would receive passwords to join a discussion or several discussions (for example, one for local students, one for all students, and one for adopting professors) with each other and the authors.

Augmented by communication, course material is not only assimilated, it may be discussed, explained (by the students), interpreted, criticized, annotated, and revised. In this "Talmudic" process, students are engaged in creating, not absorbing, the material. New students would receive only the original material, since the objective is providing a basis for active engagement, not presenting final answers. This is analogous to having students conduct experiments in a freshman physics class rather than having them read about the experiments and results of the original scientists.

This view implies the need for new ways of producing and marketing "textbooks," of scheduling classes, and granting credit to students. The professor's role will also be affected. Perhaps offering a class will consist of:

- finding and creating relevant presentation objects,
- scheduling and participating in electronic and face-to-face lectures and discussions, and
- providing pointers to related people and materials when requested by students.

Try explaining all that to the head of the campus committee on promotion and tenure.

[8] Audio is frequently overlooked as an instructional data type, but as National Public Radio and others have demonstrated, it can be quite effective. It is also cheaper than video. For example, we could afford to record all class meetings and keep them on servers for a period of time.

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