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OPENNESS AND GLOBALIZATION IN HIGHER EDUCATION: THE AGE OF THE INTERNET, TERRORISM, AND OPPORTUNITY

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ABSTRACT

Charles Vest gave the second of three Clark Kerr Lectures on the Role of Higher Education in Society on April 21, 2005 on the Santa Barbara campus. The Age of the Internet presents remarkable opportunities for higher education and research in the United States and throughout the world. The rise of a *meta-university* of globally shared teaching materials and scholarly archives, undergirding campuses everywhere, both rich and poor, could well be a dominant, democratizing aspect of the next few decades. Even as we develop the meta-university and other forms of digitally empowered educational globalization, we must maintain the openness of our campuses here in the United States. Our openness to international students, scholars, and faculty members, as well as the openness of scientific inquiry and communication, must be balanced against national security concerns in the face of terrorism. But the lessons of history confirm that openness is a great contributor to the security of our nation and world in the long run, and must be preserved.

Of all the things that have changed since the early 1960s, I suspect that the extent of internationalization of our faculties and graduate student populations in science, engineering, and management is one of the most dramatic. This change is matched or exceeded by the role of new information technologies that connect and inform us instantaneously throughout our campuses and around the globe. These are two important aspects of the essential openness of American universities.

I have come to believe that the openness of American campuses in many dimensions is one of our most important defining characteristics. Openness describes the state of our research universities at the beginning of the twenty-first century, and it establishes a remarkable field of opportunity and responsibility as we go forward in the globalization of higher education. But today our openness is also threatened, largely because of our national struggle to come to grips with the reality of terrorism. My purpose here is to share some thoughts about the interconnection of such seemingly disparate themes as the Age of the Internet, terrorism, and the global opportunity and responsibility of universities.

Things We Take for Granted

Faculty and students of my generation, and certainly those who are younger, take for granted the open flow across the borders of our campuses and nation of students, scholars, faculty, scientific and scholarly information, and educational knowledge and tools.

Our nearly unanimous opinion undoubtedly is that the openness of our national borders and especially of our campuses to talented men and women from other lands is a major factor in our academic excellence, our cultural richness, our economic success, and, in a strategic sense, our national security. At MIT we are very proud of the Nobel Laureates who teach and work on our campus. Those who received their Nobel Prizes in recent decades were born in the United States, India, Germany, Italy, Mexico, and Japan. Similarly, the recent Laureates from the University of California were born in the United States, Taiwan, Poland, France, Hungary, Germany, Austria, and Norway.

In a similar manner, universities like the University of California and MIT have prided themselves on being meritocracies that benefit from, and provide opportunity to, talented students from across America's broad spectrum of cultural, economic, and racial backgrounds. As a private institution, MIT would add geographic background to this list, and so would the University of California, though within the constraints of an institution designed to serve California citizens first and foremost.

We also would take as a given that scientific and scholarly knowledge should freely pass back and forth across our campus boundaries. Science thrives in unfettered communication among scientists everywhere, and has always had an international culture. Indeed, the conduct of science requires criticism and testing of the repeatability of experiments by other scientists. Scholarly pursuits more broadly require access to knowledge and artifacts, and are strengthened by criticism and exploration from different vantage points. One need only look back to the history of the Soviet Union to understand that science, even that practiced by brilliant people, cannot flourish in isolation.

Historically, the openness of scientific and technological knowledge has been challenged in two ways: by issues of classification or voluntary withholding of knowledge that may endanger national or international security, and by concerns that arise regarding potentially valuable intellectual property and proprietary knowledge when university researchers interact with the private sector. But for the most part, great universities come down on the side of open flow of knowledge within their campuses and to and from the world beyond. Sometimes, in what we deem to be the national interest, we conduct classified work in special, segregated units like UC's DOE laboratories and MIT's Lincoln Laboratory. Of course, we generally have strong rules to ensure open publication of the results of our campus research, and we demand that all students have access to all campus research.

Finally, we certainly assume that our courses are open to all qualified and appropriately registered students. Furthermore, through textbook publication and various electronic means, we frequently share the formal content of our classes with others.

Openness: The Post 9/11 World

We are all painfully aware that in September 2001 international terrorism arrived on our shores with the horrific attacks on the World Trade Center and the Pentagon, and the contemporaneous tragedy in the fields of rural Pennsylvania.

