THE INFORMATION REVOLUTION: IMPLICATIONS FOR HIGHER EDUCATION POLICY

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Since the early 1990's, rapid advances in information technologies have changed the ways our society receives, processes, and uses information. Akin to the Industrial Revolution of the 19th century, this new Information Revolution has a huge impact on virtually all of our institutions and ways of doing things. However, in the following Article, Professors Daniel Alpert and Robert Rich illustrate that while technological innovation may offer great promise and new opportunities, unintended threats and challenges may also be presented. The authors argue that throughout history, the promise and benefits of new technologies have often come with unintended and unforeseen negative consequences, accordingly, the Information Revolution is no different. Professors Alpert and Rich suggest that typically, the greater the promise of a technology, the greater the potential threats are. In this Article, the authors explore current efforts to strengthen the higher education enterprise through the introduction of new information technologies to illustrate their point.

Professors Alpert and Rich begin with a historical perspective illustrating how innovative technologies throughout history that have had great benefits were also accompanied by challenges. Next, the authors explore the impact of new information technologies on higher education. In particular, the authors discuss how the Information Revolution is changing the central mission and priorities of colleges and universities. Both the potential benefits and challenges of these changes are subsequently discussed. Then, Professors Alpert and Rich discuss how the Information Revolution affects distance-learning programs. They consider the concept of a "Virtual University" and explore the potential benefits and threats.

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associated with this new enterprise. Finally, the authors discuss how new information technologies may be used to build new learning environments that will maximize the benefits of these new technologies while minimizing potential threats to promote the ultimate goal of building a learning society.

Just a few years ago, a miracle occurred . . . the World Wide Web . . . [and the] point-and-click browser . . . [cleared the way] for truly intuitive access, and suddenly the basis for a truly global information infrastructure was born. Many now believe that . . . these two creations . . . will rank among the most important developments in the history of civilization, and that all aspects of how we work, learn and live will be forever changed by them.

- Joel Birnbaum, Chief Scientist at Hewlett Packard

The real question is not whether higher education will be transformed, but rather how and by whom. If the university is capable of transforming itself to respond to the needs of a culture of learning, then what is currently perceived as the challenge of change may become the opportunity for a renaissance in higher education in the years ahead.

- James J. Duderstadt, President Emeritus, University of Michigan in Ann Arbor

I. INTRODUCTION: THE INFORMATION REVOLUTION AS PROMISE AND THREAT

We as a nation and as participants in a global economy are experiencing a technological revolution of unprecedented impact. In a cumulative sequence since World War II, many novel technologies make up what we refer to as the Information Revolution, including increasingly powerful personal computing, various means for electronic textual, oral, and visual communication, sophisticated electronic data handling, interactive and collaborative support systems, high-speed communication networks, and multimedia presentation. These, in turn, have transformed ways of providing services as well as manufacturing and marketing products. The Internet and its related technologies have constituted principal catalysts for the explosive growth of the digital economy throughout the 1990's. Since 1993, when the first graphical Web browser (Mosaic) was developed at the University of Illinois, the number of host computers on the Internet has grown from only a handful to more than 100 million, distributed around the world. These Internet-related technologies have already transformed the manufacture and
marketing of goods such that the average citizen no longer knows where the factories or retailers they buy goods from are geographically located.

Like the Industrial Revolution of the 19th century, the current Information Revolution is having a worldwide impact on virtually all of our institutions and ways of doing things. Perhaps the most distinctive, as well as disquieting, features of the current revolution are the rapidity with which change is taking place and the consequences of its global dimensions.

Widespread adoption and investment in the early stages of a technological transformation are based on the expectation, that is the perceived promise, that the new technology will have advantageous effects on some features of personal, institutional, social or economic life. We are already aware of many perceived desirable consequences of the Information Revolution on our institutions and on the national economy. However, a historical survey of earlier technological innovations provides some sobering further insights; there may be a downside, a set of unintended problematic consequences of technological innovation.

Consider the following technologies, most of which had widespread acceptance in the early stages of adoption, and all of which had serious unintended consequences that were recognized at a later stage. In some cases, the adverse effects were ameliorated only after the slow processes of legal or institutional change. In other cases, the challenges still lie ahead. For the printed page and the book, public policies in support of "freedom of the press," that is to say, freedom from censorship, were not introduced until centuries after the invention of movable type by Gutenberg (in 1455). The factory as technology was introduced during the Industrial Revolution of the early 19th century; public policy in the form of child labor laws and public welfare came many decades later. The telephone came into use at the turn of the 20th century, decades before wire-tapping laws (in 1928) assured reasonable privacy and protection from intrusion by government agencies. When television was introduced following World War II, this technology was highly touted as a boon for education; today, its adverse effects on children are the subject of continuing debate. Food and drug regulations and truth-in-advertising laws followed long after unintended outcomes from the marketing of new drugs. With respect to the automobile, crash tests, seat belts, and emission controls were introduced many decades after the advent of Henry Ford’s Model T. We are still in the process of assessing and trying to alleviate other adverse effects of the automobile revolution including urban sprawl, environmental damage, wars over access to petroleum, and global climate change.

These considerations support the following premise: Major technological innovations offer the prospect and promise of new opportunities to society and its institutions. However, with desirable prospects also come new threats and challenges. Usually, the threats or challenges are unintended and unexpected outcomes of widespread adoption. When a given technology, such as the printed page, has many
distinct uses (e.g., newspapers, novels, financial or medical records) it often becomes more meaningful to argue that every new use of a technology has both promise and threat.

In general, the greater the promise, the greater the threat. The threat and the promise do not necessarily arrive at the same time, nor do they necessarily affect the same populations. Sometimes the promise benefits one group or class, while other groups are victims of the threat. In many earlier cases, the threats were ameliorated by government actions or new legislation, decades or even centuries after the introduction of the technologies. In some cases the challenges still lie ahead, even after the vast majority of citizens are quite familiar with the technologies.

