CHAPTER 4

Preparing for the Revolution: The Future of the University in the Digital Age

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"The impact of information technology will be even more radical than the harnessing of steam and electricity in the 19th century. Rather it will be more akin to the discovery of fire by early ancestors, since it will prepare the way for a revolutionary leap into a new age that will profoundly transform human culture." (Attali, 1992, p. 11)

INTRODUCTION

One of the central topics of the third meeting of the Glion Colloquium concerned the eroding boundaries of the contemporary university as traditional constraints disappear and new arrangements are demanded by a changing world. The forces driving this restructuring of the higher education enterprise are many and varied: the globalization of commerce and culture, the lifelong educational needs of citizens in a knowledge-driven society, the advanced educational needs of a high performance workplace, the exponential growth of new knowledge and new disciplines, and the compressed timescales and nonlinear nature of the transfer of knowledge from campus laboratories into commercial products. This paper concerns itself with the impact of information and communications technologies on higher education, which are rapidly obliterating the conventional constraints of space, time, organization, monopoly, and even reality itself.

Modern digital technologies such as computers, telecommunications, and networks are reshaping both our society and our social institutions. These

technologies have increased vastly our capacity to know and to do things and to communicate and collaborate with others. They allow us to transmit information quickly and widely, linking distant places and diverse areas of endeavor in productive new ways. They allow us to form and sustain communities for work, play, and learning in ways unimaginable just a decade ago.

Of course higher education has already experienced significant change driven by digital technology. Our management and administrative processes are heavily dependent upon this technology. Research and scholarship are also highly dependent upon information technology, for example, the use of computers to simulate physical phenomena, networks to link investigators in virtual laboratories or "collaboratories," and digital libraries to provide scholars with access to knowledge resources. There is an increasing sense that new technology will also have a profound impact on teaching, freeing the classroom from the constraints of space and time and enriching learning by providing our students with access to original source materials.

Yet, while information technology has the capacity to enhance and enrich teaching and scholarship, it also poses certain threats to our colleges and universities. We can now use powerful computers and networks to deliver educational services to anyone, at anyplace and anytime. Technology is creating an open learning environment in which the student becomes an active learner and consumer of educational services, stimulating the growth of powerful market forces that could dramatically reshape the higher education enterprise.

THE EVOLUTION OF INFORMATION TECHNOLOGY

It is difficult to understand and appreciate just how rapidly information technology is evolving. During the first decades of the information age, the evolution of hardware technology followed the trajectory predicted by "Moore's Law"—that the chip density and consequent computing power for a given price doubles every eighteen months (Deming & Metcalf, 1997). This corresponds to a hundredfold increase in computing speed, storage capacity, and network transmission rates every decade. Of course, if information technology is to continue to evolve at such rates, we will likely need not only new technology but even new science. But with emerging technology such as quantum computing, nanocomputers, and biocomputing, there is significant possibility that Moore's Law will continue to hold for at least a few more decades.

To put this statement in perspective, if information technology continues to evolve at its present rate, by the year 2020, the thousand-dollar notebook computer will have a computing speed of 1 million gigahertz, a memory of thousands of terabits, and linkages to networks at data transmission speeds of

gigabits per second. Put another way, it will have a data processing and memory capacity roughly comparable to the human brain (Kurzweil, 1999). However, the computer will be so tiny as to be almost invisible, and it will communicate with billions of other computers through wireless technology.

This last comment raises an important issue. The most dramatic impact on our world today from information technology is not from the continuing increase in computing power, but rather from the extraordinary rate at which bandwidth is expanding, that is, the rate at which we can transmit digital information. In a sense, the price of data transport is becoming zero, and with rapid advances in photonic and wireless technology, telecommunications will continue to evolve very rapidly for the foreseeable future.

The nature of human interaction with the digital world—and with other humans through computer-mediated interactions—is also evolving rapidly. We have moved beyond the simple text interactions of electronic mail and conferencing to graphical-user interfaces and then through voice to video. With the rapid development of sensors and robotic actuators, touch and action at a distance will soon be available, i.e., "telepresence".

