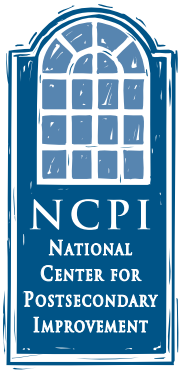

Technology and Higher Education: Opportunities and Challenges for the New Era

PATRICIA J. GUMPORT

MARC CHUN

National Center for Postsecondary Improvement
Stanford University
School of Education
520 Galvez Mall, 508 CERAS
Stanford, CA 94305-3084

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It is difficult to overestimate the influence of technology on the everyday life of academe. The extensive reach of technology into higher education is captured by briefly recounting the process of writing this chapter. For much of the time that the chapter was being written, we were traveling, and therefore communicated with each other and with the editor via phone, voice mail and e-mail. References and background information were located through computerized searches of the library holdings, by reviewing on-line journals, and via the World Wide Web. Drafts of the chapter flew through phone lines as electronic versions and as faxes. Not only did technology provide access to the information we used, but it also shaped the very way in which we collaborated. In other words, both the product and process were heavily influenced by technology. However, despite the many ways technology facilitated this process, there were also numerous incidents of technological difficulties: problems converting files between computers, inability to access e-mail, and network servers that went down. An irony, of course, is despite the fact that the chapter acknowledges the power of technological advancements and that we have come to rely on them, the end result is not distributed on CD-ROM or posted on a web page, but is of course a chapter in a book, a medium now considered a low-tech means of disseminating knowledge. Although many of us may take for granted the ways that technology has altered academic work, such experiences remind us that it is useful to step back and reflect on the nature of these changes.

As we near the turn of the millennium, advancements in information technology and communications technology have made possible new approaches to teaching, learning, and research that were previously unimagined. While some advancements have been wholeheartedly embraced as valuable educational innovations, others have been less enthusiastically received. The goal of this chapter is to discuss how technology potentially impacts higher education, while acknowledging its interdependence with a complex array of opportunities and pressures that reside in the higher education system and in the wider societal context. We focus our analysis on five areas: (1) higher education and technology in modern society; (2) the historical impact of technology on education; (3) the arenas of impact for contemporary advancements in higher education; (4) wider policy pressures and legitimacy considerations; and (5) resistance to widespread technological change within higher education.[1]

Higher Education and Technology in Modern Society

In modern society, the educational system has been called upon to engage in teaching, learning, and research in the name of "progress." Toward this end, in the United States, the federal and state governments have taken an interest in education at all levels with dramatically different arrangements across the basic levels: while assuming primary responsibility for elementary and secondary education (to the extent that K-12 educa-

tion is both mandatory and publicly funded), postsecondary education is characterized by more decentralized control at state, campus, and classroom levels. Although the government provides financial support for tuition and research through various funding mechanisms to states, to campuses and to students, and legislates policies (e.g., Title IX, health and safety regulations), there are few constraints on higher education's core academic processes—that is, curriculum, teaching, learning and classroom practices.

Given this context, higher education institutions have historically been accredited as legitimate "providers" and well positioned within teaching and research markets. At the same time, however, higher education has long been susceptible to a wide range of market forces and dynamics, with new providers vying to provide educational opportunities to the post–high school population. A wide range of institutional resources enable students to avail themselves of the many sources and combinations of information and knowledge in a market economy.[2] With advancements in technology, especially in the post-World War II era, however, the strong market position of traditional higher education providers has become more vulnerable to challenges from new providers with potentially farther reaches (e.g. corporations, proprietary schools, and other for-profit ventures).

Some observers claim that recent advances in technology will revolutionize teaching and learning practices and delivery systems for higher education. Spreading with the speed and heat of a wildfire, the current spate of technology has been branded a panacea for efficiency, access, quality and other enduring challenges facing higher education. However, as with other movements that sit between revolution and merely fashionable trend, technology may in the end drastically disappoint, rendered a victim of unrealistic expectations.

Applications of technology for higher education must be seen in light of broader societal transformations in the past two decades. Technology—and more specifically, information and telecommunications technology—has already become well entrenched in everyday life, so much so that we often overlook the range of functions served. In the home, we find telephone answering machines, videocassette recorders, cable television, and personal computers. Similarly, in the workplace it is common to see networking for local work groups, computer work stations, access to the Internet for communication and expanded markets, and so on. The personal computer has perhaps the greatest impact, having gained a significant presence in the daily lives of many Americans who comfortably log on, re-boot, input, copy, paste, spellcheck, scroll, e-mail, download, search, print, escape, and quit several times a day. The range of applications for computers seems limitless: they are used for word processing, e-mail, and accessing the Internet for information on news, travel and library collections; for round-the-clock banking services and shopping; and even for the annual filing of tax returns. Such technological breakthroughs for the home and for the office are typically celebrated for the ways in which they make life easier.

Technology is also reshaping the world of higher education. Consider the wide range of technological applications underway at Stanford University in 1997. An aeronautical engineering professor is lecturing to her class on wing design, when interactive video enables a classmate from one of several remote company sites to interrupt and explain that their company's wing design practice is now different. Interactive video links students for a music class from three locations simultaneously—with one third of the class on-campus, one third at San Jose State University, and one third at Princeton University—and together the class critiques a classic performance. In another classroom, only one quarter of the students are present for a physics lecture, while the remainder of the students registered for the class had schedule conflicts and will later watch the lecture on video by logging onto the World Wide Web.

In another classroom, students work on problem sets, and their notes are incorporated into the original class material for future access onto a device called a Softbook. A doctoral oral exam is underway, and video conferencing connects those at the exam with two faculty examiners located off-campus, one in Boston and the other in London. In another classroom, a course on Shakespeare is taught jointly by faculty at Stanford and MIT. In a mechanical engineering classroom, students work in teams of three to design products; yet the students are not located in the same place: linking Stanford, Tokyo and New York, these students collaborate on product design through e-mail, desktop video conferencing complete with a shared workspace, and overnight package delivery services. Students in a French class use computers to complete their homework and a voice emulator allows them to listen to lessons. Across campus in the main library computer cluster, one student logs on to check her grades for her courses last quarter, while her friend does a search through biology journals on the World Wide Web. An anthropology professor demonstrates for his students a CD-ROM he developed that provides a virtual reality walk through an archaeological excavation site. Students in an English class who are working on an project about World War II access materials from the Hoover Archives on the Web, and from their computer screens review photographs, propaganda posters, and recordings of Hitler's speeches. Few faculty and students are aware of the full range of these initiatives. And nationwide, even fewer can afford them.