To establish context, let me turn back the clock to March 15, 2001, when the U.S. Commission on National Security in the 21st Century, co-chaired by former senators Gary Hart and Warren Rudman, released a report. In chillingly prescient language, the Hart-Rudman Commission stated:

> The combination of unconventional weapons proliferation with the persistence of international terrorism will end the relative invulnerability of the U.S. homeland to catastrophic attack. A direct attack against American citizens on American soil is likely over the next quarter century.

The U.S. scientific and educational communities are aware that in this report the Commission also stated:

> Second only to a weapon of mass destruction detonating in an American city, we can think of nothing more dangerous than a failure to manage properly science, technology, and education for the common good over the next quarter century.

The interplay between the issue of terrorism and the management of "science … and education for the common good" became all too real in the fall of 2001. Just three weeks after the attacks on New York and Washington, I participated in a previously scheduled seminar on science policy together with other academicians, technologists, and a bipartisan group of current and former Congressmen. Before we began our meeting, the chair went around the table and asked each of us to share a few immediate thoughts regarding the terrorist attacks. In his characteristically concise and insightful manner, former defense secretary and Stanford professor Bill Perry responded that he had two things to say. First, that there would be a very forceful military response, and second, that guarding our civil liberties would need to be a strong priority in the months ahead. And this is precisely how things have played out.

The federal government thus had thrust upon it a daunting responsibility to protect the lives of people in the U.S. – but to do so within a new, complicated environment far different than that of the Cold War years during which much of our national security policy was shaped. Protecting citizens is, of course, a fundamental responsibility of our government. Productive consideration of the ramifications of terrorism defense for our universities or the conduct of effective dialogue with federal officials must begin with recognition of this responsibility.

This new world of homeland and international security also presented opportunities to the research-university community to serve the nation through security-related R&D.

MIT is engaged in such service in a variety of ways, as is the University of California. But the academic community also recognized very quickly that reactions to these all-too-real dangers would inevitably pose conflicts with some of our most deeply held values, and indeed with the fundamental methodology of science.

Immigration policy and access of international students and scholars to our campuses, and to scientific meetings, would come into question; restrictions on publication and open scientific dialog about topics of potential use by terrorists would be proposed; and safeguards and restrictions on the use in our campus laboratories of potentially dangerous materials, especially biological agents, would be established.

Indeed, each of these concerns became real in the months following 9/11. The passage of the USA Patriot Act in late October 2001, as well as various executive orders, affected immigration policy and raised the issue of limited access to what were termed "sensitive areas of study." The Student and Exchange Visitor System (SEVIS) that tracks basic information about foreign students and scholars was upgraded and expanded at a highly accelerated pace. International students, scholars, and visitors to the U.S. were subjected to new reviews, interviews, delays, and much more frequent denials of visas. Ill-defined terms like "Sensitive but Unclassified" appeared more frequently in federal research-policy contracts. The Bioterrorism and Response Act of 2002 established a framework for protecting certain pathogens, referred to as "select agents," from misuse. The editors of a large group of important journals in the life sciences established a self-policing mechanism to restrict publication of information that might be key to the development of unusually dangerous mechanisms of bioterrorist attacks.

The **issue** before us became, and remains, how can our nation and our universities be <u>both</u> secure and open? The **goal** we in research universities had to pursue, and must continue to pursue, is the establishment of sound federal policy.

These complicated issues are not without precedent. In 1947, as our federal research policy was developing on the foundation of the famous Vannevar Bush report, *Science: the Endless Frontier*, and on the subsequent work of William T. Golden, concerns about security in the face of the Soviet threats and the spread of communism led President Truman's Scientific Research Board to eloquently state:

> Strict military security in the narrow sense is not entirely consistent with the broader requirements of national security. To be secure as a Nation we must maintain a climate conducive to the full flowering of free inquiry. However important secrecy about military weapons may be, the fundamental discoveries of researchers must circulate freely to have full beneficial effect. Security regulations, therefore, should be applied only when strictly necessary and then limited to specific instruments, machines or processes. They should not attempt to cover basic principles of fundamental knowledge.

Beginning just two years later, and extending into the 1950s, we faced the terrible intrusions and excesses of the McCarthy-era House UnAmerican Activities Committee, whose history we know all too well. Nonetheless, federal science policy proceeded forward with a reasonably straightforward framework of military classification of certain scientific and technological matters, especially those associated with nuclear weapons.

Most classified work was conducted in federal weapons laboratories, but some such work was conducted on various campuses.