The penetration of digital technology into our society has proceeded at an extraordinary pace. Already the Internet links hundreds of millions of people. Estimates are that, by the end of the decade, this number will surge to billions, a substantial fraction of the world's population, driven in part by the fact that most economic activity will be based on digital communication. Bell Laboratories suggests that within two decades a "global communications skin" will have evolved, linking together billions of computers that handle the routine tasks of our society, from driving our cars to monitoring our health.

In other terms, over the next decade, we will evolve from "giga" technology (in terms of computer operations per second, storage, or data transmission rates) to "peta" technology (one million-billion or 1015). A petabyte of data is equivalent roughly to the capacity of a stack of CD-ROMs nearly 2 km high. We will denominate the number of computer servers in the billions, digital sensors in the tens of billions, and software agents in the trillions. We will evolve from "e-commerce" and "e-government" and "e-learning" to "e-everything"!

Of course, our world has experienced other periods of dramatic change driven by technology, for example, the impact of the steam engine, telephone, automobile, and railroad in the late nineteenth century, which created our urban industrialized society. But never have we experienced a technology that has evolved so rapidly and relentlessly, increasing in power by a hundred-fold or more every decade, obliterating the constraints of space and time, and reshaping the way we communicate, think, and learn.

There are several characteristics of information technology that set it apart from earlier experiences with technology-driven change: 1) its active rather than passive nature; 2) the way that it obliterates the constraints of space and time (and perhaps reality); 3) its extraordinary rate of evolution, relentlessly increasing in power by factors of 100 to 1000 fold decade after decade; and 4) the manner in which it unleashes the power of the market place. Furthermore, this technology drives very significant restructuring of our society and social institutions through what Brown and Duguid (2000) term the 6-D effects: demassification, decentralization, denationalization, despecialization, disintermediation, and disaggregation. Perhaps we should add a seventh "D", democratization, since the technology provides unusual access to knowledge and knowledge services (such as education) hitherto restricted to the privileged few. Like the printing press, this technology not only enhances and broadly distributes access to knowledge, but in the process it shifts power away from institutions to those who are educated and trained in the use of the new knowledge media.

Most discussions concerning information technology and higher education deal primarily with technology's impact upon instruction, for example, online distance education or virtual universities. But the roles of the contemporary university are broad and diverse, ranging from educating the young to preserving our cultural heritage; providing the basic research essential to national security, economic prosperity, and social well-being; training our professionals and certifying their competence; and challenging our society and stimulating social change. Knowledge is the medium of the university in the sense that each of its many roles involves the discovery, shaping, transfer, or application of knowledge. In this sense, it is clear that the rapid evolution of information and communications technologies will reshape all of the roles of the university. Thus, to understand the future of the university in the digital age, it is important to consider the impact of technology on each of its activities.

THE IMPACT OF INFORMATION TECHNOLOGY ON THE ACTIVITIES OF THE UNIVERSITY

The earliest applications of information technology in research involved using the computer to solve mathematical problems in science and technology. Today, problems that used to require the computational capacity of rooms of supercomputers can be tackled with the contemporary laptop computer. The rapid evolution of this technology is enabling scholars to address previously unsolvable problems, such as proving the four-color conjecture in mathematics, analyzing molecules that have yet to be synthesized, or simulating the birth of the universe.

The availability of high bandwidth access to instrumentation, data, and colleagues is also changing the way scholars do their work. They no longer need to focus as much on the availability of assets such as equipment or the physical proximity of colleagues, and instead can focus on hypotheses and questions. It has also changed the way graduate students interact and participate in research, opening up the environment for broader participation. In fact, information technology is "democratizing" research by allowing researchers and institutions that would normally not have access to the sophisticated facilities and libraries of research universities to become engaged in cutting edge scholarship.