The information age has arguably brought about a transformation of society, dramatically changing communication, the workplace, science, and entertainment. It has also impacted education, but the nature and scope of such changes are still contested. Many have trumpeted technology as educational cure-alls, surely to transform the delivery and nature of educational processes. Others remain more skeptical, claiming that systemic educational problems cannot be simply solved by technology alone, as technologies are merely tools, successful use of which may entail a paradigmatic shift in the orientation of all involved in teaching and learning. Technology provides pressures and opportunities that make possible transformation, but such change is not guaranteed. This point can be exemplified by taking an historical perspective.

An Historical Perspective on the Impact on Education

> *"I believe that [it] is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of textbooks."*[3]

Although this could easily be a current quote from an Apple or Microsoft executive about the future of computers, it is, in fact, Thomas Edison speaking 75 years ago about the motion picture. History demonstrates two certainties with respect to the impact of technology on education: first, prognosticators will herald the radical rebirth or inevitable demise of the educational system; and second, more often than not, their predictions are wrong. The educational timeline for adoption of technology is dotted with unexpected failures and unexpected successes.

Americans seem to be in love with the idea that any new technology can, in and of itself, fix all problems. Despite the overwhelming multiplicity of problems facing education, many seek the latest gizmo as the "technical fix" that the system requires. The arrival of new technologies for education has often been accompanied with bold predictions for its transformation. Recent claims about the power of "high technology" to revitalize education likely conjure up a collective sense of social *deja vu*. The introduction of the blackboard was expected to turn education on its ear. Some predicted that the spread of television would eliminate illiteracy in America; in 1957 a Ford Foundation report foresaw television as "the greatest opportunity for the advancement of education since the introduction of printing by movable type."[4]

By the same token, many experts often sound the tocsin of doom, predicting the new technology will bring forth the downfall of the educational system. Even in the 5th century B.C., there was tremendous controversy surrounding the use of written records in teaching (considered to be the first technological innovation). Stanford Philosopher Patrick Suppes notes that at the time, many believed that the adoption of written materials would undermine the learning process and diminish the quality of the personal relationship between tutor and student. Plato observed the shift from the oral to the written tradition and recorded Socrates' concerns that putting words on paper undercuts the "art of dialectic." In the dialogue "Phaedrus," Socrates predicted that the use of written materials "will create forgetfulness in the learners' souls, because they will not use their memories; they will trust to the external written characters and not remember of themselves. . . . They will appear to be omniscient and will generally know nothing."[5] It was also feared that the printed word would undermine the authority of the scholar, because students would have new access to another source of knowledge. In addition, some observers were concerned that this shift towards written text and standardizing knowledge leads to impersonal and repetitious action, precluding opportunities for creativity (such as when scribes would amend the manuscripts they were copy-

ing). A more recent example of doomsday concern comes from the early 1960s, when instructional television disappointed proponents and users alike. Initial high hopes were accompanied by grave fears; some predicted that classrooms would be staffed primarily by teaching assistants whose sole role was to keep students quiet.[6]

As we now know, the predictions attached to such extreme hopes for the massive improvement and such dire warnings of the unavoidable collapse of the educational system never came to pass. This is not to say that the effects of such technology are not felt on college and university campuses; rather, it is to suggest that by no means did the actual impact live up to grandiose expectations. However, it is nevertheless interesting to consider prominent examples of technology and their subsequent impact on education.

The introduction of technology into educational settings has often initially met with lukewarm support and mixed results, but its slow adoption has led to far-reaching impact. Returning to the above example, written materials eventually gained popularity and found widespread use, contrary to the chorus of warnings. Moreover, not only was this technology adopted, but it also brought about other significant and profound changes in teaching and learning. The eventual accumulation of written documents led to the development of libraries as well as to centralized and organized bodies of knowledge that would be expanded as scholars developed intellectual networks. These developments occurred in tandem with the growth in the academic profession and the proliferation of academic disciplines that so prominently carve up the academic landscape in the twentieth century.

In some cases, the lag between the development of technology and its adoption can last centuries. The historical record shows instances of some innovations spreading slowly and gaining momentum only later. Continuing with the example of written materials, the technology of mass printing, developed by the mid-1400s, permitted educational documents to be distributed, both widely and inexpensively. Suppes notes, however, that surprisingly the use of textbooks did not catch on until the end of the eighteenth century. Another example is formalized testing which has widespread use in the United States as a means to remove bias in evaluation, as well by researchers to establish standards and to measure achievement and skills. Nevertheless, Suppes reports that testing had been used centuries before in China for the selection of mandarins.[7]

In some cases, the impact will not be realized until the technology has an opportunity to spread, in much the same way that the revolutionary influence of the telephone was not felt until there was a critical mass of users.[8] When the technology radically alters the basic structures of the educational process or challenges long-held assumptions, it is likely to face such opposition. By contrast, when the technology fits within the basic paradigm, its adoption is often less controversial; for example, the photocopying ma-

chine—which in essence replaced the mimeograph machine—was integrated into educational settings immediately.

Of course, the adoption of technology has not necessarily led to actual changes in the educational process. Many bemoan the long stream of misbegotten fads, each with its own bevy of advocates and cult of enthusiasts, and each of which eventually fell by the wayside. The promise held for radio and filmstrips never materialized. Tremendous initial investments were made in computer systems that are now outdated. Huge cadres of students learned computer languages which are now obsolete. Moreover, there is to date very little evidence of sustained improvements in student performance as a result of new information technology, both at the K-12 and postsecondary level. Despite decades of research and wave after wave of reform, not much has changed in the classroom. In fact, the book still remains the primary classroom tool, and the coming together of teachers and students the essential means of teaching and learning.