Donald Schon has presented a persuasive analysis of the role of technology in society as well as the impact of technological change on social systems:

It is always futile to seek a single “cause” for a system’s being the way it is. There is always a complex of interacting components. The social system contains [organizational] structure, technology and theory. The structure is the set of roles and relations among the individual members. The theory consists of the views held within the social system about its purposes, its operations, its environment and its future. Both reflect and in turn influence, the prevailing technology of the system. These dimensions all hang together so that any change in one produces change in others. ³

These considerations offer insights into many unintended outcomes brought about by a major technological revolution. In many cases, political gridlock is generated when opposing factions have differing perceptions of whether the same technology offers threat or promise. Well-motivated efforts may fail because stakeholders who agree on the validity of technological change cannot agree on the desirability of making corresponding changes in the organizational structure or in the views held about its purposes, practices, or future.

This paper seeks to offer a contextual setting and assessment of current efforts to strengthen the higher education enterprise through the adoption of advanced information technologies (“IT”) in its various services, policies, and practices. We propose to identify potential opportunities and challenges, as well as obstacles or positive incentives for change. We proceed to explore key issues in the following sequence: 1) Expectations for the central missions of higher education; 2) Changing priorities of academic public service; 3) Performance of technology-supported teaching/learning and obstacles to reform; 4) The opportunities and challenges of distance learning; 5) The virtual university—promise and threat; 6) Learning to learn—building learning environments; and 7) Building a learning society.

II. CHANGING EXPECTATIONS FOR THE CENTRAL MISSIONS OF COLLEGES AND UNIVERSITIES

Driven by massive technological change, a pervasive global array of powerful economic, social, and political forces is fueling changes in the needs of society and is, in turn, forcing change on the institutions called upon to meet these new needs. The changing environment offers both promise and threat for American higher education. We start with the realization that the Information Revolution has different, though strongly related consequences for the three central missions of universities and colleges: (1) research and scholarship; (2) service in the public interest; and (3) teaching/learning at various levels. These new technologies have also changed the administrative practices in colleges and universities, including funding solicitations, business transactions, payroll and student admissions, and records.

A. The Centrality of the Research Mission – Opportunities and Challenges

At the outset, it is important to recognize that the Information Revolution has already had a powerful impact on the research and scholarly activities of virtually all universities and of many colleges as well. Supported in large measure by federal grants to individual researchers and to interdisciplinary research centers, the academic research mission is widely recognized as a major contributor to the "high tech" economy, to national defense, and to the nation's protection from ill health and disease. The research mission has contributed greatly to the levels of technical sophistication and computer literacy of research faculty and their graduate students. Thus, graduate students have been key participants in many technology-supported teaching/learning projects. At many universities and colleges, the academic research and development ("R&D") efforts have also instigated high-speed networking and technology-rich laboratory environments, subsequently made available to the entire campus.

For the past half century, the role of the professor as researcher or scholar has come to have a higher status than that of the professor as teacher or public servant. Research support, professional recognition, and corresponding rewards have become features of a national system of peer review carried out by prominent researchers in the various disciplinary and professional fields. Along with the positive outcomes, this national system for the support and recognition of academic research has had negative consequences for the other central academic missions.

James Duderstadt, President Emeritus of the University of Michigan, has presented a widely shared view of the priorities and culture of the research university:

Although the government-university partnership has had great impact in making the U.S. research university the world leader in
both the quality of scholarship and the production of scholars, the partnership also has its downside. Pressures on faculty for success and recognition have led to major changes in the culture and governance of universities. The peer-reviewed grant system has fostered fierce competitiveness, imposed intractable work schedules, contributed to a loss of collegiality and community, and shifted faculty loyalties from the campus to disciplinary communities. Publication and grantsmanship have become a one-dimensional criterion for academic performance and prestige, to the detriment of teaching and service.

As the definition of organizational excellence has come to be equated with the peer assessment of curiosity-driven research performance in the many areas of academic specialization, the disparities in academic commitment to public service and teaching missions were to be expected. The public service mission was further confused, first by dropping the word “public” and then, in many cases, replacing the word “service” with the term “outreach.”

B. The Public Service Mission – Changing Priorities and Goals

The public service mission, initiated with the Morrill legislation following the Industrial Revolution of the early 19th century, offered two new objectives for the nation’s newly established “land grant” universities and colleges: (1) to bring scientific knowledge and technology to bear on regional problems in agriculture and industry; and (2) to expand access to both liberal and practical education for the children of workers and farmers. The success of these efforts is reflected in the remarkable increase in the productivity of American agriculture and the expansion of public higher education at all levels.

The Information Revolution has brought forth new opportunities and challenges for service in the public interest. Politicians, business leaders and college presidents have become increasingly sensitive to changing needs for “knowledge workers” and the many potential contributions of applied R&D to the new regional economies. In one broad area of major societal need, some faculty members on various university and college campuses are engaged in educational R&D and public service aimed at upgrading our public schools. The Kellogg Foundation has provided support for partnerships of “engaged” institutions linking colleges, communities, and schools to improve learning for young people. In a recent article, Parker, Greenbaum, and

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4. Duderstadt, supra note 2, at 41.
Pister present persuasive arguments for redefining the public service mission to address the widely perceived national crisis in K-12 education.

Since the K-12 educational mission has been historically viewed as the province of state and local government, there may well be expressions of political concern about framing these concerns as a national problem. Like other pervasive problems facing our society, this is a distributed national problem, in which participants at all levels including teachers, parents and school boards, as well as state boards of education, should play distinctive roles both in framing and addressing the issues. An academic public service mission would invite participation by faculty and students from many disciplines and professional fields. To attract the leadership and the long-term public support that would be needed, the academic enterprise would be called upon to set new priorities and build partnerships with other engaged institutions.

C. The Teaching/Learning Mission – Opportunities and Challenges

The digital economy has brought into the public consciousness an increasing awareness of the role of knowledge and education at all levels in our society, greatly enhancing individual and national aspirations for the future. In virtually every nation, more and more people seek education as the hope for a better future; an avenue to better careers and to meaningful and fulfilling lives. The changing make-up and personal goals of students have been accompanied by many opportunities to use the new technologies for strengthening the teaching/learning processes. As we shall note, the new technologies may also offer ways to modify courses and curricula so as to be responsive to changing understandings of the learning process and to overcome organizational obstacles to change or transformation. We proceed in the next section to explore the role of advanced technologies in the teaching/learning mission.