The preservation of knowledge is one of the most rapidly changing functions of the university. The computer—or more precisely, the "digital convergence" of various media from print-to-graphics-to-sound-to-sensory experiences through virtual reality—will likely move beyond the printing press in its impact on knowledge. The library is becoming less a collection house and more a center for knowledge navigation, a facilitator of information retrieval and dissemination (*Daedelus*, 1966, pp. v-vii). In a sense, the library and the book are merging. One of the most profound changes will involve the evolution of software agents that will collect, organize, relate, and summarize knowledge on behalf of their human masters. Our capacity to reproduce and distribute digital information with perfect accuracy at essentially zero cost has shaken the very foundations of copyright and patent law and threatens to redefine the nature of the ownership of intellectual property (Barlow, 1994). The legal and economic management of university intellectual property is rapidly becoming one of the most critical and complex issues facing higher education.

The traditional classroom paradigm is also being challenged, not so much by the faculty, who have by and large optimized their teaching effort and their time commitments to a lecture format, but by students. Members of today's digital generation of students have spent their early lives immersed in robust, visual, electronic media—home computers, video games, cyberspace networks, and virtual reality. They expect—indeed, demand—interaction, approaching learning as a "plug-and-play" experience; they are unaccustomed and unwilling to learn sequentially—to read the manual—and instead are inclined to plunge in and learn through participation and experimentation. Although this type of learning is far different from the pyramidal approach of the traditional college curriculum, it may be far more effective for this generation, particularly when provided through a media-rich environment.

For a time, such students may tolerate the linear lecture paradigm of the traditional college curriculum. They still read what we assign, write the required term papers, and pass our exams. But this is decidedly not the way

they learn. They learn in a nonlinear fashion, skipping from beginning to end and then back again, and building peer groups of learners, developing sophisticated learning networks in cyberspace. In a very real sense, they build their own learning environments that enable interactive, collaborative learning, whether we recognize and accommodate this or not.

Sophisticated networks and software environments can be used to break the classroom loose from the constraints of space and time and make learning available to anyone, anyplace, at any time. The simplest approach uses multimedia technology via the Internet to enable distance learning. Yet many believe that effective computer-network-mediated learning will not be simply an Internet extension of correspondence or broadcast courses. Since learning requires the presence of communities, the key impact of information technology may be the development of computer-mediated communications and communities that are released from the constraints of space and time. There is already sufficient experience with such asynchronous learning networks to conclude that, at least for many subjects and when appropriately constructed, the computer-mediated distance learning process is just as effective as the classroom experience (Bourne, 2000).

The attractiveness of computer-mediated distance learning is obvious for adult learners whose work or family obligations prevent attendance at conventional campuses. But perhaps more surprising is the degree to which many on-campus students are now using computer-based distance learning to augment their traditional education. Broadband digital networks can be used to enhance the multimedia capacity of hundreds of classrooms across campus and link them with campus residence halls and libraries. Electronic mail, teleconferencing, and collaboration technology is transforming our institutions from hierarchical, static organizations to networks of more dynamic and egalitarian communities. Distance learning based on computer-network-mediated paradigms allows universities to push their campus boundaries outward to serve new learners. Those institutions willing and capable of building such learning networks will see their learning communities expand by an order of magnitude.

In the near term, at least, traditional models of education will coexist with new learning paradigms, providing a broader spectrum of learning opportunities in the years ahead. The transitions from student to learner, from teacher to designer-coach-consultant, and from alumnus to lifelong member of a learning community seem likely. And with these transitions and new options will come both an increasing ability and responsibility on the part of learners to select, design, and control the learning environment.

IMPACT ON THE FORM AND FUNCTION OF THE UNIVERSITY

Colleges and universities are structured along intellectual lines, organized into schools and colleges, departments and programs that have evolved over the decades. Furthermore, the governance, leadership, and management of the contemporary university are structured also to reflect this intellectual organization, as well as academic values of the university such as academic freedom and institutional autonomy. The "contract" between members of the faculty and the university reflects the unusual character of academic values and roles, the practice of tenure being perhaps the most visible example.