The current wave of technological advances may mark a new chapter in the history of higher education. The primary differences between this technology and that of the past are its extreme flexibility and relative pervasiveness. Today's technologies are extremely malleable and do not come with an obvious targeted application or audience; it is entirely possible that some technologies may have an unlimited number of applications. In contrast to the printing press, which was a single technology with the explicit purpose to mass produce books, consider three-dimensional (3D) modeling and its potential in educational settings: in biochemistry to examine, build and manipulate molecular structures; in archaeology to map with great precision the features of a site on another continent so that students can later examine it in labs; in art history to model the architectural details of an ancient cathedral such that a student can "virtually" enter it and study it from an unlimited number of vantage points. In each case, the student could see things not necessarily intended by the 3D modeler. In some important educational ways, the model may be considered "better" than the real site because it provides more complete access to more information, which can be retrieved and reviewed without the constraints of place and time.

In addition to its flexibility, the new technology is becoming omnipresent throughout the system for those who can afford it. Although a large part of the vast array of applications of technology to higher education settings remains yet to be identified, the effect on higher education is already evident: All levels of the national system of higher education and its participants are affected, including the external agencies that fund, regulate, and interact with campuses, entire state systems, campus operations, faculty work roles, library services, and student life. More specifically, for example, prospective students and parents can get information about colleges and universities on-line, and in some cases they can apply for admission and financial aid electronically. Course regis-

tration now occurs on-line; gone are the days of students standing in long lines in gymnasiums. Students and faculty alike can search through scholarly citations and electronic databases, and in some cases obtain the full text of library documents, either from on-campus or off-campus with a terminal and a modem as opposed to wandering through the stacks in a library. Academic support staff use computers rather than carbon paper and typewriters, order supplies and process reimbursements on-line, and regularly use e-mail to communicate with faculty, students, and other staff members. At the same time, some academic departments have eliminated secretarial positions while encouraging their faculty members to be more self-sufficient and handle their own scheduling, correspondence, preparation of course materials and manuscripts. It is also increasingly common for students to use a videocassette player; in the event that they miss a class lecture, they can now check out a video of the lecture from a departmental library in much the same way they borrow a book.

These are just a few of the examples of how technological advancements have already altered the rhythms of higher education settings and have the potential to transcend previously assumed constraints of time, place, and participants in the process. Technology circulates so pervasively through modern society that traditional higher education is unlikely to be insulated; as new educational providers that rely on technology enter the market, they reshape the landscape of higher education. Although history has shown us that the impact of technology is impossible to predict and that the most outspoken advocates and naysayers have often been inaccurate in their prognostications, it is almost certain that there will be some effect. Thus we now turn to a discussion of the potential arenas for impact.

The Arenas of Impact on Higher Education

Contemporary advancements in technology may be characterized as potentially impacting three broad arenas of higher education: 1) the nature of knowledge; 2) the process of teaching and learning; and 3) the social organization of teaching and learning in higher education.

The Nature of Knowledge

At the most basic level, technology has affected the nature of knowledge itself. It shapes what counts as knowledge, how knowledge is produced, how people are involved in the production of knowledge, and how academic knowledge is valued.

There is a burgeoning assumption that legitimate knowledge must be capable of being computerized. Knowledge is increasingly created, processed, manipulated and stored with technology. In addition, the way in which knowledge is produced in academic

settings has been greatly expanded; new ways to conduct research are only now possible because of technological advances. Computers make feasible complex statistical analyses, laboratory equipment enables the study of subatomic matter and distant galaxies, x-ray technology allows the examination of images hidden beneath the paint on artistic masterpieces.

Changes in the nature of knowledge also affect the relationships between people and knowledge in higher education. For example, the nature of what it means to be "educated" has shifted, in that now one must be able to demonstrate computer literacy, with rapid changes occurring in what constitutes that literacy. In this new era of the Internet, access to many forms of knowledge are restricted to those who have the skills and equipment. Even the daily lives of knowledge producers have changed; for instance, faculty who in the past gave dictation to their secretaries to type now create their work themselves on the computer. Computers allow easier revisions (compared to the past when changes would require retyping an entire document); allow easier collaboration with both local and distant colleagues (exchanging documents on-line); and allow new forms of knowledge dissemination (electronic journals that can be read on-line; access to documents from World Wide Web sites).

More generally, however, the advances in technology have occurred in tandem with an increased awareness of the knowledge industry in which higher education participates.[9] New markets for knowledge have ushered in new and complicated issues of intellectual property, as notions of the "production" and "consumption" of knowledge have become internalized by faculty and their employing institutions. This orientation has profound implications for conceptualizations of higher education's social functions, principally a shift in the primary emphasis from the development of the individual to an emphasis on the transmission, production, and dissemination of knowledge. Thus students and faculty are more often seen as knowledge consumers and knowledge producers who function within market forces. As new technology has opened up new possibilities for the exchange and packaging of information, a proprietary orientation has gained prominence in higher education, given new markets for research and teaching products. New policies and personnel are required to mediate between individuals and higher education institutions in the ownership and management of academic knowledge.

The Process of Teaching and Learning

Technology has also affected teaching and learning processes in higher education. The dominant ideal for teaching and learning in traditional higher education settings has presupposed that faculty and students come together in the same place at the same time, principally communicating with the spoken word, and using the very basic tech-

nology of chalk and blackboard and printed materials (e.g., textbooks). The image of the faculty member has been that of "sage on the stage"; this mode of instruction gives students credit-for-contact, also known as "seat time," whether they are in a lecture, seminar, discussion or laboratory format.[10] Some uses of new technologies have effected essentially "first-order" changes, efforts to make such traditional teaching and learning activities more efficient or expedient, without altering the basic premises. Technology might change the medium of information exchange, without significantly changing the content.