III. ADVANCED TECHNOLOGIES IN THE TEACHING/LEARNING MISSION OF HIGHER EDUCATION

How we learn is changing and technology is at the heart of this transformation.

- Richard Riley, U.S. Secretary of Education

9. Some of the issues delineated in this paper are relevant to community colleges, many of which make use of technology-supported online learning. However, the missions of community colleges include a broad range of instruction beyond those covered here including remedial education for at-risk and under-prepared students as well as access to the first two years of a baccalaureate degree. Some offer four-year professional degree programs, and others offer certificates for acquisition of specific professional skills and overlap in mission with "career universities."
If you’re headed in the wrong direction, technology won’t help you get to the right place.

- Stephen C. Ehrmann, Vice President, The Teaching, Learning and Technology Group, an Affiliate of the American Association of Higher Education

A four-year undergraduate curriculum lies at the heart of most traditional collegiate institutions, with universities typically adding graduate and professional education in varying degrees. The undergraduate experience represents the symbolic basis for public commitment to higher education as well as for widespread institutional loyalties and alumni support. In recent years, many professional schools such as business, law, library and information science, and engineering have experienced growing demands for graduate programs. Work toward the masters degree is an increasingly attractive feature of training for mid-career clients seeking a change in jobs or promotion. Life-long learning is also becoming a necessity for practitioners in every professional field, including government leaders, business executives, professors, and college presidents.

The digital economy has brought with it a broad popular acceptance of the idea that advanced information systems may also offer opportunities for expanding access, lowering costs, and increasing the effectiveness of the teaching/learning process. This belief, shared by many government officials, college administrators, and business leaders, has stimulated a widespread proliferation of technology-supported projects at American colleges and universities. However, as we shall note, the attitudes of faculty members, as well as the outcomes of efforts, to date are mixed.

A. Impact of Advanced Information Technologies on the Efficiency and Effectiveness of the Teaching/Learning Mission

To sharpen our assessment of the value of new technologies in the teaching/learning area, we find it valuable to ask this question: Are we considering improvements in the efficiency or the effectiveness of our teaching/learning mission? As these terms are defined by Pfeffer and Salancik, "[o]rganizational efficiency is an internal measure of performance . . . . [T]he question whether what is being done should be done is not posed, but only how well it is being done. Efficiency is measured by the ratio of resources utilized to the output produced." 12 In contrast, "[t]he effectiveness of an organization is its ability to create acceptable outcomes and actions . . . [it] is an external standard of how


well an organization is meeting the demands of the various groups and organizations that are concerned with its activities.\textsuperscript{13}

The efficiency-effectiveness dilemma has been phrased in terms of organizational learning. Does the situation call for retaining existing norms, goals and structures and doing better the things we are now doing? Or does it call for reformulating the norms, goals, and structures and embarking in innovative directions to create acceptable outcomes? It will be immediately apparent that the various constituencies associated with colleges and universities may have differing (at times conflicting) views as to which type of organizational learning is called for. A common pitfall is focusing solely on efficiency or effectiveness. In many cases, the situation calls for improving both.

A related but different perspective is revealed by two other questions. Does the situation call for educational reform in the context of traditional curricula and pedagogical activities? Or does it call for transforming important features of the educational landscape to respond in adaptive ways to the dramatic changes of the economic, social, and technological environments? In other words, to promote effectiveness of the teaching/learning mission, there may be a need either to expand ongoing educational reform or to seek transformation in educational purposes, norms, policies, and practices.

1. Opportunities

Most faculty researchers and scholars have contributed, as individuals to the teaching mission, by guiding graduate research and/or teaching undergraduate courses. But with the increasing burdens of grantsmanship and competition for personal recognition, they are understandably too overloaded to immerse themselves in the reform or transformation of undergraduate teaching/learning at the institutional or national levels. In general, our colleges and universities leave curricular decisions to the individual department and leave the design and implementation of instruction to the individual professor to teach his or her course. Not surprisingly, this cultural environment has also carried over to an individualistic approach, to the design and application of new technologies in the instructional process.

At many colleges there are already dozens of technology-supported online courses in place. At research universities, there may be hundreds of online or distance-learning courses, often several in the same department. A single organization, the Globewide Network Academy,\textsuperscript{14} claims more than 30,000 distance courses and 3500 programs.\textsuperscript{15} The latest report of the National Center for Educational Statistics indicates that there were some 54,470 different technology-supported courses offered in 1997-98, of which the large majority (49,690) were credit granting at 2-

\textsuperscript{13} Id.

\textsuperscript{14} GLOBEWIDE NETWORK ACADEMY, \textit{at} http://www.gnacademy.org (last visited Jan. 24, 2002).
year and 4-year college levels. According to the Campus Computing Project, the largest continuing study of the role of information technology in U.S. higher education, as of Fall 1998, more than half (59.3%) of college courses used e-mail, while two-fifths (42.7%) of college courses drew on content from the Web. Two-thirds (65.8%) of the two- and four-year colleges had IT support-centers to assist faculty with instructional integration of technology. At least half a dozen journals deal with college-level distance learning as their main theme. While the claims of such large numbers may include courses with minimal uses of e-mail or the Internet, and very few courses have as yet been integrated as degree programs, the number of courses using some form of advanced technology is impressive.

If the proliferation of computers and of access to the Internet is used as an indicator of technological acceptance in our colleges and universities, major advances have taken place during the 90s. Kenneth C. Green, director of the Campus Computing Project, observes that there is little doubt that "technology – as a function and as a resource – has in fact entered the pedagogical mainstream in American colleges and universities."