In 1980, concerns about critical defense-related technologies leaking to the Soviet Union became a matter of high-profile concern to the Department of Defense and Congress. Universities were seen as prime targets for espionage and disclosure of technological knowledge that our adversaries could use against us. Even the National Academies suspended bi-lateral exchanges for a period.[1]

In 1982, Executive Order 12356 broadened the authority of the government to classify defense-relevant information, but the order stated that, "Basic scientific research information not clearly related to national security may not be classified." There was much debate about the interpretation of this sentence, and great uncertainty about how it would be interpreted. An answer soon came. As an optics researcher, I remember vividly the community's discussions about a meeting of the SPIE, the Society of Photo-Optical Instrumentation Engineers, in San Diego in August 1982. The talk was about the withdrawal, under government pressure and with less than ten days' notice, of the presentation of more than 150 technical papers on cryptography.

A debate raged, and numerous groups addressed these matters. The National Academy of Science and the National Research Council appointed a panel to study the issue. They concluded that "security by secrecy" would inevitably weaken U.S. technological capabilities, and that it is not possible to restrict international scientific communication without disrupting domestic scientific communication. But this panel did recommend that controls be devised for "gray areas."

During this same period, Dr. Richard DeLauer became Undersecretary of Defense for Research and Engineering. He took great interest in this topic and exerted quietly effective leadership, especially by co-chairing with Donald Kennedy, then president of Stanford, a DOD–University forum. Largely on the basis of their work, a move to elucidate a category of "sensitive but unclassified" was dropped, and DeLauer issued a memorandum to the Armed Services and DARPA emphasizing that university research should either be classified or unclassified.

DeLauer's efforts and memorandum became the basis for President Ronald Reagan's September 1985 National Security Decision Directive 189 (NSDD 189), which stated:

> It is the policy of this Administration that, to the maximum extent possible, the products of fundamental research remain unrestricted … that where the national security requires control, the mechanism for control of information generated during federally funded fundamental research in science, technology, and engineering at colleges, universities and laboratories is classification.
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> Each federal government agency is responsible for: a) determining whether classification is appropriate prior to the award of a research grant, contract, or cooperative agreement and, if so, controlling the research results through standard classification procedures; b) periodically reviewing all

[1] V. F. Weisskopf and R. R. Wilson, "United States – Soviet Scientific Exchange" (editorial), *Science* 208.4447 (30 May 1980).

> research grants, contracts, or cooperative agreements for potential classification.
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> No restrictions may be placed upon the conduct or reporting of federally funded fundamental research that has not received national security classification, except as provided in applicable U.S. Statutes.[2]

After 1985, the general issue of export controls in academic settings more or less lay dormant for over a decade, but by the late 1990s it was gathering steam again. Universities began to be told that the conduct of basic scientific research that utilized satellite systems, and in some cases computer systems, were off-limits to foreign students and to collaborative efforts with other countries, even close friends like Japan. If non-U.S. citizens worked on projects and came into contact with certain specialized equipment, the knowledge they gained was considered a “deemed export” of sensitive technology and they were either barred from that contact or required to pass certain security reviews. Quiet but essentially fruitless discussions between university leaders and federal officials ensued, and in several instances universities turned down such contracts rather than accept restrictions on their students.

Not all threats to scientific and technological openness have been based on national security concerns. During the 1980s and early 1990s, many manufacturing-based U.S. corporations found themselves unable to compete well in global markets. Japan in particular had eclipsed us in the ability to manufacture goods with high quality, efficiency, and throughput, and with short product-cycle times. Japanese engineers and business people learned a lot about U.S. products and innovations, but they also developed business processes, factories, and approaches to total quality management that strongly outperformed us.

Somewhat predictably, there was pressure to raise the ramparts – through classical trade protectionism and through shielding our technological innovations. Because MIT had long-standing good relationships with Japanese companies, we came under strong criticism. In 1989, the House Government Operations Committee Subcommittee on Human Resources held a very contentious hearing during which MIT president Paul Gray was roundly criticized, in essence for giving away America’s crown jewels of technology through exchange activities with Japanese companies and scholars. In 1992, a U.S. Senator promulgated a graphic image entitled “The Circle of Shame.” It depicted technical knowledge being passed from MIT to Japanese students, only to be developed by them into products marketed to damage the U.S. economy. The U.S. intelligence community was increasingly focused on international industrial espionage. Universities across the country were criticized for their increasing populations of international, and especially Asian, students. There were strong pushes to bar international students from university research programs.