Just as the university is challenged in adapting to new forms of teaching and research stimulated by rapidly evolving information technology, so too its organization, governance, management, and its relationships to students, faculty, and staff will require serious re-evaluation and almost certain change. For example, the new tools of scholarship and scholarly communication are eroding conventional disciplinary boundaries and extending the intellectual span, interests, and activities of faculty far beyond traditional organizational units such as departments, schools, or campuses. This is particularly the case with younger faculty members whose interests and activities frequently cannot be characterized by traditional disciplinary terms.

Beyond driving a restructuring of the intellectual disciplines, information technology is likely to force a significant disaggregation of the university on both the horizontal (e.g., academic disciplines) and vertical (e.g., student services) scale. Faculty activity and even loyalty is increasingly associated with intellectual communities that extend across multiple institutions, frequently on a global scale. New providers are emerging that can far better handle many traditional university services, ranging from student housing to facilities management to health care. Colleges and universities will increasingly face the question of whether they should continue their full complement of activities or "outsource" some functions to lower cost and sometimes higher quality providers, relying on new paradigms such as e-business and knowledge management.

It has become increasingly important that university planning and decision making take account not only of technological developments and challenges, but draw upon the expertise of people with technological backgrounds. Yet all too often, university leaders, governing boards, and even faculties ignore the rapid evolution of this technology, treating it more as science fiction than as representing serious institutional challenges and opportunities. To a degree this is not surprising, since in the early stages, new technologies sometimes look decidedly inferior to long-standing practices. For example, few would regard the current generation of computer-mediated distance learning programs as providing the socialization function associated

with undergraduate education in a residential campus environment. Yet there have been countless instances of technologies, from personal computers to the Internet, that were characterized by technology learning curves far steeper than conventional practices. Such "disruptive technologies" have demonstrated the capacity to destroy entire industries, as the explosion of e-business makes all too apparent (Christensen, 1997).

IMPACT ON THE POST-SECONDARY EDUCATION ENTERPRISE

In higher education, digital technology is redefining the basis for competitive advantage and survival. It redefines boundaries and blurs roles. This technology, coupled with the emergence of competitive forces driven by changing societal needs (e.g., adult education) and economic realities (erosion in public support), is likely to drive a massive restructuring of higher education. From the experience with other restructured sectors of our economy, such as health care, transportation, communications, and energy, we can expect to see in higher education the mergers, acquisitions, new competitors, and new products and services that have characterized other economic transformations. More generally, we may well be seeing the early stages of a global knowledge and learning industry, in which the activities of traditional academic institutions converge with other knowledge-intensive organizations, such as telecommunications, entertainment, and information service companies.

The size of the education component of this industry, consisting of K-12, higher education, and corporate learning, is enormous, estimated at over $740 B in the United States and $2 trillion globally (Moe, 2000). It is growing rapidly, driven by the increasing importance of human capital to our knowledge-driven economies. Business leaders are united in their belief that there is no bigger challenge in the global marketplace than how to obtain, train, and retrain knowledge workers. The new economy is a knowledge economy based on brainpower, ideas, and entrepreneurism. Technology is its driving force, and human capital is its fuel.

A key factor in this restructuring has been the emergence of new aggressive for-profit educator providers that are able to access the private capital markets (over $4 billion in 2000). Examples include the University of Phoenix, Sylvan Learning Systems, the British Open University, the Western Governors University, and a growing array of "dot-coms" such as Unext.com and Blackboard.com. It is important to recognize that while many of these new competitors are quite different than traditional academic institutions, they are also quite sophisticated in their pedagogy, their instructional materials, and their production and marketing of educational services. They approach the market in a highly sophisticated manner, first moving into

areas characterized by limited competition, unmet needs, and relatively low production costs, but then moving rapidly up the value chain to more sophisticated educational programs. These IT-based education providers are already becoming formidable competitors to traditional postsecondary institutions.