Such first-order changes in higher education classes are common. Several technological advancements have provided faculty with a wider range of ways to present and represent information (including slides, filmstrips, motion pictures, and overhead projectors). Several other technological advancements have enabled faculty to capitalize on economies of scale in the classroom (the introduction of the microphone, computerized scanners for scoring tests, and mimeographing machines to duplicate course materials). Communication outside of class hours and across distances has been strengthened through the postal service and the telephone. E-mail exchanges can dramatically increase the frequency and alter the nature of student-faculty interaction into "anytime, anywhere" contact. There are numerous reports by faculty that the use of e-mail is increasing the participation of those students who have not been inclined to speak in face-to-face class discussions.[11]

Some other uses of technology extend the traditional teaching and learning processes, using technology to exponentially expand the scope of activity, again without altering the underlying educational model. For example, whereas in the past students have used datasets available to them on their own campuses, computers now provide the opportunity to access databases around the world. This development has also changed the nature of research, expanding access to newer and newer forms of information as well as the range of possible areas for investigation. For the most part, such technological adaptations are simply "bolted" onto old instructional methods.[12]

Computers are a prime example of technology that created first-order change, where the basic activities of education remain the same. Computerized equipment allows students to be more precise in their work, and word processing applications make revising drafts of a paper more convenient, just as pocket calculators made mathematical computations easier. Computers have also enjoyed widespread adoption; although many campuses are using this technology, there is variability in campus approaches to implementation. Some colleges and universities require all students to purchase a computer, whereas others supply equipment for the campus community to share. It is not uncommon for students to own personal computers with CD-ROM drives, multimedia software, and access to the World Wide Web, although estimates of computer ownership and usage

differ.[13] Although computers offer students the potential for desktop publishing, computer-aided design, and high-level modeling, some observers have claimed that despite this tremendous power, computers are most often used primarily to perform the most pedestrian tasks, such as word processing. Computers also permit a first-order change on a previous second-order revolution: Just as the postal service made correspondence courses available, distance learning via the computer renders the extension of this enterprise more efficient and far-reaching. (First-class mail sent through the postal service is now referred to as "snail mail.") All of this, of course, does not alter the traditional teaching and learning paradigm; technology has been used essentially to enhance the fundamental faculty-student classroom interaction.

The introduction of technology can potentially bring about transformations on another level, creating "second-order" change. Requiring more money and the redesign of courses to incorporate specific technological applications, this level of change potentially alters core educational processes, and in fact the very nature of teaching and learning. As technology alters how knowledge is obtained, classified, utilized and represented, such changes may reshape both the content and the delivery of education.

With respect to content, technology can enable teachers to shift the focus and orientation of their courses. By relinquishing the drudgery of technical work to computer models and simulations, faculty need no longer devote large proportions of class time to routine work (for example, calculating ANOVAs by hand), and can instead consider additional principles or higher-order concepts. In addition, technology can change the nature of the "laboratory," seen previously as a pedagogical device exclusive to the natural sciences. Increasingly, faculty in the social sciences are using "laboratories" as a means for students to gain hands-on experience with course material in much the same way as they have in biology, chemistry, physics, or astronomy. For example, a professor teaching a course in social stratification might ask students to manipulate census data as means to gain more direct experience with statistical patterns of discrimination (rather than just reading about the topic in a text). Students can then come to their own conclusions about social patterns based on their laboratory work. In other words, technology can facilitate a shift from passive to more active learning. A transformation is taking place, from thinking of the classroom as faculty-centered to student-centered, from giving academic credit for time spent on subject matter coverage to crediting students for their learning outcomes and demonstrated competence.

The potential incorporation of such technologies extends to faculty across the disciplines, as they gain access to resources that may entail redesign of courses and teaching activities. Faculty can consider how to enhance the display of information in the classroom, from the art history class where you can zoom in on details of paintings to the literary criticism class where you can show a scene from a play. Computers are no longer seen solely as

"number crunchers," but are conceived of more broadly as "symbol crunchers," with the ability to manipulate numbers, words, concepts, and images, as well as to extend communication and ultimately enrich teaching and learning relationships.

To summarize, this era has witnessed the transformation of some of the very basic building blocks of the teaching and learning process: new technology alters the roles of the *participants* (students as active rather than passive learners; faculty as a "guide on the side" rather than a "sage on the stage"; the increasing importance of other actors, such as software developers); it changes the dimension of *time* (rather than subject to the regimented schedules characteristic of classroom settings, students can use educational software packages at their own pace and at times of their choice and convenience); and it changes the nature of *content* (advancing the trend towards discrete knowledge units, the syllabi, lectures, course readings, and class notes are all-important artifacts that can be placed on-line). Such changes put more responsibility on students to integrate the knowledge bundles, and faculty to assume a primary role in assisting them to do so.

The Social Organization of Teaching and Learning

Finally, technology has affected the social organization of teaching and learning, by expanding the delivery of higher education. Technology opens up the possibility of thinking the fundamentals of the higher education setting: the dimensions of roles, time, place, and organizational participants.

First, technology can alter the nature of the participants' roles. As discussed, the shift in higher education may be toward a more learner-centered mode: as students turn to more individualized learning, teachers are called upon to guide students through the information resources rather than being the primary distributors of content. The role of faculty becomes that of helping students learn *how to learn:* for example, faculty may now help students decide which computerized module will best suit their educational needs or how to take greatest advantage of the package. It also changes the nature of the participants, allowing access to people heretofore unable to participate—including both those without the resources to attend, as well as "adult learners" for whom distance learning is more convenient; in addition, the information networks permit contact and interchanges across all conventional bounds of geography (e.g., a student can use e-mail to consult with people and resources anywhere in the world).

Second, technology can alter the temporality of education. Computer modules can accommodate individual needs through self-pacing. When students use learning modules, they can review material or move forward to new material, while the professor can expand her monitoring throughout an entire computerized lecture hall, taking on a role more like that of a coach.

Third, technology may alter the geography of education. Not only does technology permit students in traditional education settings to shift where they engage in the learning process (e.g., they may watch a "live" simulcast from a satellite classroom, listen to a presentation in the lecture hall, or watch a videotape in their residence hall room), distance education allows students to participate in educational programs without setting foot on campus. Out-of-class communication can be enhanced through e-mail, list servs, and on-line discussions, blurring the boundary between being in and out of class. Perhaps an even more profound shift is the incorporation of individuals who are "place-bound" and geographically located at remote sites as regular students into a "live" class . Downlink locations may be set up at other campuses, companies, community learning centers, or even high schools. Dramatic progress has been made with the use of two-way video and audio transmission.

Fourth, this fundamental upheaval in the established assumptions of higher education has resulted in dramatic shifts in the organizational landscape. Many organizations—most noticeably computer and software companies—have recast themselves as participants in the knowledge business, and as new providers of teaching resources they challenge the market share of existing colleges and universities.