Of course, much of the economic threat was very real. Japanese policies did not result in a level playing field for our automotive and consumer-electronics industries. But Japan also had the advantage of building new industries and “green field” factories,

[2] I want to recognize Dr. John C. Crowley, formerly MIT’s vice president for federal relations, for his research and strong contribution to my understanding of the history of these issues in the period 1947–1985.

unencumbered by aging plants and equipment, tired management practices, and executives who had grown unused to serious competition.

Ironically, in the end, the U.S. learned a great deal about management and quality control from Japan. While there is no way to quantify this, I suspect that we gained more value from these management innovations than they did from learning about our technology. Indeed, by the early 1990s, universities were criticized, with some good reason, for not having been ahead of this curve in teaching their business and engineering students about total quality management and new approaches to product development in the first place.

In any event, the openness of our universities survived these stresses more or less unscathed. Subsequently, many of our large industries transformed themselves into efficient and high-quality manufacturers, and the entrepreneurial sector led us into strong economic growth in the late 1990s. Most of the criticism of international students and connections then abated.

Predictably, however, following the collapse of the dot-com economic bubble, national paranoia about leaking technological knowledge and mild xenophobia recurred. In fact, it was, and is, more a case of policy schizophrenia. Both before and after 9/11, the dominant reason for rejecting students applying for visas to study in the U.S. appears to have been *immigrant intent*, i.e., the government was afraid that these prospective students would stay in the U.S. after they completed their studies.[3] On the other hand, many policy makers simultaneously decried the fact that increasing numbers of international students who had studied here were returning to their countries of origin to contribute to the development of their economies and universities rather than to ours.

Thus, for five decades, the international population of our graduate programs in science, engineering, and management has grown steadily. Science has had a strong culture of international cooperation and communication throughout this period. As in industry, higher education and research have increased their global reach and international interactions. But periodic episodes of federal interference with scientific communication and concerns about international students have occurred. These were driven both by Cold War security concerns and commercial concerns that tended to be counter cyclical to the strength of our economy.

With this historical context, let me return to the debates, issues, and accomplishments regarding universities and national security in the post-9/11 era. The most visible issues have revolved around the policy and practice of granting visas to foreign students planning to study in U.S. universities. Since the fall of 2001, this has been a complicated mixture of legitimate concerns, overreaction, bureaucratic foibles, risk aversion, antiquated systems, good intentions, bad policies, heart-rending personal experiences, and, finally, slow but steady improvement.

As a nation, we have done great, though hopefully still reversible, harm to both our image and reality because we substantially pulled back the celebrated American welcome mat. It was suddenly withdrawn, and then slowly rolled back in the general

[3] Section 214(b) of the Immigration and Nationalities Act of 1952 requires that visitors prove to the satisfaction of a consular officer that they do not intend to stay in the United States beyond the visit for which they request admission.

direction of the prominent position it occupied in past decades. Personally, I don't feel a lot safer at night because of all this.

My colleagues Alice Gast and Danielle Guichard-Ashbrook, MIT's vice president for research and associate graduate dean, respectively, summarized the situation succinctly, as they contemplated pending Congressional discussion of student and scholar visa issues in 2005:

> The cumulative effects of all the post 9/11 initiatives have harmed our nation's long-standing reputation as the premier environment for engaging in innovative and unfettered research in science and technology. The perception among our foreign national colleagues is that the US is no longer a welcoming place. The DOS and DHS processes in place treat our foreign national guests as potential threats, and the most talented among them are questioning the value of putting up with that attitude. They are actively exploring increasingly attractive options, in the PRC, in India, Europe and Asia. We will need to compete for the best international students in ways we never had to before.
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> International students apply to DOS for student visas based on much-documented evidence confirming their academic acumen and their personal backgrounds. Upon entry to the US, they are fingerprinted and photographed. Once in the US, they are tracked each term through SEVIS on everything from marital status to change in degree level. They cannot get social security numbers or drivers licenses without the SSA confirming their immigration status with Immigration and Customs Enforcement, known as ICE. They cannot be employed without explicit permission from their academic institutions and/or Customs and Immigration Services (CIS). They need our signatures on their immigration documents in order to re-enter the US from a trip abroad. Between academic databases and federal databases such as SEVIS, there is a surfeit of trackable data on these foreign nationals. Given this, one might ask why additional bureaucratic processes are needed for an overwhelmingly compliant and low risk group of foreign nationals. Among our international students and scholars, it promulgates ambivalence about studying in the US.[4]

The effects are real. Between 2003 and 2004 the number of international students applying to U.S. graduate programs fell by 32 percent, and the number of such students admitted to graduate programs declined by 18 percent.[5] This major shift, however, is not yet fully understood. Although unhappiness with U.S. policy and perceived attitudes is clearly a major factor in this sudden shift, competition from universities in other parts of the world, economic factors, and even fear of moving about in a troubled world are undoubtedly in play as well.