Although traditional colleges and universities will also play a role in such a technology-based, market-driven future, they could be both threatened and reshaped by shifting societal needs, rapidly evolving technology, and aggressive for-profit entities and commercial forces. Many of the predictions about the growth of demand for distance learning are overly optimistic, at least for the near term. But, clearly the university will lose its monopoly for students, faculty, and resources, and it is likely to lose market share as well, as commercial competitors position themselves to address the rapid need for adult education. The successful penetration of this market for most universities will involve partnerships with the commercial sector.

The research university will face particular challenges in this regard. Although rarely acknowledged, most research universities rely upon cross-subsidies from low-cost, high profit-margin instruction in general education (e.g., large lecture courses) and low cost professional education (e.g., business administration and law) to support graduate education and research. Yet these high margin programs are just the low hanging fruit most attractive to technology-based, for-profit competitors. In this sense, the emergence of a significant technology-based commercial sector in the post-secondary education marketplace could undermine the current business model of the research university and threaten its core activities in research and graduate education.

As a knowledge-driven economy becomes ever more dependent upon new ideas and innovation, there will be growing pressures to commercialize the intellectual assets of the university–its faculty and students, its capacity for basic and applied research, the knowledge generated through its scholarship and instruction. Public policy has encouraged the transfer of knowledge from the campus to the marketplace. But since knowledge can be transferred not only through formal technology transfer mechanisms such as patents and licensing, but also through the migration of faculty and students, there is a risk that the rich intellectual assets of the university will be stripped away and commercialized by its own faculty, even as support for graduate education and research erodes.

THE CHALLENGE OF UNIVERSITY LEADERSHIP IN THE DIGITAL AGE

Today's college and university leaders face myriad important questions and decisions concerning the impact of information technology on their institutions. For example, they need to understand the degree to which this tech-

nology will transform the basic activities of teaching, research, and service. Will the classroom disappear? Will the residential campus experience of undergraduate education be overwhelmed by virtual universities or "edutainment?" How should the university integrate information technology into its educational programs at different levels? Will information technology alter priorities among the different university activities?

What kind of information technology infrastructure will the university need? How will it finance the acquisition and maintenance of this technology? To what degree should an institution outsource the development and management of IT systems? How should the university approach its operations and management to best take advantage of this technology? How can institutions better link planning and decision making with likely technological developments and challenges? How can one provide students, faculty, and staff with the necessary training, support, and equipment to keep pace with the rapid evolution of information technology? What is the role of universities with respect to the "digital divide", the stratification of our society with respect to access to technology?

How do colleges and universities address the rapidly evolving commercial marketplace for educational services and content, including, in particular, the for-profit and dot.com providers? What strategies and actions should they consider? What kinds of alliances are useful in this rapidly changing environment? With other academic institutions? With business? On a regional, national, or global scale? Should colleges and universities join together to create a "best practice" organization that provides assistance in analyzing needs and opportunities?

How can colleges and universities grapple with the forces of disaggregation and aggregation associated with a technology-driven restructuring of the higher education enterprise? Will universities be forced to merge into larger units, or will they find it necessary to outsource or spin-off existing activities? Will more (or perhaps most) universities find themselves competing in a global marketplace, and how will that square with the regional responsibilities of publicly supported universities? Will new learning lifeforms or ecologies evolve based upon information technology that will threaten the very existence of the university?

The list of questions and issues seems not only highly complex but overwhelming to university leaders, not to mention the many stakeholders who support higher education. Yet, surveys suggest that despite the profound nature of these issues, information technology usually does not rank high among the list of priorities for university planning and decision making in the United States (Government-University-Industry Research Roundtable and National Science Board, 1997). Perhaps this is due to the limited experience most college and university leaders have with this emerging technology.

It could also be a sign of indecisiveness and procrastination in the face of complexity and uncertainty. Yet, as the pace of technological change continues to accelerate, indecision and inaction can be the most dangerous course of all.