2. Challenge #1: As of yet, the new technologies have not enhanced the efficiency of higher education missions.

The widespread publicity given to IT in the teaching/learning process reflects the conviction of many faculty members that advanced technologies offer substantial benefits for teaching and student learning. For some faculty proponents, the underlying motivation may be self-serving, seeking recognition for being on the "fast track" in a widely popular avenue for official recognition. Whatever the motivation, adoption tells us little about the costs of the new approaches. First of all, the estimates of costs are difficult to make. How does one measure the dollar value of faculty efforts, or of earlier capital investments in libraries, or digital infrastructure? More than three fourths of the colleges and universities that offer a choice charge the same tuition for both traditional classroom instruction and technology-supported versions of the same course. Even though many projects employ qualified students to reduce expenditures, few institutions base their advocacy on

17. Id.
18. Id.
lower costs. For those who view advanced technology as a way of increasing the efficiency of the teaching/learning mission, the experience so far would be disappointing.

We have noted that the great majority of technology-supported projects in colleges and universities have been devoted to a single course and consistent with the curriculum of a single academic unit. The individualistic approach to course design offers few prospects for the cost-reduction of technology-supported innovation. It may take years for curricular software ("courseware") to be developed and then to become widely accepted. The costs of designing, evaluating, and publishing the courseware increase substantially if each individual or institution focuses on a given course in its unique instructional setting. This approach reduces the marketability and economies of scale of the resulting highly individualized material. The costs are not restricted to the producers of courseware. This process also calls for significant time and effort on the part of instructors who would prefer to utilize courseware designed by others in learning to adapt and make effective use of the specialized "ready-to-use" courses.

3. Challenge #2: The new technologies have made only a modest contribution to reform or transformation

Having observed that the new technologies have entered the pedagogical mainstream in academia, K. C. Green submits the following reservations:

These indicators notwithstanding, we need to acknowledge that information technology has yet to transform classrooms, the instructional activities of most faculty, or the learning experience of most students. Truth be told, despite endless numbers of conference sessions, journal articles, and strategic plans, the evidence suggests that as an enterprise, higher education remains mostly unprepared . . . much of the writing and planning addressing these issues seems conventional, piecemeal, even dated . . .

On the one hand, those involved with education can no longer conceive of their enterprise as separate from the realm of the new technologies. On the other hand, organizations such as the Institute for Higher Education Policy recognize that there is still much to learn, and continues to study these issues in order to better understand how this technology can enhance the learning and teaching process, particularly at a distance.

22. Id. at 11.
23. Id.
In a recent article, Lazerson, Wagener, and Shumanis summarized the state of teaching and learning in higher education.\textsuperscript{25} Based in part on faculty surveys by the Higher Education Research Institute (at UCLA) and the North Central Association of Colleges and Schools, they concluded:

\begin{quote}
[a]nd yet, for all the pedagogical innovations – even the advent of the Web – there has been precious little deeper reform. Individual professors may teach somewhat differently than they did two decades ago and discussions about how to assess learning are more common than in the past, but there is little evidence that the changes add up to a systemic reconsideration of how and why students learn or of how institutions, rather than simply individual professors, can revise their approaches to teaching. With few exceptions, teaching changes have not been tied to higher education's incentive and reward system. Research remains the primary avenue to individual and institutional prestige.\textsuperscript{26}
\end{quote}

These observations clearly question the notion that, of itself, the insertion of the new information technologies is a sufficient condition for either the reform or the enhanced efficiency of the educational mission. As every teacher who has worked to bring technology into education has learned, the simple addition of new devices has little chance of producing real change. As Ehrmann observed, "[t]echnology can enable change in educational activity, but technology availability almost never compels change in the activity."\textsuperscript{27}

4. Challenge #3: Overcoming structural obstacles to educational reform – the need for organizational learning

We have previously noted that the typical approach to the development of technology-supported courseware is led by an individual professor modifying a single course designed in the context of the existing curriculum of a single academic unit. This approach does not lead to a consideration of how institutions rather than the individual professors can revise their approaches to teaching and learning. As Ehrmann has concluded:

very few institutions are asking whether their uses of technology are fostering institution-wide changes in teaching and learning practice. It is easy to understand why teaching and learning are the province of individual faculty teaching isolated courses. It's hard to see what is going on in more than one class at a time – but we need to be able to see across the curriculum.\textsuperscript{28}

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\textsuperscript{26} Id.
\textsuperscript{28} Id.
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In the absence of campus or college-wide efforts to plan, support, implement, and assess projects and their assessment, most faculty members and administrators are quite uninformed about the goals, successes, or limitations of various technology-supported efforts. Except for those in which they have been personally involved, few members of the academic staff are familiar with technology-supported projects at the national level, or even with other projects in their disciplines or on their own campuses. Thus, it remains a challenge for faculty members, administrators or policy-makers to ascertain the state of the art or the state of practice for technology-supported teaching/learning.

This fragmentation of oversight may overlook or fail to recognize the merits of exemplary efforts that do not fit into the established curricular framework. At the University of Illinois, for example, among the large number of courseware projects under way, some projects have initiated significant curricular reforms, a few tested with thousands of students. These instructional units include sophisticated virtual laboratories for undergraduate chemistry and a biology workbench for undergraduates originally designed for genetic researchers. They also include applications of “virtual reality” in engineering or architectural design and for visualizing biological or physical phenomena that cannot be otherwise observed. One interesting initiative is a cross-disciplinary approach to math, science, and technology for technical students at high- or middle-school levels.

Ernest Lynton calls attention to a pervasive limitation of the assessment and reward of faculty performance and its effects on technology-supported instruction:

[In academia] [w]e judge a person’s work in isolation and make little or no attempt to place it within the broader context of the collective task of his or her department, college or university. . . . Institutions are finding that the potential of information technology can be realized only through coherent institution-wide efforts. [There is] a growing need for a more collective and coherent approach to faculty work.29

Some colleges and universities have established centers or institutes devoted to the support and encouragement of faculty uses of technology-supported instruction. However, many of these academic units are not in the mainstream of academic life, have limited financial and moral support, and have inadequate status for institutional planning. Overcoming such structural obstacles underscores a pervasive need for organizational learning – at the system level as well as at the individual college or university.