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[4] Alice P. Gast and Danielle Guichard-Ashbrook, Private Communication (17 May 2005).
[5] *Policy Implications of International Graduate Students and Postdoctoral Scholars in the United States*, Commmittee on Scientific, Engineering, and Public Policy (Washington, DC: The National Academies Press, 2005).

Universities in other parts of the world see a clear opportunity to take advantage of this situation. While we are obsessed with trying to guess which student applicants might do us harm or return home to start an entrepreneurial business, others say, in effect, "If the U.S. doesn't want you, come here where you are welcome." For example, several outstanding European universities are shifting their instructional language to English to better appeal to students from other parts of the world. This perception also affects our faculty recruiting.

Despite the frustrating nature of these matters, many people of goodwill in corners of the State Department, the Department of Homeland Security, and the White House understand the damage being done and have worked hard to keep the nation both secure and open. Systems have slowly improved, times required for security reviews have been reduced, and more personnel have been hired to interview and process applications in consulates around the world. While he was Secretary of State, Colin Powell issued instructions that gave visa-processing priority to students and scholars. More recently, the time period during which an international student or scholar can leave and reenter the country without having to reapply for a visa has been extended from one to up to four years, once they have received what is termed Visa Mantis clearance. The systems are becoming smoother and more efficient, although numerous problems continue to exist. This is important progress, but it certainly has not completely restored our global image as open and welcoming. International participation in scientific meetings held in the United States has declined, because some scientists dislike what they consider to be negative attitudes and undue complexity, or because visa applications could not be processed in time. International collaborative efforts are suffering for the same reasons. This remains a serious problem.

There are deeper trends that I worry about even more. These have to do with restrictions on research and scientific communication. Some are mind-boggling. Consider the actions of the Treasury Department's Office of Foreign Assets Control (OFAC). In 2003 OFAC addressed the publication in American scientific journals, specifically those of the IEEE, of papers by authors who reside in countries that we consider to threaten our interests or harbor terrorists. Their interpretation of the law was that journals could publish such papers, but they could not edit them or transmit reviewer's comments, because editing manuscripts would constitute commerce with that nation. This is truly in the spirit of Alice in Wonderland. Eventually, OFAC reversed the IEEE ruling, but uncertainties about the generality of its ruling remain. OFAC currently is refusing to grant a license to MIT architecture students to travel to Cuba as part of a studio course.

Closely related to OFAC and export-control regimes – and far more widespread – is the increasing appearance of national security-based restrictive clauses in university-based federal research contracts with universities. Typical restrictions include invoking a clause from the Federal Acquisition Regulations Act (FAR) that absolutely prohibits publication of research unless approved by the government; requiring *ad hoc*, non-standard agency reviews of publications; restricting involvement of foreign nationals in research or requiring special security reviews of them; and limiting distribution of data or reports, even though they are not classified. Such restrictions are at odds with the bright line of classification spelled out in NSDD 189. As discussed above, NSDD 189 was adopted in 1985; however, in the fall of 2001 the President's National Security Advisor, Dr. Rice, reiterated in a letter to former secretary of defense Harold Brown that it remained operative.[6]

This puts universities squarely on the line. It is our choice to accept or reject contracts that include such restrictions. It is essential in my view that we be certain that on our campuses contracting officers carefully scrutinize contracts for such troublesome clauses, and that we have specific processes for reviewing and deciding whether to accept them. Frequently, universities that have pushed back and carried the discussion higher in sponsoring agencies have succeeded in getting such clauses removed. In cases where this is not possible, some institutions have rejected the contracts, whereas others have accepted them.

I personally believe that the default for universities should be to reject such clauses. They represent a slippery slope that could lead to a serious erosion of basic values of openness of U.S. universities and could harm the fundamental process of scientific inquiry. I believe that we best serve our nation by adhering to these values and processes. It also is my view that we teach our students in how we react to these sometimes-difficult situations.