As information technology continues to evolve, organizations in every sector are grappling with the need to transform their basic philosophies and processes to collect, synthesize, manage, and control information. Corporations and governments are reorganizing in an effort to utilize technology to enhance productivity, improve quality, and control costs. Entire industries have been restructured to better align with the realities of the digital age.

To date, the university stands apart, almost unique in its determination to moor itself to past traditions and practices, to insist on performing its core activities much as it has done for decades. In spite of the information explosion and the profound impact of digital communications technology, the use of information and dissemination and learning remain fundamentally unchanged in higher education. Most universities continue to ignore the technology cost learning curves so important in other sectors of society. They insist that it remains simply too costly to implement technology on a massive scale in instructional activities—which, of course, it does, as long as we insist on maintaining their traditional character rather than re-engineering educational activities to enhance productivity and quality. Our limited use of technology thus far has been at the margins, to provide modest additional resources to classroom pedagogy or to attempt to extend the physical reach of our current classroom-centered teaching paradigm. It is ironic indeed that the very institutions that have played such a profound role in developing the digital technology now reshaping our world are the most resistant to reshaping their activities to enable its effective use.

A NATIONAL ACADEMY PROJECT

In the United States, the National Academies (i.e., the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine) have a unique mandate to monitor and sustain the health of the nation's research universities as key elements of the national research enterprise and the source of the next generation of scientists, engineers, and other knowledge professionals. This role becomes particularly important during periods of rapid change. It was from this perspective that the presidents of our National Academies launched a project in 2000 to understand better the implications of information technology for the future of the research university. I was asked to chair the steering group for this effort, comprised of leaders with backgrounds in technology, higher education, and public policy.

The premise of the National Academies study was a simple one. The rapid evolution of digital technology will present many challenges and opportunities to higher education in general and the research university in particular. Yet there is a sense that many of the most significant issues are neither well recognized nor understood by leaders of our universities or those who support and depend upon their activities.

The first phase of the project was aimed at addressing three sets of issues:

- To identify those technologies likely to evolve in the near term (a decade or less) that could have a major impact on the research university.
- To examine the possible implications of these technology scenarios for the research university: its activities (teaching, research, service, outreach); its organization, structure, management, and financing; and the impact on the broader higher education enterprise and the environment in which it functions.
- To determine what role, if any, there was for federal government and other stakeholders in the development of policies, programs, and investments to protect the valuable role and contributions of the research university during this period of change.

Our steering group met on numerous occasions to consider these issues. We visited major technology laboratories, such as Bell Labs and IBM Research Labs, and drew upon the expertise of the National Academy complex. In 2001, we convened 100 leaders from higher education, the IT industry, and the federal government, and several private foundations for a workshop at the National Academy of Sciences.

There was a consensus that the extraordinary evolutionary pace of information technology is likely to continue for the next several decades and even could accelerate on a superexponential slope. Photonic technology is evolving at twice the rate of silicon chip technology, with miniaturization and wireless technology advancing even faster, implying that the rate of growth of network appliances will be incredible. For planning purposes, we can assume that within the decade we will have infinite computer power, infinite bandwidth, and ubiquitous connectivity (at least compared to current capabilities).

The event horizons for disruptive change are moving ever closer. The challenge of getting people to think about the implications of accelerating technology learning curves as well as technology cost-performance curves is very important. There are likely to be major technology surprises, comparable in significance to the appearance of the personal computer in the 1970s and the Internet browser in 1994, but at more frequent intervals.

The impact of information technology on the university will likely be profound, rapid, and discontinuous–just as it has been and will continue to be for the economy, our society, and our social institutions. It will affect our activities (teaching, research, outreach), our organization (academic structure, faculty culture, financing and management), and the broader higher education enterprise as it evolves into a global knowledge and learning industry.

Yet, for at least the near term, the university will continue to exist in much its present form, although meeting the challenge of emerging competitors in the marketplace will demand significant changes in how we teach, how we conduct scholarship, and how our institutions are financed. Universities must anticipate these forces, develop appropriate strategies, and make adequate investments if they are to prosper.