IV. THE PROMISE AND THREAT OF DISTANCE LEARNING

We [have heretofore] define[d] schooling to be the activity that occurs within a certain space, the classroom, and a certain time, the school day . . . . Today, a heretical group proposes to abolish that placement – to deny the centrality of both the school building and the school calendar – and along the way, the textbook and perhaps the teacher too . . . . Economic forces and new technologies may together bring about a Copernican revolution in the nature of formal education and there is ample evidence of change already.

- Bertram Bruce

A. Opportunities: Distance Learning and Online Learning

Access to higher education for students who live or work at a distance, or who work full or part time, was initiated more than 100 years ago with widespread correspondence courses, and expanded with the establishment of "open universities" for degree programs supported by electronic communications technologies. As previously noted, the advent of the Internet/Web has led to an explosive growth in the number of "distance courses" at undergraduate levels offered by residential colleges and universities. A modest number of universities have developed effective distance learning degree programs at the masters' level, of special interest to mid-career professionals.

An early version of electronic online learning was incorporated in the PLATO computer-based education network in the 1970's, which was integrated with classroom instruction on several residential college or university campuses. Since then, technology-supported "online" courses have been introduced on many residence campuses to augment or enrich the regular classroom instruction. Many campuses have installed broadband networks, and students may access the courseware in their own living quarters or places of work and at any time of day or night.

The appeal of "distance learning" has led to the expansion of so-called "virtual universities," universities without residential facilities. As one prominent example, the University of Phoenix, a for-profit institution, accredited since 1978 by the North Central Association of Colleges and Schools, is proud of its enrollment of 160,000 students, its focus on working adults and its close ties with employers. These institutions have most often been motivated by corporate commitments to recruit or offer advanced professional education for "knowledge workers." They are sometimes operated on the premise that the "brick and mortar" campus can, and ultimately will, be replaced by less expensive digital systems for teaching/learning.

B. Challenges for Distance Learning: the “Knowledge Delivery” View of Teaching/Learning

Teaching in [a traditional] view, is a delivery service and school a loading site. . . . An implicit delivery view also leads some to think of educational technology as a sort of intellectual fork-lift truck. . . . The knowledge delivery view, however, profoundly misunderstands how people learn, where they learn, and when they learn. . . .
- John Seely Brown and Paul Duguid

The pedagogical strategies and technologies associated with “distance learning,” as well as the metaphor itself, often entail the same limitations that have intensified calls for educational reform of “traditional” classroom teaching. If the distance learning is limited to the “knowledge delivery” metaphor, it is unlikely to satisfy the full potential of technology-supported teaching/learning processes. As others have noted, and we discuss in subsequent sections, learning is not just the acquisition of information by an individual student. At its best, effective teaching/learning recognizes that learning is a social, rather than individualistic, phenomenon. As teachers or students, we learn from interactions with our colleagues and peers and in our everyday experience. Thus, distance learning should seek to transcend the social isolation of the distant student, adapting pedagogical strategies and collaborative software, as well as face-to-face interactions, to enhance the learning process.

In the teaching/learning context, transcending “social distance” may be an even greater challenge than overcoming “geographic distance.” For mid-career professionals, this calls for face-to-face collaborative interactions, and separating learning from the workplace may actually be detrimental to the learning process.

V. THE PROMISE AND THREAT OF THE VIRTUAL UNIVERSITY

A. Opportunities

Like the “land grant” universities of the last century, virtual universities aspire to fulfill a valuable niche in a rapidly changing world. They offer access to higher education for mid-career professionals and for other students who cannot afford the time or money required for traditional residential institutions. Since many of these institutions enroll career-oriented students, these institutions have sometimes been referred to as “career universities.” Their student clienteles are often seeking non-traditional markers of post-secondary education, such as certificates

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rather than baccalaureate degrees. In addition, they are not bound to traditional curricula for professional preparation.

During the past few years, many dozens of career universities have been established through subsidies from parent industrial firms, with such familiar names as Dell University, Sears University, United Airlines University, and Sun Microsystems University. In some cases, virtual universities are in direct competition with traditional land grant universities. They may also seek to provide life-long learning, not only for knowledge-workers, but also for the large and growing category of older citizens for whom education is a leisure activity as well.

Career universities may operate with or without a residential campus. Their corporate environment is usually not constrained by traditional academic faculty prerogatives and autonomy. Instructional materials are typically developed by teams made up of course writers, technology experts, assessment professionals, and other consultants. Quite apart from relaxing residential requirements, the team approach and close association with industrial firms enables them to address some features of career education more effectively than traditional colleges or universities. A number of such universities in the so-called Corporate University Xchange are considering the feasibility of an arrangement whereby the courseware may be transferable for certification from one such university to another. The virtual universities overlap with the missions of research universities at one domain of student aspirations and goals and with community college missions at another. We cannot be sure how education services will be provided in the future, and we cannot know for certain who will provide it. It seems quite likely that the virtual career university will develop in future years as a continuing category of higher education institutions.

A substantial number of prestigious traditional universities, including Cornell, Columbia, New York University, and the University of Maryland, have established for-profit subsidiaries to market and update technology-supported courseware and software developed at their institutions. We also note that Stanford, Oxford, and Yale universities have formed a non-profit Alliance for Life-Long Learning to provide online learning in the arts and sciences and to expand the boundaries of distance learning.33 California has a state-wide Virtual University, which in 1999 offered few degree programs but more than 1600 courses, while Pennsylvania State University has a "World Campus."34 Clearly, a new academic "publishing" industry for developing and marketing technology-supported education is emerging, initiated by academic institutions and being readied for the market in either the public or private sector. This trend may also represent a

realization that, by and large, individual faculty members do not have adequate personnel, financial resources, or management structures to commercialize and market their online instructional programs.

B. Challenges for Virtual Universities

The expanded influence of the virtual university is being challenged by a number of traditional universities and colleges, which are reorienting faculty incentives, addressing issues of mid-career education and life-long learning, or developing new models of service in the public interest. An initial challenge is therefore competition from traditional research universities and colleges that in principle can offer degrees as well as certificates of achievement for a wide range of student clienteles. A second category of challenges is inherent in those listed in the previous section, namely overcoming geographical and social distance in non-traditional classroom settings.