In summary, these are complicated times as we try to balance very real security concerns against the critically important openness of our institutions and scientific and scholarly activities. There has been some respectful and productive dialog between our community and the federal government, but we are not out of the woods. Continued vigilance and change will be required if we are to maintain the world leadership of our educational and research institutions.

Openness: The Internet, World Wide Web, And Educational Sharing – Toward A Meta-University

Even as we face and resolve the thorny issues of balancing security and openness to sustain our campuses as great magnets for the brightest minds from around the world, modern information and communication technologies have fundamentally altered what it means to be an open scholarly or educational community. At the same time, India, China, and other countries are making strong investments to bring their research universities to world-class status. Strong forces and great opportunities are extant in higher education. How will the use of so-called educational technology play out? What will be the nature of globalization in higher education? Will the Age of the Internet and what lies beyond it fundamentally reshape education and research? Are residential universities dying dinosaurs, or models to be propagated further?

My personal assessment of these matters is made in the context of two admitted biases. First, I remain hopelessly in love with the residential university – with Clark Kerr's "multiversity." Teaching is a fundamentally human activity, and it is difficult for me to envision anything better than the magic that happens when a group of smart, motivated, and energetic young men and women live and learn together for a period of years in an intense university environment.

[6] Condoleezza Rice, Letter to Harold Brown (1 Nov. 2001).

Second, years ago I read a book by Princeton's Gerrard O'Neil in which he looked back over the centuries at what futurists of each period had predicted, and then he compared these predictions to what turned out to be the realities.[7] The primary lesson from this study was that the rate of technological progress was almost always dramatically under-predicted, and the rate of social progress is almost always dramatically over-predicted. I share this view.

What I envision, therefore, is a way in which relatively stable and conservative institutions will develop enormous synergies through the use of ever-expanding technological tools. Indeed, this is already happening in profound ways. Computers, of course, have had a strong influence on higher education since the 1960s, starting out as a specialized tool in science, engineering, and mathematics, and then propagating across the humanities, arts, and social sciences, as well as to business, law, and medicine. During the late 1990s, following the development of the World Wide Web, and accelerated by ever-decreasing prices of storage and processing, higher education everywhere began to see information technology as a transformative force. This coincided with the dot-com era in the world of business, so attention turned rather immediately to how universities could teach large numbers of students at a distance, and how they could realize financial profits by doing so. Journalists, critics, and many of our own faculty concluded that classroom teaching in lecture format was doomed. Economies of scale could be garnered and many more people could afford to obtain advanced educations via digital means. For-profit distance education was assumed to be the emerging coin of the realm.

Profit-making arms of some major universities, such as Fathom.Com at Columbia, were formed, and new providers like Phoenix University were founded. The Western Governors Conference established a distance-education program as a collective effort of public universities in their states. University faculty and administrators across the country wrestled over the ownership of intellectual property when a professor's course was made available electronically.

The model that was proposed over and again was, "find the best teacher of a given subject, record his or her lectures, and sell them in digital form." There is an appealing logic to this proposition, and I very much believe that there is a role for this kind of teaching tool, but the image of students everywhere sitting in front of a box listening to an identical lecture is one that repels me. It struck me as odd that many of the same critics who decried the lack of personal attention given students on our campuses seemed eager to move to this model. Nonetheless, the dominant proposition was that a university should project itself beyond its campus boundaries to teach students elsewhere.

But in the meantime, many other things were happening. Increasingly effective computer-based tools for language acquisition were being developed. On-line journals were published. Computer simulations were used in subjects ranging from fluid mechanics to theater stage design. Studio-style instruction with heavy use of computational tools became increasingly prevalent. As Murray Gel-Man likes to say, "The sage on the stage was being replaced by the guide at the side." Multiple institutions shared large scientific databases. Massive search engines made information

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[7] Gerrard K. O'Neil, *Two Thousand Eighty-One: A Hopeful View of the Future* (New York: Simon & Schuster, 1980).

available to anyone with a Web browser. Informal electronic learning communities formed, both within and among universities. Distinguished architects sitting on multiple continents used video and Web interactions and judged architectural studios.

In other words, information technology, usually through increasingly large accumulations of modest, local activities, was transforming much of what we do on our campuses. More important still, information technology was bringing the world to the students on our campuses, as well as projecting our activities outward.

