MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Report of the President
For the Academic Year 2001–2002

Response and Responsibility

Balancing Security and Openness in Research and Education

The scale and nature of the ongoing revolution in science and technology, and what it implies for the quality of human capital in the 21st century, pose critical national security challenges for the United States. 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.

U.S. Commission on National Security in the 21st Century

March 15, 2001

Openness and Security

The ability of our nation to remain secure in the face of both traditional military threats and international terrorism while maintaining the excellence and pace of American science and technology requires a delicate balance. It depends first and foremost on effective dialogue and joint problem solving by those responsible for maintaining our security and those who lead our scientific, engineering, and higher education communities.

Our immediate impulse when threatened is to wall ourselves off and to regulate the release of information of potential use to our enemies. This is understandable, and frequently justified, but in today's complicated world, the security issues raised regarding research and education do not lend themselves to simple responses—especially when long-term consequences are considered. Why?

The future health, economic strength, and quality of life in America, and indeed the world, depend on the continued rapid advance of science and technology, and on the education of scientists and engineers at the most advanced levels. The rapid progress of science and technology, and the advanced education of scientists and engineers, in turn, depends critically on openness of process, openness of publication, and openness of participation within our institutions and across national boundaries.

Historically, our nation and world have faced many challenges to peace and security. Now we face a constant threat of determined terrorists. Their immediate objectives are to kill large numbers of people, or to cause terror, panic, or disruptions of our lives and economy.

As we respond to the reality of terrorism, we must not unintentionally disable the quality and rapid evolution of American science and technology, or of advanced education, by closing their various boundaries. For if we did, the irony is that over time this would achieve in substantial measure the objectives of those who disdain our society and would do us harm by disrupting our economy and quality of life.

Americans are learning that the balance between protection of our lives and of our liberties is as difficult to strike as it is essential that we do so. I believe that it is equally imperative that we strike the right balance between security and the openness of our scientific research and education. But I conclude that we must rely very heavily on maintaining that openness.

In the year since the murderous attacks in New York, Washington, and Pennsylvania, the experience of MIT and other leading research-intensive universities has been primarily one of calm and reasoned interaction and consultation with the Federal government on such matters as the admission of international students and scholars, the openness of scientific research, and the control of dangerous chemical and biological agents.

However, the discussion of these issues and the establishment of a regulatory environment associated with homeland security are far from over. It therefore seems timely to address some of the fundamental issues and long-term consequences of our decisions.

Before doing so, let me make clear that, although it is not the topic of this essay, MIT and our sister institutions take very seriously our responsibility to serve our nation by applying our talents and capabilities to the protection of human life and infrastructure in our homeland and throughout the world. (See, for example, our website on MIT research and education on homeland and global security: *http://web.mit.edu/homeland/index.html*.)

It is equally imperative that we strike the right balance between security and the openness of our scientific research and education. But we must rely very heavily on maintaining that openness.

International Students

A matter of current debate, legislation, and policy implementation is the degree to which our university campuses should remain open to international students and scholars. Who should receive student visas? Should there be limitations on what foreign-born students can study? What criteria should be applied when answering such questions?

American research universities hold deep and longstanding values of openness in scientific research and education. Yet we must test these values and their implications against the realities of the catastrophic terrorist acts that left 3,000 dead within our borders in a single, horrific day. The fact is that an environment requiring careful evaluation of these values and their security implications had developed well before September 11, 2001.

For decades, the outward diffusion of people, ideas, and collaboration from our universities has been celebrated as important and timely. This diffusion has been accelerated by the Internet and the World Wide Web, and by the rapid evolution of globalization and internationalization. These forces of openness and outward pull are now opposed by concerns about their possible implications for our vulnerability to terrorism and for the nation's broader posture regarding export controls on certain technologies and information.

Clearly, the resolution of these issues requires an ongoing, substantive dialogue between the academic community and the Federal government. In my view, during the past twelve months, such a dialogue has begun and in general has proceeded well toward reasoned resolution of several core issues. Nonetheless, the underlying sense of partnership is fragile and is vulnerable to political winds that can shift in a moment. It would be devastating to our long-term national interest if substantive dialogue and mutual problem solving were not continued.