The most dramatic case of the changing social organization of teaching and learning is that of "virtual" higher education. Transcending time and place for new learning opportunities, this alternative to face-to-face education extends prior conceptions of distance education, or distance learning, that took the form of correspondence courses which were initially made possible by the postal service. During the past two decades, a range of additional communications technologies have been used in virtual higher education, including telephone, television by satellite, video tapes, and more recently, modems and fiber optic networks.

The advent of digital interactive computer technology opens up more possibilities, including the emergence of new organizations and institutional forms. These forms present the possibility of either collaboration or competition between existing campuses and the new providers. Some envision multi-site learning communities, replacing the classroom, the faculty, and the campus. Communications technology allows for both synchronous and asynchronous communication. When communication is synchronous, in an on-line discussion, for example, it simulates "live" interaction. When it is asynchronous, it enables students to go back for review as often as they consider necessary. A vivid illustration of the latter is the dissection of a virtual cadaver; instead of plunging at once into a real body with scalpel and rib spreaders, a student perform a "post-mortem" on a simulated patient, repeating the exercises until the skills are perfected.

Why is there so much interest in virtual higher education? Numerous external forces are driving the newfound interest. A major reason is demographic, relating to the emerging

needs of adult learners in particular. From the perspective of the employer, workers need to update their knowledge and skills in order to adapt to rapid technological changes in the workplace. At the same time, adults themselves may simply want intellectual enrichment; since the late 1980s one company—which advertises that just because "you are not in school anymore doesn't mean you want your mind to turn to mush"—has annually enrolled five thousand students in its cable channel classes.[14]

Given the contemporary era of resource constraint in higher education, especially for public universities, virtual higher education might enhance collaboration in the sharing of educational resources when comprehensive field coverage is deemed too costly. For example, if a University of California at Berkeley has an expert in ancient Greek, a course could be taught for students on other UC campuses. Similarly, Berkeley could be a receiving site for UCLA's courses in a history or linguistics specialization, if such subject matter specialists were not on the local faculty. Other proposals for virtual higher education involve cooperation within a state. For example, states such as North Dakota and in Maine have developed an extensive interactive video network.

Alternatively, virtual higher education may generate competition and subject existing higher education providers to unprecedented market forces. Virtual private, for-profit ventures are becoming more visible. For example, the University of Phoenix, perhaps the oldest such institution, was founded in 1978 to provide educational programs for working adults; enrolling over 40,000 students in undergraduate (e.g., business and health care) and graduate programs (e.g., business and education), the University claims to have granted over 370,000 degrees and certificates, and thus has a market share of part-time students. While the University of Phoenix has a reputation for producing MBAs, the National Technological University has a reputation for strength in engineering education. Founded in 1984, NTU uses advanced satellite technology to enable those in the workplace to be educated as engineers or managers of technology.

As of 1990 another virtual higher education initiative was launched as the Teaching Company with fifteen courses on videotapes and written materials. By 1997, the Teaching Company offered over 100 courses, boasting videos of lectures by star faculty from some of the country's most selective universities. In addition, the Teaching Company's newest division, Mirus University, has gained preliminary certification for degree-granting status by the State Council on Higher Education in Virginia to offer a master's or bachelor's of arts in liberal studies.[15] It is interesting to note that this approach reinstates the faculty as "sage on stage"—as the central performer, if not genuine authority.

Another example of a virtual higher education provider is Magellan University, based in Tucson, Arizona, which in 1995 started promoting its virtual classes that rely on the Internet's World Wide Web network. While this organization began as a nonprofit, its

founder, hoping to establish a market niche amidst the tens of millions of homes and businesses that have networking capabilities, is optimistic it will one day be viable as a commercial enterprise .

Perhaps the most visible initiative across state lines is the proposal to establish a Western Governor's University. Endorsed by the Western Governor's Association in 1995, the planning for the cyber-university is proceeding with two aims: to broaden access to technologically-delivered educational programming for "anytime, anywhere" access; and to provide certification of competency (that is, learning achieved regardless of source). The goal is to establish a free flow of high quality educational materials across institutional, state, and other boundaries, yet maintain access at in-state tuition rates. According to the implementation plan, the new entity will broker the distribution of services, foster the development of new educational materials, and help connect "users" with "providers" through student support services. At the time of this writing, thirteen governors have committed $100,000 each during fiscal year 1997, have agreed to assist with efforts to obtain financial resources that are required to develop the virtual catalog and management systems, and have promised to remove barriers that would prevent the initiative from functioning effectively. At the state level, such barriers may include, simply stated, "regulation, bureaucracy, tradition, and turf."[16]

Proponents of the Western Governors University tout substantial potential benefits for several constituencies: students will have greater access; employers will be able to assess skills of new employees and enable current employees to upgrade skills; colleges and universities, in addition to other providers of "educational modules," will have an expanded market; and states will better meet the demands emerging out of changing demographics and labor force needs. At the same time, however, several concerns have been voiced about quality (i.e., how to insure standards) and the possible loss of public funds for existing colleges and universities. It is noteworthy that California's Governor Pete Wilson decided not to participate in the Western Governors University and has instead launched a plan for a California Virtual University. Reflecting confidence in California's established and accredited colleges and universities, the California plan aims to serve the needs of the state while generating funds within California.

The financing of such virtual ventures along with other virtual universities concerns participants and observers alike. On the one hand, there may be tremendous cost savings since there will be no buildings, no faculty, and no printed catalog. There will still be personnel costs, but these will be limited, to the extent that only a few faculty need to be hired.

Many questions remain. Who will underwrite the cost of the technology? Many hardware, software, and teaching video companies are jockeying for position, in hopes of securing big profits. How will learning outcomes be assessed? Among the critics, some

claim the inappropriateness of competency-based assessment, noting that higher education provides an all-important credentialling function rather than knowledge acquisition or skill-building per se; from this perspective, a college degree may also demonstrate the ability and willingness to persevere in pursuit of a long-term goal rather than subject matter competency. A focus on learning outcomes and competency-based testing is criticized by still others for missing crucial socialization functions. Even at its best, critics argue, virtual higher education would provide a suboptimal educational experience, the antithesis of Goffman's conception of "total institution," where socialization is most readily achieved in the bounded, residential nature of classical colleges. Of course, with the increase in part-time enrollments and the expanded reach of community college courses, that classical model may end up serving a smaller and smaller proportion of the postsecondary student population, raising challenges for finding socialization alternatives such as in community-based organizations.