At the Andrew W. Mellon Foundation, William C. Bowen and his colleagues developed ideas about how to empower large numbers of scholars and institutions through a combination of technology and economy of scale that in 1990 coalesced in the establishment of JSTOR. JSTOR makes available digital copies of scholarly journals in the liberal arts and humanities for modest annual fees scaled to institutional size. Currently, JSTOR includes over 500 scholarly journals from almost 300 publishers and serves 2600 institutions. It helps individual scholars conducting advanced scholarly research at major universities. It also enables small liberal arts colleges with very modest resources to collectively or individually mount courses in areas of the humanities for which they could not have afforded appropriate library collections. In 2001, the Mellon Foundation launched a second major venture, ARTSTOR, that uses a similar approach to develop a huge, carefully developed archive of high-quality digital images of great works of art. In 2006, ARTSTOR will expand to include 5,000 images.

In my view, JSTOR was a particularly important development in bringing the power of the Internet, and of sharing large digital archives, to humanistic scholars and students in a wide array of colleges and universities. It pointed toward a new type of “openness” in higher education.

In 1997, I prepared for that inevitable duty of a university president – leading a capital campaign. Our resource development staff had organized a dozen dinners, each in a different city, for prospective donors and thoughtful alumni, at which I would hold dialogues about MIT’s future. At each dinner the first question asked of me was, “What is MIT going to do about information technology and distance learning?” My answer was always some variant of, “I don’t know.” But the answer soon came from our faculty.

Our provost, Bob Brown, had appointed a task force to explore this question, building on earlier work of a Council on Educational Technology. Frankly, the bias going into this exercise was toward some sort of profit-generating production of educational modules on up-to-the-minute engineering and scientific topics that would be of particular interest to our alumni, and to high-level engineers and managers in corporations with which we have research partnerships.

The committee worked diligently exploring various concepts and models, even studying the business plans of a large number of for-profit distance-learning organizations. They concluded that in the context of advanced higher education, distance learning would be complicated, highly competitive, and unlikely to turn a profit. This sowed the seed of a beautiful idea – why not just make detailed educational materials broadly available on the Web, free of charge?

From this beginning, the MIT OpenCourseWare (OCW) initiative was born. With generous financial support from the Mellon and Hewlett Foundations, the Institute pledged to make available on the Web, free of charge to teachers and learners everywhere, the substantially complete teaching materials from virtually all of the approximately 2000 subjects we teach on campus. For most subjects these materials include a syllabus, course calendar, well-formatted and detailed lecture notes, exams, problem sets and solutions, lab and project plans, and, in a few cases, video lectures. The materials have been cleared for third-party intellectual property and are available to users under a creative commons license so that they can be used, distributed, and modified for non-commercial purposes. This is a new, open form of publication. It is not teaching, and not the offering of courses or degrees. It is an exercise in openness, a catalyst for change, and an adventure.

It is an adventure because it is a free-flowing, empowering, and potentially democratizing force, so we do not know in advance the uses to which it will be put. Currently, materials for 1100 courses are mounted. The OCW site – which typically has 20,000 unique visits per day – has 43 percent of its traffic from North America, 20 percent from East Asia, 16 percent from Western Europe, and the remaining 20 percent of the users are distributed across Latin America, Eastern Europe, the Middle East, the Pacific Region, and Sub-Saharan Africa. International usage is growing rapidly. Roughly 15 percent of OCW users are educators, and almost half of their usage is directly for course and curriculum development. One third of the users are students complementing a subject they are taking at another college or university, or simply expanding their personal knowledge. Almost half of the users are self-learners.

An Arizona high school teacher motivates and supervises group study of MIT OCW computer-science materials within his after-school artificial-intelligence club. A group of then-unemployed programmers in Silicon Valley used MIT OCW materials to master advanced computer languages, upgrading their skills when the job market became very tight. An educator at Al-Mansour University College in Baghdad is utilizing material from an MIT OCW Aeronautics and Astronautics course in his air traffic control research. The computer science department of a university in Legon, Ghana is updating its entire curriculum, and is using MIT OCW materials to help benchmark and revise their courses. An underground university based largely on MIT OCW educates young men and women who, because of their religion, are forbidden to attend one country's universities. Heavy use is made of OCW by almost 70 percent of the students on our own campus to review courses they have taken in the past, to reinforce the classes they are currently taking, and to explore other areas of study.