The MIT Context

Let me begin with the MIT context. Approximately nine percent of our undergraduate students are international. They come from 88 countries. About 37 percent of our graduate students are international. They come from 91 countries. Across our institution, there is a deep belief that these young men and women contribute immensely to MIT's educational environment—one in which all students are exposed to a variety of cultures, personal experiences, and worldviews.

These international students are the best and brightest from their nations, and they strongly enhance the excellence of learning and research at MIT. They are not some spice added to the mix; rather, they are an integral and highly valued part of what makes MIT great. Furthermore, the industries and institutions in which our graduates will live and work are highly globalized, so that even from a purely pragmatic perspective, cross-cultural and cross-national learning and experience are highly valuable and in our national interest.

MIT has a long tradition of educating both immigrants and citizens who have often been the first in their families to go to college. Although we maintain no data to confirm it, my impression is that many of our students are U.S. citizens whose parents came to this country from elsewhere. Engineering and science in this country have traditionally been pathways up the ladder to economic success and productive contribution to our society.

If ever there were a meritocracy, it is the MIT Faculty, which has selected many in its ranks from those who have come to this country from elsewhere. The recent Nobel laureates on the MIT Faculty include people born in Japan, India, Mexico, Italy, and Germany, as well as the United States. Most of them came to this country as graduate students. Or consider our Institute Professors, the dozen or so faculty members who have achieved the highest faculty rank at MIT. They were born in the United States *and* in Belgium, Italy, Mexico, Israel, and China. Any of our great universities would offer similar lessons.

The preponderance of our graduates appear to have remained in this country, contributing to the ranks of other faculties and the leadership of our high-tech industries, and participating broadly in our ongoing civic enterprise. Today, it is widely assumed, though not well documented, that as economies have improved around the world, especially around the Pacific Rim, more graduates are returning home than has been the case previously.

And those who have returned to their native countries have frequently contributed greatly to their leadership and to their industries. They take to their nations new knowledge and training that can grow strong economies and attenuate the inequities that are at the core of world strife. MIT's Department of Economics has graduated many PhDs who went on to become economic ministers or other high-level officials around the world. The Sloan Fellows Program of advanced executive education has had a large international enrollment from its inception. Sloan Fellows are found all over the world in leadership roles. A visitor to practically any country will find MIT-educated engineers and scientists leading faculties and industries. The vast majority carry with them an understanding of and respect for our institutions and for many of our national values and characteristics.

Have MIT graduates returned to other countries and worked against the interests of the United States? There are undoubtedly a few such instances, given the large numbers of graduates and the ebb and flow of history. There were examples of this in China during the Cold War and elsewhere, just as a tiny few of the tens of thousands of our U.S. citizen graduates may have been less than a source of pride. I can draw no conclusion, however, other than that MIT, the United States, and the world have overwhelmingly benefited from the international character of our student body.

The National Context
What is the broader national context?

Over the last 25 years, the number of foreign-born scientists and engineers in the U.S. has grown in all degree levels, in all sectors, and in most fields of study. The largest group of foreign students are those studying in our business schools. Currently, 25 percent of all U.S. doctorate holders, and roughly 45 percent of PhD engineers and computer scientists, were born abroad. One-third of the science and engineering PhDs working in our industries were born elsewhere, with this number exceeding 50 percent in engineering and computer science.

Over the years, the dominant national origins of international students studying science, engineering, and computer science in the U.S. have shifted, largely propelled by the strength of various national economies, and attenuated by political conflicts. When I was a young faculty member, the largest numbers of international students in U.S. engineering programs came from Iran and Nigeria. Today, they come from Asian countries.

When considering the large influx of international students in engineering and science, we must recognize that these demanding studies and professions are not highly valued in our popular or political cultures. It is incumbent on us to strengthen our K-12 science and math education, and for the government and private sector to maintain exciting research and educational environments to attract bright young Americans. I should note that as federal funding for biomedical research has dramatically increased during the last few years, the percentage of doctorates in that field granted to U.S. citizens has begun to increase, albeit slowly.