To summarize, technology has affected or is likely to affect many dimensions of higher education, including the nature of knowledge, the nature of teaching and learning, and the organization of teaching and learning. The case of virtual higher education incorporates issues from all three arenas, and raises many difficult questions. In the previous two sections of this chapter we have discussed the impact of technology on education in the past and the present, as well as its potential for the future. We have noted how some technologies have brought about revolutionary change, while others have had little (if any) impact. As noted at the outset, our claim is that such variability in effect is neither the result of chance, nor a Darwinian survival of the fittest. Rather, viewing change as affected by social, political, and economic factors, we believe it is essential to consider the wider policy pressures and opportunities that accompany the discourse about technology. At the same time, it is essential to note that technology is carried forward by individuals who negotiate the policy pressures and at times resist the extent to which technology may take hold in higher education.

Educational Policy Pressures and Sources of Legitimacy

Scholars have argued that the nature of higher education (multiple goals and unclear core technology, according to organizational theorists) leaves it susceptible to policy pressures as well as institutional imperatives for legitimacy. That is, colleges and universities are able to justify their activities (and therefore can be seen as "modern" and legitimate) by appealing to culturally-approved assumptions.

Improvements to higher education activities are therefore often presented as responsive to distinct policy pressures. Given the pervasive demands on higher education to reduce costs, increase access, and improve quality, it is not surprising that campuses are anxiously considering technological breakthroughs and their potential applications. The

cumulative pressure on colleges and universities to "do more with less" is a powerful catalyst for explicit reconsideration of delivery systems, curricula, organizational structures, and the mix of technology and personnel.[17] The hope is that technology will be the key to more affordable, accessible, and effective teaching and learning.

At the same time, improvement tends to be constructed through one of three legitimizing frames: efficiency, access, or quality, each of which is cast as advancing societal aims. Notions of "efficiency" often invoke the metaphors of neo-classical economics, aim to optimize the delivery of education to individuals and to maximize their subsequent contributions to society. "Access" is often constructed as emancipation and social justice, where educational opportunities are extended to those who, for numerous reasons, have previously been excluded from the system of higher education. "Quality" often includes aspects of the other two, but includes a range of supporting rationales. Each will be discussed below.

Technology is often framed as a means for improving efficiency. Higher education has traditionally been a labor-intensive industry. Strategies for cutting costs in higher education often focus on personnel, which has historically accounted for approximately eighty percent of campus expenditures. Common sense indicates that less expensive labor could replace more expensive labor, and that economies of scale may be achieved by having instructors handle larger enrollments in their classes. From this perspective, the potential for educational technology to reduce costs by replacing faculty becomes an even more attractive policy option, given anticipated higher education enrollment increases in many states over the next two decades. However, while changing the mix of technology and personnel may result in long-run cost savings, the development and delivery of technology incurs its own costs, not only not only those of investing in hardware, software, and networking infrastructures, but also the costs of hiring new personnel to maintain and support its usage as well to retrain and upgrade the skills of existing personnel. It is worth noting that even proponents of such investments acknowledge that substituting technology for labor is unlikely to reduce costs.[18] In addition, given the outstanding social and economic returns to higher education, it is worrisome to think that the burden of capitalization of technology might be shifted to the consumer (the student).

A second way to think about how technology is constructed is to focus on pressures for higher education to expand access to students in geographically distant areas as well as to students who might not otherwise have opportunities to engage in higher education. Just as we have moved from elite to mass higher education in the United States, the pressure is now to provide universal higher education. This means that colleges and universities are increasingly called upon to provide educational opportunities to those who have been excluded from the system by virtue of demographic as well as geo-

graphic factors. Moreover, with the social value placed on "lifelong learning," increasing numbers of "adult learners" are seeking access to higher education, given the availability of learning opportunities that overcome the boundaries of time and place. The question of course, is access to *what*? If it is access to academic programs at one of the 3,600 accredited colleges and universities, then a set of logistical challenges can be identified and resolved. If, on the other hand, it is access to a wider range of learning opportunities in virtual classrooms and virtual universities—offered by a wider range of providers—the challenges for quality assurance are enormous.

Third, the application of technology has been framed as a way to improve the quality of teaching and learning. The idea is to use information and communications technology to enhance student-faculty relationships, as well as student-student and faculty-student interactions. The hope is also to provide educational services tailored to the needs of a more diverse student population, which is increasingly characterized by a wider range of cognitive learning styles and varying degrees of academic preparation. Such outcomes are not assured. In fact, several skeptics are concerned that technological applications may have the opposite of its intended effect and undermine the quality of teaching and learning. It is possible that e-mail will replace office hours, videos will replace active participation in class, and students at remote sites will miss out on some crucial aspects of the "hands-on, in-class" experiences. There are numerous concerns, including the viability of conducting an educational operation without faculty, the ultimate value of a credential from such an experience, the validity and utility of competency-based credentials, and whether such students will be (or will be perceived to be) less competitive in the job market and perhaps less well-socialized as citizens and leaders than their counterparts who graduated from traditional colleges and universities.

Although issues of efficiency, access, and quality are often addressed separately in policy arenas, they are interdependent considerations in what constitutes legitimate higher education. For example, the argument that technology makes "continuing education" and "lifelong learning" available relies upon both rationales of efficiency (producing a workhorse that can be retrained to contend with the changing requirements of the workplace) and access (ensuring that "adult learners" can participate in the system where direct contact with teachers is replaced by machines, content no longer flows directly from teacher to student, and students are increasingly learning on their own, at their own pace, in their own space). A range of legitimizing frames can be used to justify this emphasis for the higher education enterprise: while some may claim that this is increasing access, others may claim that the underlying goal is to increase efficiency, but its legitimacy is secured by framing the change as that of increasing access. Lyotard cautions that we should be mindful and critical of such rhetorical games, knowing which is the "Trojan horse" for which political agenda.[19]

Policy pressures for efficiency, access, and quality are long-standing and complex. However, despite some proponents' and hopeful observers' claims that the current wave of technological advancements is a magic wand to resolve these policy issues, we contend that history has shown that vigilance is advisable. The degree to which a technological change is embraced depends in part on how it is constructed and the social legitimacy it can marshal. While information technology and new networking capabilities may enhance communications environments, learning infrastructures, and information infrastructures, this new landscape of opportunities must not be embraced without caution. The adoption of such technological advances are not automatic, and may have unforeseen consequences.