OpenCourseWare seems counterintuitive in a market-driven world, but it represents the intellectual generosity that faculties of great American universities have demonstrated in many ways over the years. In an innovative way, it expresses a belief that education can be advanced around the world by constantly widening access to information and pedagogical organization, and by inspiring others to participate.

MIT OCW is starting to catalyze other participants in a movement to deploy and use well-organized open-course materials. Universia, a network of 840 universities in Spain, Portugal, and Latin America, has translated the materials of almost 100 MIT OCW courses into Spanish and made them available on their website. The People's Republic of China has established CORE (China Open Resources for Education), a network of 100 universities with more than 10 million users. CORE's goal is to enhance the quality of higher education in China by translating MIT OCW and other course materials into Chinese, and also by sharing Chinese courses globally. Rai University in India has established a very substantial activity called Rai Courseware. Japan and France have OCW efforts underway.

Here in the U.S., the University of Michigan, Utah State University, the Johns Hopkins University School of Public Health, and Tufts University's Health Sciences and Fletcher School of Diplomacy all have established OCW efforts. Here I use the term OCW to denote substantial, comprehensive, carefully managed, easily accessed, searchable, Web-based collections of teaching materials for entire courses presented in a common format.

In this emerging open-course-ware movement, it is not only the teaching materials that are shared. We have also implemented and actively encouraged the sharing with other institutions of software, "know-how," and other tools developed by MIT OCW.

On the horizon in science and engineering education is the use of Web-based laboratories. The concept is simple, but its ramifications could be profound. Most experimental apparatus today is computer controlled, and therefore can be interfaced through the World Wide Web and operated from anywhere. Students can conduct experiments across campus from a laptop in their dorm rooms. Just as easily, a student can run the experiment from the other side of the world. Such control at a distance is well developed in certain areas of research like the operation of ground-based and space-based telescopes, but its use in more routine education is just being explored.

MIT faculty have developed a program called iLab, with financial support from Microsoft. Through the Web, students can operate experiments in transistor characterization, heat-exchanger dynamics, vibration response of structures, polymer crystallization dynamics, and dynamic-signal analysis. Professor Jesus DelAlamo, who spearheaded MIT's iLab, is working with colleagues in three universities in Sub-Saharan Africa to utilize it, and also to develop their own contributions to Web lab experiments and education.

Day-to-day communication and data transfer among scholars and researchers now are totally dominated by Internet communications. Large, accessible scholarly archives like JSTOR and ARTSTOR are growing and heavily subscribed. The use of OpenCourseWare is developing in the U.S., Asia, and Europe. To paraphrase the columnist Tom Friedman, the earth is getting flat. I believe that openness and sharing of intellectual resources and teaching materials – not closely controlled point-to-point distance education – is the most important emerging ethos of global higher education.

In my view, a global *meta-university* is arising that will accurately characterize higher education globally a decade or two hence in much the same way that Clark Kerr's "multiversity" accurately characterized large American universities forty years ago. Like the computer operating system Linux, knowledge creation and teaching at each university will be elevated by the efforts of a multitude of individuals and groups all over the world. It will rapidly adapt to the changing learning styles of students who have grown up in a computationally rich environment. The biggest potential winners are in developing nations.

This will happen because nation after nation is committed to enhancing and expanding their higher education, and because there are global efficiencies and economies of scale to be had by collectively sharing high-quality materials and systems that are too expensive for each institution to develop independently. It will happen because this kind of sharing is not prescriptive. It is not paternalistic, and it need not be politically or culturally laden, because each individual institution, professor, or learner is free to use only those parts of the material he or she chooses, and may adapt, modify, or add to it in fulfillment of the local needs, pedagogy, and context. Campuses will still be important, and universities will still compete for resources, faculty, students, and prestige, but they will do so on a digital platform of shared information, materials, and experience that will raise quality and access all around.

Conclusion

The Age of the Internet presents remarkable opportunities for higher education and research in the United States and throughout the world. The rise of a meta-university of globally shared teaching materials, scholarly archives, under girding campuses everywhere, both rich and poor, could well be a dominant, democratizing aspect of the next few decades.

Even as we develop the meta-university and other forms of digitally empowered educational globalization, we must maintain the openness of our campuses here in the United States. Our openness to international students, scholars, and faculty members, as well as the openness of scientific inquiry and communication, must be balanced against national security concerns in the face of terrorism. But the lessons of history confirm that openness is a great contributor to the security of our nation and world in the long run, and must be preserved.