Over the longer term, the basic character and structure of the university may be challenged by the IT-driven forces of aggregation (e.g., new alliances, restructuring of the academic marketplace into a global learning and knowledge industry) and disaggregation (e.g., restructuring of the academic disciplines, detachment of faculty and students from particular universities, decoupling of research and education).

Although information technology will present many complex challenges and opportunities to university leaders, procrastination and inaction are the most dangerous courses of all during a time of rapid technological change. To be sure, there are certain ancient values and traditions of the university that should be maintained and protected, such as academic freedom, a rational spirit of inquiry, and liberal learning. But, just as it has in earlier times, the university will have to transform itself once again to serve a radically changing world if it is to sustain these important values and roles.

Although information technology will continue its rapid evolution for the foreseeable future, it is far more difficult to predict the impact of this technology on human behavior and upon social institutions such as the university. It is important that higher education develop mechanisms to sense the changes that are being driven by information technology and to understand where these forces may drive the university. Because of the profound yet unpredictable impact of this technology, it is important that institutional strategies include: 1) the opportunity for experimentation, 2) the formation of alliances both with other academic institutions as well as with for-profit and government organizations, and 3) the development of sufficient in-house expertise among the faculty and staff to track technological trends and assess various courses of action.

To conclude, for the near term, information technology will drive comprehensible if rapid, profound, and discontinuous change in the university. For the longer term (two decades and beyond), all bets are off. As noted, implica-

tions of a million-fold or billion-fold increase in the power of information technology are difficult even to imagine, much less to predict, for our world and, even more so, for our institutions.

THE FUTURE OF THE UNIVERSITY IN THE DIGITAL AGE

The digital age poses many challenges and opportunities for the contemporary university. For most of the history of higher education, we have expected students to travel to a physical place to participate in a pedagogical process involving tightly integrated studies based mostly on lectures and seminars by recognized experts. Yet, as the constraints of time and space—and perhaps even reality itself—are relieved by information technology, will the university as a physical place continue to hold its relevance?

In the near term, it seems likely that the university as a physical place, a community of scholars and a center of culture, will remain. Information technology will be used to augment and enrich the traditional activities of the university, in much their traditional forms. To be sure, the current arrangements of higher education may shift. For example, students may choose to distribute their college education among residential campuses, commuter colleges, and online or virtual universities. They may also assume more responsibility for and control over their education. In this sense, information technology is rapidly becoming a liberating force in our society, not only freeing us from the mental drudgery of routine tasks, but also linking us together in ways we never dreamed possible. Furthermore, the new knowledge media enable us to build and sustain new types of learning communities, free from the constraints of space and time. Higher education must define its relationship with these emerging possibilities in order to create a compelling vision for its future as it enters the next millennium.

For the longer term, the future of the university becomes far less certain. Although the digital age will provide a wealth of opportunities for the future, we must take great care not simply to extrapolate the past, but instead to examine the full range of possibilities for the future. There is clearly a need to explore new forms of learning and learning institutions that are capable of sensing and understanding the change and of engaging in the strategic processes necessary to adapt or control it.

While the threats posed to traditional roles and practices by emerging information and communications technology may serve usefully as a warning shot across the bow of our institutions–particularly their faculties–university leadership should not be simply reacting to threats but instead acting positively and strategically to exploit the opportunities presented by information technology to improve the quality of education and scholarship. Technology will allow colleges and universities to serve society in new ways, perhaps

more closely aligned with their fundamental academic mission and values. It will also provide strong incentives for building new alliances among diverse educational institutions, thereby providing systemic opportunities for improving the quality of higher education.

Hence, while college and university leaders should recognize and understand the threats posed by rapidly evolving information technology to their institutions, they should seek to transform these threats into opportunities for leadership. Information technology should be viewed as a tool of immense power to use in enhancing the fundamental roles and missions of the university as it enters the digital age.

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