Resistance and Uneven Impact

As technological advancements are accompanied by underlying pressures and opportunities for higher education transformation, the impact will nonetheless depend on institutional willingness and individual actors—their resources, professional interests, and specific locations.

Historically, higher education has been slow to adopt changes, in part explained by its founding. The university emerged during medieval times, and because it has not changed dramatically since that time, it in many ways reflects the past. The scientific revolution took place for the most part outside of academe, and many academics shunned the industrial revolution.[20] The university's tremendous inertia is the result of a long-standing, well-established system.

Despite the tremendous public attention given to technology, to date, the majority of the academic profession across the country has not dramatically transformed its teaching methods or redesigned its courses.[21] To do so is time-consuming, as is the development of innovations in courseware. Such activities have not yet been significantly rewarded in promotion and tenure review the way scholarly publications are. The disincentives of the current academic reward structure are a factor that may in fact account for the notable absence of a burgeoning educational technology industry for higher education, in contrast to the K-12 level. From another perspective, it is important to note that even willing faculty members are likely to be unprepared to take on such projects. On some campuses, new positions for information resource specialists have been established, to work one-on-one with faculty who want to learn.

Advancements in instructional technology are not likely to spread uniformly across the many types of higher education institutions in the United States. Differences in mission and financial resources between community colleges, liberal arts colleges, and research

universities, for example, may guide the decision-making about alternative investments.[22] A liberal arts college, for instance, may decide that it is preferable to link all classrooms to the Internet, since it cannot afford to build huge computer labs; a community college, on the other hand, trying to maintain expanded access, may decide that it cannot afford *not* to do both. In fact, in the past several decades, community colleges have positioned themselves as one of the most visible and frequent users of numerous mechanisms for learning from off-campus, offering their students correspondence courses, classes broadcast on television, and programs of study available on video- or audiocassettes.

Clearly, all higher education institutions face the reality that both state-of-the-art equipment and skills have a relatively shorter life cycle, becoming obsolete at a pace faster than ever before. While the problem of obsolescence is not unique to higher education as workplaces and educational settings, what is arguably new is the enormous cost and risk involved in proceeding with technological investments—or, in failing to do so. Even Harvard did not immediately adopt computer technology early on; one observer noted, "They have the financial resources to let everyone else make the mistakes and then buy their way to the forefront when the dust has settled."[23]

It is interesting to note that much of the opposition to the technological applications in education have been waged against widely touted "efficiency" imperatives, with many critics concerned about the "quality" of education delivered by new media. As a case in point, statewide interactive video networks illuminate the tension. Whether such networks should simply export programs to those whose geography precludes access or whether the networks themselves should become degree-granting electronic campuses has emerged as a topic of great controversy. In Maine, after faculty protests, the Chancellor resigned after a vote of "no confidence" from all seven Maine campuses; among the most vocal critics of the Educational Network of Maine, faculty were reported to have feared that the distance education opportunities would "empty their classrooms and rob them of their livelihoods."[24] Yet the most evident concerns focused on matters of quality overriding potential gains in efficiency and access, noting that effective teaching and learning delivered over such networks require different pedagogical skills than those traditionally used in face-to-face classroom interaction. Thus, while the use of technology may indeed make more information available (issues of access and efficiency), the question remains as to whether such "advancements" are desirable for higher education (issues of quality).

Conclusion

In this essay, we have identified a number of technological applications for higher education in addition to some foreseeable opportunities and challenges. Having the potential to enrich traditional classroom settings and to extend the boundaries for teaching and learning in higher education, the possible applications prompt us to rethink some fundamental beliefs about the nature of colleges and universities—as places, communities, storehouses of knowledge, and sites of learning. They also prompt us to consider the respective roles of teachers and learners and the optimal conditions for learning. Unlikely to solve higher education's problems of costs or quality, the technological advances at the turn of the millennium do have the potential to provide expanded access and to tailor learning to the needs of those with different cognitive styles and levels of preparation. A new library service model is fundamentally virtual, as it must provide access to information resources, not merely to store collections themselves. Such possible applications also reconceptualize higher education providers as service providers, requiring existing colleges and universities to rethink delivery systems and devise strategies to protect and extend their selected market niches. Thus, the implications for rethinking the "what, where, how, who and when" of higher education are limitless.

How will the current wave of information and communication technologies affect the future of higher education? Will technological advances allow universities to provide a higher quality education to a larger fraction of the populace? Or will they result in a net decrease in educational quality and accentuate the divide between the educational "haves" and "have nots"? Will they make possible cost savings and productivity increases that will rescue colleges and universities from steadily tightening budgets? Or will they place additional pressure on those budgets as colleges and universities are forced to keep up technologically without any compensatory reduction in costs or growth in revenues? Will the advances, as some have claimed, spell the eventual demise of higher education as we know it?[25]

The only prediction that can be made with real confidence is that technology will have an impact on higher education, and that the impact will be far reaching. To pretend we can see the future with much greater clarity is, in this arena, simple hubris. The role that any specific technology will play in higher education cannot be forecasted with any accuracy. Consider the very different histories of two recent technologies: multimedia software and the World Wide Web. These developments are similar in that they both allow us to bring a range of existing base technologies together into easily usable packages. Multimedia has been around for five years or more. An industry darling, it has been consistently overpromoted and has just as consistently underperformed. In contrast, the World Wide Web just exploded from a European physics lab and a midwestern supercomputing center—out of nowhere, from the perspective of the commercial com-

puter industry. These examples illustrate an important point to bear in mind: In the arena of technology, the event horizon—beyond which accurate predictions cannot be made—is roughly six months. This is due partly to the unpredictability of technological development, but more to the complex social, behavioral, and economic contexts in which new technologies are embedded. Predicting which entertainment technologies will work and which will not, which will appeal and which will not, which will sell and which will not, is extremely difficult. Predicting the future of educational technology—embedded as it is in a far more complex and poorly understood endeavor—is close to impossible.