As will be elaborated in subsequent sections, electronic communication systems are powerful media for the storage, handling and exchange of information. They are of limited value for the use of narrative and the presentation of arguments – powerful attributes of communication for overcoming social distance. Face-to-face communication is highly regarded as essential for the development of trust within communities of learning and practice. In some successful examples, the teaching/learning takes place in the workplace or with groups of students who work together in their normal work relationships. In some virtual university arrangements, distance learning is periodically interspersed with face-to-face seminars, discussion groups and joint student or student-faculty projects. To lead some such programs, the quality of the instructors or facilitators emerges as a scarce and costly factor.

VI. THE INTERNET/WEB: A TRANSFORMATIVE LEARNING TECHNOLOGY?

Like earlier revolutionary information technologies such as the written word, printing press, book, computer, telephone, radio, and TV, the Web and its associated technologies have already played key roles in restructuring major social relationships: interpersonal, inter-group, and inter-institutional. In many realms of commercial and R&D activities, the Web has changed the ways in which products are bought and sold, how work is organized and how firms have related to individuals and groups at distributed locations. In support of recreational and entertainment activities, the Web has also transformed access to libraries, museums, musical recordings, travel services, etc.

In the field of education, the Web has changed some of the ways that work is organized, some of the relationships between faculty members and students and interactions with researcher/scholars at other
institutions. However, there are significant domains of teaching and learning for which the Web has not, as yet, transformed the academic enterprise, including our understanding of the learning process itself. Although it is beyond the scope of this paper to attempt a detailed analysis, we proceed with a listing of some of the features of the Web which present opportunities and challenges that may lie ahead.

A. Opportunities

Unlike the one-to-many feature of traditional media for teaching/learning, for example, the lecture, the printed page, the book or radio/TV broadcasting, the Internet/Web is a many-to-many medium. Its users can be receivers and transmitters of information, and, whether experts, novices, or "true believers," they may have the entire world as audiences or as sources of information, codified knowledge, gossip, or entertainment.

The Internet/Web is a flexible medium that offers many diverse modalities or interpretive styles for learning: abstract, textual, visual, musical, and social. The new technologies enable people to become engaged in their preferred way of learning, in terms of medium and method. The Web helps establish an ecology of information, knowledge, and distributed intelligence settings where responsible, informed, and engaged interactions among people and information technologies may flourish. It permits various experts to interact informally and casually. It also permits individuals to "publish" materials that are not accepted in existing (and often narrowly constrained) refereed journals.

As an adjunct of the learning process, the Web offers rapid access to works of art, literature, law, medicine, and science already available at explosive encyclopedic levels. The use of the Web as a learning medium demands and stimulates a new form of inquiry, discovery-based or activity-based learning, and offers the opportunity to be your own personal reference librarian. The Web provides a support infrastructure for collaborative efforts within and across institutional boundaries, identifying, creating or supporting learning communities variously described as communities of practice, communities of inquiry, technological ecologies, or interpretive communities.

Learning to learn is a challenging enterprise, whether it is learning to solve mathematical problems, to compose music, or to write persuasive proposals. To acquire the necessary knowledge, know-how, or skills, the learner calls upon differing forms of intelligence and judgment. For the acquisition of know-how in many fields, these qualities of mind lie in the domain of tacit knowledge, typically acquired by experience in appropriate learning communities. While many users have made use of the Web to join informal communities with participants

35. Brown, supra note 32, at 12.
around the world, the Web itself does not create the wisdom to judge whom to trust, and on what grounds.

B. Challenges

1. Searching for, evaluating, and interpreting information on the Web

There are many superb resources on the Web, but its sheer size constitutes a challenge. The larger the Internet grows, the more difficult it is to find a simple, accurate answer to one’s questions. Web portals (e.g., Yahoo! and Google) are great helps, but new tools are needed as the system grows. New organizing principles are needed to categorize and assess the vast array of courseware and supporting software for instructional programs.

2. Limiting fraud, illegal, and political misuse of the Internet

The capacity for any Web user to “broadcast” and access information also affords any political group or fringe activist the ability to promulgate as facts or scientific conclusions its own privately generated political doctrines and causes. Thus, like TV, the Web already exhibits a blurring of education and politics. Some such issues are embedded in the controversial questions of regulation as a tool for quality control or for preventing fraudulent or illegal uses of the Internet. Would such regulation create a greater threat – placing limits on freedom of speech? Who sets the societal standards? It is too early to predict whether and in what ways the many-to-many broadcast features of the Net will be used to strengthen or to corrupt the democratic process.

3. Protection of intellectual property

Napster and similar Web services have let millions of people freely exchange their musical recordings. Analogous services have extended into the questionable copying or utilization of Web supported courseware, course notes, etc. As noted previously, the development of a viable system for the protection and marketing of educational courseware should include ways of preserving reasonable income or recognition for those who did the work.

4. Assuring validity, authenticity, and quality control of information on the Web

On the Web, good information may often become intermixed with bad. As one illustrative domain, a virtual explosion of health-related online textbooks, encyclopedias, journals, and discussion groups has given millions of computer users access to health information that once required a trip to the doctor or library. According to a Harris poll
released in August 2000, at least 98 million Americans took advantage of these resources in 1999. Yet, "[i]n a recent survey released by the Federal Trade Commission, 67 percent of those who reported using the Internet for health-related purposes said they had difficulty evaluating the information they obtain[ed]." This is a serious problem, as many Web sites contain inaccurate and perhaps even harmful information.

C. Response to These Challenges

To deal with these issues, we need new levels of critical judgment, new ways of asking the right questions and new tools for screening and evaluating the quality of information. In traditional scientific and scholarly publication, peer review is an accepted process that places limits on prerogatives to publish. For quality control on the Web, new institutional structures may be needed. One possible approach is illustrated by the recently established Office for Mathematics, Science and Technology Education ("MSTE") at the University of Illinois at Urbana-Champaign. MSTE offers access and support for math and science teachers in the form of innovative courseware, and tools for searching the Web for specific applications. Its Web site has attracted thousands of continuing users nationwide and abroad. This activity, supported heretofore by the University as a public service, started with a limited audience of the local campus, but exposure soon expanded its "audience" to the national and then, international scene. A key question is how such ongoing services which serve the public interest will be funded.