When considering how technology will affect higher education, we must also keep in mind that there is no single answer. Since differentiation has long been the hallmark of higher education in the U.S., technological investments and applications are likely to show great variation across campuses, with dramatically different opportunities available across different populations of students and faculty. Although we advocate proceeding with caution, we also believe that it is not useful to react defensively. The massive technological changes of the new era cannot be resisted; if they are going to happen, they will happen in spite of defenses. Just as one responds to news of an imminent tidal wave, a prudent course may be to position ourselves in order to survive. Others of course may decide that a prudent course of action is to be out in front, determined to embrace and, where possible, shape the impact. In either case, we believe that technological advancements need to be seen as means to several potential ends, not just as ends in themselves.

Finally, as we have discussed, change in the processes and products of higher education is the result of a complex interplay of wider societal forces. While technology provides opportunities, it also creates vivid pressures which at times entail contradictory prescriptions for those who are responsible for shepherding the higher education enterprise through turbulent times. We must keep in mind that technology is not a magic wand, but merely a set of tools. The ultimate challenge may involve not only positioning and investing amidst various social, political, and economic considerations, but nurturing the imagination for harnessing its power and as-of-yet unimagined educational potential.

Endnotes

1. Before proceeding, it is of course important to define the relevant terms. Although "technology" has many different meanings, for this chapter, we are talking more narrowly about the fungible categories of information and communications technology, which includes those devices that are used to collect, transmit, and process information. We begin with the assumption that technological change is a *social process*—not only does technology impact society, but it is also cultural product subject to larger social structures and social trends.

2. R. Usher and R. Edwards, *Postmodernism and Education* (London: Routledge, 1994).

3. S. Lohr, "When the Alma Mater Ends with '.edu'," *New York Times* , 7 July 1996, sec. 4, p. 2, col. 1.

4. R. C. Snider, "The Machine in the Classroom," *Phi Delta Kappan* 74, no. 4 (December 1992).

5. E. Fiske, "Computers in the Groves of Academe," *The New York Times* , 13 May 1984; Snider, "Machine in the Classroom."

6. Lohr, "Alma Mater."

7. For this and other examples, see W. Massy, *Leveraged Learning: Technology's Role in Restructuring Higher Education* (Stanford, CA: Stanford Forum for Higher Education Futures, 1995).

8. Fiske, "Groves of Academe"; C. Fischer, " 'Touch Someone': The Telephone Industry Discovers Sociability," *Technology and Culture* (1988): 29, 32-61.

9. J. Lyotard, *The Postmodern Condition: A Report on Knowledge*, (Manchester: Manchester University Press, 1984). At the same time, the academic study of the knowledge industry is gaining visibility. While previously the domain of sociologists of knowledge and science, the endowment of a new chair for a "distinguished professor of knowledge" in the business school of the University of California at Berkeley signals broader interest in the phenomena. (See J. Sterngold, "Welcome to Berkeley: Professor Knowledge is Not an Oxymoron," *New York Times*, 1 June 1997, sec. 4, p. 5.)

10. The role of faculty as coach or "guide on the side" has become a shorthand for describing the shift away from a belief that the faculty member should be the focus of attention and authority.

11. S. Gilbert, "Making the Most of a Slow Revolution," *Change* 28 (March/April 1996):12.

12. C. Twigg, "Navigating the Transition," *Educom Review* 29 (November/December 1994).

13. For attempts to gauge usage and ownership, see Gilbert, "Slow Revolution," 10-23; and K. Green, "The Coming Ubiquity of Information Technology," *Change* 28 (March/April 1996): 25-31; and K. Green and S. Gilbert, "Great Expectations: Content, Communications, Productivity, and the Role of Information Technology in Higher Education," *Change* (March/April 1995): 8-18.

14. See R. Cushman's excellent article ("From a Distance: Who Needs a Campus When You Have a Downlink," *Lingua Franca* 6, no.7 (November 1996): 53-63) in reference to the Mind Extension University.

15. G. Jacobsen, "Three Entrepreneurial Companies Offer Educational Services," *Success* 44, no. 2, (March 1997): 24.

16. Reference by M. Leavitt, Governor of Utah, in "The Western Governors University: A Learning Enterprise for the CyberCentury," unpublished manuscript, 1997, available at *http://cause-www.colorado.edu/information-resources/ir-library.*

17. For a discussion of changing environmental demands and emerging restructuring initiatives, see P. Gumport and B. Pusser, "Restructuring the Academic Environment," in*Planning and Management for a Changing Environment*, edited by M. Peterson, D. Dill, L. Mets, and associates (San Francisco, CA: Jossey-Bass Publishers, 1997): 453-478. For analysis of resource allocation tradeoffs, see Massy, *Leveraged Learning*, and "Life on the Wired Campus," in *The Learning Revolution*, edited by D. Oblinger and S. Rush (Anker Publishing Company,
forthcoming).

18. W. Massy and R. Zemsky, *Using Information Technology to Enhance Academic Productivity* (Washington, DC: EDUCOM, 1995).

19. Usher and Edwards, *Postmodernism and Education.*

20. Snider, "Machine in the Classroom."

21. Green, "Coming Ubiquity," for reports on the pattern of diffusion, specifically the slow adoption by the majority of the faculty.

22. For attempts to characterize differences in technological applications by institutional type, see K. Green, "Coming Ubiquity," as well as R. Heterick, Jr., (ed.), "Reengineering Teaching and Learning in Higher Education: Sheltered Groves, Camelot, Windmills, and Malls," CAUSE professional paper series, no. 10 (Boulder, CO: CAUSE, 1993).

23. Fiske, “Groves of Academe.”

24. Cushman, “From a Distance,” 56.

25. For a thoughtful perspective on some of these questions, see G. Casper, “Come the Millennium, Where the University?” (paper presented at the annual meeting of the American Educational Research Association, San Francisco, Calif., 18 April 1995).