VII. BUILDING NEW LEARNING ENVIRONMENTS – COMMUNITIES OF PRACTICE – FOR ENHANCING THE LEARNING PROCESS

Researchers at the Institute for Research on Learning have contributed valuable insights regarding the settings, goals and values of learning communities, which they refer to as "communities of practice" ("COP"s). At the core of these insights are the following observations selected or paraphrased from an unpublished manuscript by Etienne Wenger.

38. Id.
39. University of Illinois at Urbana-Champaign, Office for Mathematics, Science and Technology Education Web site, at http://www.MSTE.uiuc.edu (last visited Jan. 24, 2002). D. Alpert has been a member of the MSTE Board of Advisors since its founding in 1994.
A. Opportunities

Learning is not just the activity of a sole individual but the primary vehicle for engagement with others. Learning is a social phenomenon. It is through our membership in COPs that we come to know and to be empowered by what we know. We all belong to COPs, at work, at school, and in our personal activities. Any institution encompasses an ensemble of interconnected COPs, whose boundaries do not necessarily (or usually) follow the formal boundaries of the organization.

1. On educational reform and organizational reform

Institutions must find ways to support the development of COPs that link its members meaningfully and productively to the larger goals of the institution and society. Restructuring efforts, whether in schools or in the workplace, must recognize the organic nature of the development of COPs. Communities of practice cannot be mandated or even created, but they can be recognized and supported.

2. On technology and the learning process

The learning potential of information systems lies as much in the connections that they open up among people and in the collaboration they support, as in the information they deliver. It is therefore essential that we think of technology not as a means of delivering knowledge and manipulating activity, but as a means of empowering the development of communities of practice, and of encouraging participation in and communications among them.

B. Challenges

We have noted that for much of the 20th century a number of structural economic and political features have shifted the academic missions and measures of performance from a major focus on teaching/learning to a dominant emphasis on research and scholarship. In turn, this cultural change has shifted faculty loyalties from the campus to research related communities, which transcend college and university boundaries and constitute the primary avenue to both individual and institutional prestige. In contrast, there are relatively few communities of practice in the instructional mission that transcend departmental or campus boundaries. We offer three examples of areas of teaching/learning practice and policy that would benefit from effective communities of practice.

1. Assessing student and faculty performance

The practices of educational testing and performance assessment are complex and subject to controversy, even for the traditional
classroom setting. In the context of the burgeoning interest in online teaching and learning, appropriate assessment practice is a key domain for collaborative research and development. For technology-supported instruction, student performance has often been measured by comparing the test scores of students enrolled in online courses with those of students enrolled in "traditional" classroom settings. Such comparisons often have shortcomings for both categories of students, especially if the "traditional" setting is implicitly considered an acceptable standard.

Regarding performance assessment, Lazerson, Wagener and Shumanis reported that campus conversations about teaching may be occurring, but the dialogue on professorial responsibility for student learning appears modest at best. A recent national survey by the National Center for Postsecondary Improvement showed little sustained commitment by institutions or programs to use assessment information to improve learning.

Stake and Cisneros-Cohernour have observed that faculty collaboration focused on evaluating teaching performance is rare, even within a given department:

The traditional concept of evaluating college teaching involves the evaluation of each individual autonomous instructor in each classroom across the campus. This approach sees the teaching and its evaluation as taking place in the classroom, and as a single instructor's responsibility. . . . [A] competing concept . . . focuses on evaluating the contribution each instructor makes to the maintenance and improvement of all instructional programs in the department.

Some efforts to develop new assessment strategies have moved beyond existing models of performance assessment and toward the development of learning communities that cross campus and institutional boundaries. For example, Thomas Angelo in "The Campus as Learning Community," describes a "transformative assessment paradigm" that reflects and evaluates the transformation of colleges and universities from "teaching factories" into "learning communities." The challenge includes building the reward systems for forming groups of students and faculty working intensively and collaboratively toward shared, significant learning goals, often across traditional disciplines.

41. Lazerson et al., supra note 25, at 12.
42. Marvin Peterson et al., Institutional Support for Student Assessment: Methodology and Results of a National Survey, NATIONAL CENTER FOR POSTSECONDARY IMPROVEMENT (1999).
45. Id.
2. Activity-based pedagogical strategies

Some innovative online pedagogical strategies have been designed primarily for the efficient delivery of subject matter. Other online projects have made effective use of "learning through doing" strategies that have evolved since the seminal pioneering work of John Dewey. Under such rubrics as problem-based, inquiry-based, research-based, or discovery-based learning, projects offer students hands-on experience for collaborating with many constituencies on complex real-world problems. In some cases they offer the challenge of relating the efforts of stakeholders with differing values or interests. Students may be called upon to address problems posed by industrial or government clients, who may later serve with faculty members in the assessment of student performance. In general, these activity-based projects offer opportunities for students (and/or faculty) to develop critical thinking skills and systems thinking.

3. Learning for citizenship in a changing world

Our educational system clearly needs to do better in developing the skills of the populace in relation to numeracy, earth-system science, interdisciplinary thinking, and envisioning both the consequences of a "business as usual" future and pathways toward more promising alternatives.

- John Holdren, of the John F. Kennedy School of Government at Harvard

The traditional curriculum has long been centered in the individual department and on courses based on the delivery of codified knowledge in the instructor's discipline.

To do better will require new approaches to learning for citizenship such as: 1) learning that engages students in real-world projects to develop skills for addressing and understanding complex issues; 2) learning that requires students to draw from many information sources and disciplines in order to solve problems; and 3) learning to collaborate with colleagues in industrial, non-profit and government institutions on long-term societal issues.

A genuine democracy is also a learning society, and good citizenship requires the capacity to form a community with others. Learning for citizenship will involve a shift in mindset and goals for all types of stakeholders in the educational enterprise. Responding effectively to the above mentioned areas of opportunity and the many others on the international scene will demand new levels of collaboration within or


across institutional lines. They call for learning communities that include professionals with differing backgrounds, skills, and experience, and for greater participation by women and minorities. They call for innovation in framing problems, new uses of technological support, and new ways of measuring student outcomes. Many significant learning communities have emerged, not from colleges and universities, but within organizations such as the Xerox Palo Alto Research Center, the Center for Innovative Learning Technologies, or the Rocky Mountain Institute.48

If we are to encourage the development of such learning communities within the academic settings, we must provide resources, incentives, and “safe places” for such communities to develop. Some modest “slack” in the budget is essential, and that is a challenge for far-sighted college presidents and politicians at various levels. The college or university capable of accomplishing educational transformation will be one that recognizes and takes the risks of supporting such collaborative learning communities.

At some universities, major mission-oriented technology projects have provided infrastructure and have at times “boot-legged” support for ingenious, unorthodox, and otherwise unrecognized learning communities. At the University of Illinois, several such mission-oriented projects were primarily devoted to the development of innovative computer systems. These projects include the pioneering PLATO project in the Computer-based Education Research Laboratory,49 the ILLIAC IV supercomputer project in the Center for Advanced Computation,50 and more recently, the National Center for Supercomputing Applications (“NCSA”), where the Mosaic browser was invented.51 NCSA has also formed partnerships with major corporations to explore educational and industrial applications of supercomputing, broadband communication networks, virtual reality, and other advanced technologies.

To accomplish the academic teaching/learning mission is inherently within the province of state and local governments and of colleges and universities. However, substantial federal support will also be needed to take advantage of the changes associated with the Information Revolution. Such support needs to go beyond providing communications infrastructure or access to computers. Clearly we need to raise the level of effort devoted to educational R&D, to promote understanding of program evaluation and performance assessment, and to enhance the planning and implementation of online learning. Some progress has been made; the National Science Foundation has already reformulated

its original mission to include the support of educational innovation and reform within fields of science, mathematics and technology.  

VIII. BUILDING A LEARNING SOCIETY – A PARTIAL SUMMARY OF KEY ISSUES

The Information Revolution and its widespread adoption in the new global economy have brought into the public consciousness a new awareness of the value and role of education for individuals, for colleges and universities, and for society. The shift is consistent with the recognition by economists that investment in human capital – i.e., ideas, skills, and knowledge – offers returns much greater than investment in physical capital. This change in public attitude may well be the most significant example of the impact of the technological revolution on higher educational policy. The individual need for advanced education and skills will require a willingness to continue to learn throughout life and a commitment on the part of institutions to provide such opportunities. For the most part, neither the educational institutions nor the political leaders of this country have grappled with the profound implications of a learning society.

We have found that the new technologies have entered the pedagogical mainstream in American colleges and universities. Distance learning and online learning, as well as the adoption of Internet-related technologies for learning any time anywhere, have captured the imagination of many constituencies. However, an emerging conceptual framework for learning and knowing poses new challenges that remain to be widely addressed, creating new learning environments to leverage the natural ways that humans learn.

Despite widespread publicity, the overall impact of advanced technologies on educational effectiveness has been modest, and the costs of technology-supported instruction may well be higher than current classroom practice. Efforts to improve effectiveness continue to be carried out by individual faculty members, but more far-reaching educational reform can only be recognized through institution-wide or nationwide efforts. Organizational learning is a key challenge that colleges and universities face in their effort to adapt to a changing environment or to institute educational reform or transformation. Duderstadt has argued that to accomplish these goals, "[c]hanging times demand a new social contract between society and the institutions of higher education."  

Our educational leaders and policy-makers are faced with an overarching challenge – to augment our national collective intelligence in each of the following arenas:

53. Duderstadt, supra note 2, at 37.
1. Reconstituting our educational institutions as related learning communities, strengthening conceptual frameworks for learning, and knowing in order to promote educational effectiveness on a campus- and system-wide basis;

2. Reinventing the contract between universities, colleges and society to promote academic service in the public interest through partnerships with other engaged institutions (industrial firms and non-profit organizations) as well as federal, state, and local agencies;

3. Providing universal educational opportunities through traditional residential campuses, virtual learning environments, career universities, and industrial learning (research) parks. Traditional colleges and universities have important choices to make: to collaborate, to incorporate, or to compete with virtual universities;

4. Designing and utilizing innovative learning technologies to revise curricula and pedagogical strategies and to develop new approaches for retrieving reliable information from the oceans of unfiltered information provided on the Web;

5. Building public understanding about the regulation and governance of the Web at local, national, and international levels. Issues in need of broader public understanding include the protection of privacy and of intellectual property and limitation of fraud and other illegal uses. Educational institutions have a special stake in building bridges and understandings across jurisdictional boundaries.

The Information Revolution has signaled a shift to a knowledge-intensive global society, accompanied by growing demands for ecological sustainability and economic equity, as well as new incentives for learning at all levels.\(^{44}\)

49. MIT Open Courseware – offering worldwide opportunities and challenges for institutions and individual users. On April 4, 2001, President Charles M. Vest of MIT issued a news announcement of “MIT OpenCourseWare,” one of the most interesting initiatives in recent years relating to Internet-supported learning:

MIT [will] make nearly all course materials available free on the World Wide Web . . . [This] unprecedented step challenges “privatization of knowledge.” OpenCourseWare (OCW) looks counter-intuitive in a market driven world . . . Simply put, [it] is a natural marriage of American higher education and the capabilities of the World Wide Web . . . OpenCourseWare combines two things: the traditional openness and outreach and democratizing influence of American education and the ability of the Web to make vast amounts of information instantly available. Although many instances of free distribution of courseware on the Web have heretofore been provided by courseware designers or individual academic units (such as MSTE described above), this initiative at the institutional level of a ranking research university has major implications for American higher education, and for education at all levels. A recent critique of the OpenCourseWare program is presented by Philip D. Long, \emph{OpenCourseWare: Simple Idea, Profound Implications}, \emph{SYLLABUS}, January 2002, at 12.