As we consider the implications for homeland security of our openness to international students, we should be cognizant that other national emergencies have raised similar questions in the past. In the late 1970s, during the Iranian hostage crisis, grave concerns were raised about Iranian students in this country, and strong actions were contemplated, and to some extent taken, against them. In the late 1980s and early 1990s, MIT and other universities were castigated because of our visitors from, and interactions with, Japan. It was feared that the Japanese would milk advanced technology from our university laboratories, commercialize it, and drive our economy into the ground. Indeed, a U.S. senator widely circulated a diagram titled "The Circle of Shame" with MIT depicted at the heart of this presumed nefarious activity.

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Three Conclusions
From this background and context, I draw three conclusions:

- The openness of U.S. research universities to foreign students and scholars has been overwhelmingly successful in building the excellence of our institutions, enhancing the educational experience of our students, contributing to American industry and academia, furthering the advancement of nations around the world, and disbursing good will toward and understanding of our system and values.
- Nationally, the proportion of foreign students in science and engineering doctoral programs continues to grow.

This, however, is largely a reflection of problems in our secondary educational system coupled with a popular culture that does not promote or value the dedication and long years of hard work required for success in these fields.

- Our openness to international students and scholars has been questioned or reviewed many times throughout our history, including during the most recent decades.

We now find ourselves in perilous times that require that we consider, in partnership with our Federal government, whether our openness to foreign students requires modification. Indeed, statutory requirements for such determinations are already in place. We have the harsh reality that a few of those responsible for the bombing of the World Trade Center in 1993, and the mass killings in New York, Washington and Pennsylvania last year, entered this country on student visas. We also have the concern that future catastrophic terrorism—unlike that committed to date—might require advanced scientific knowledge or materials that could be acquired in university classrooms or laboratories.

Thus two questions are raised: Should we track the whereabouts of foreign students, and should there be restrictions on what they study?

Tracking International Students
Students and visiting scholars must be issued visas by U.S. consular officers around the world after they have been admitted to study at a U.S. university. The consuls have the responsibility for judging the appropriateness of admitting each such student. This is the proper division of labor—universities evaluate academic credentials, and federal officials in the State Department determine admissibility to the United States.

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It is broadly agreed that once students arrive in this country universities should maintain and provide to the government fundamental "directory information" including whether each individual is enrolled and what area of study he or she is pursuing. It certainly is legitimate for the government to track non-immigrant students and scholars, and determine whether they are pursuing the purposes for which they were admitted. Despite numerous comments by journalists and politicians to the contrary, the higher education community has supported, and continues to support, such tracking.

The problem has been that this information, which is already collected by the universities, gets buried in a vast amount of paper that cannot be processed or analyzed in a timely manner. A new computer system, SEVIS (Student and Exchange Visitor Information System), is under rapid development to correct this situation. MIT supports the deployment of SEVIS, and so does every major higher education association.

Sensitive Areas of Study
Presidential Decision Directive No. 2, issued by President Bush in October 2001, requires that the Federal government, in consultation with the higher education community, determine "sensitive areas of study" that should be off limits to students from certain nations.[1] Even this is not a new concept. There has existed for some time a State Department system called Mantis that is alerted when a potential student from certain countries applies to study in a field that appears on the Technology Alert List, e.g., nuclear engineering, lasers, sensors, ceramics, radar, electronic guidance systems, or munitions. The State Department must then generate a specific opinion as to whether the student should be granted a visa.

Nonetheless, I am deeply concerned about where implementation of this directive could lead. The basic framework, developed by the White House in consultation with agencies such as the State Department and the Department of Justice, and with considerable discussion with the higher education community, is fundamentally sound. The core of this framework is the Interagency Panel on Advanced Science and Security (IPASS). The proposed task of IPASS is widely understood to be to determine whether students or scholars applying to enter the U.S. will engage in research activities that provide access to advanced science or technology of direct relevance to the development, deployment, or delivery of weapons of mass destruction.

This framework, if I have accurately portrayed it, has two important positive features. First, it establishes a high-level review panel, rather than generating a list of specific subjects or courses considered off limits. Second, it applies to matters associated with weapons of mass destruction, which, as I will explain later in this essay, seems appropriate to me. Third, it places this judgment with the admitting authorities *at the time of visa application*, thus maximizing the openness of our institution to students once they are properly admitted to the U.S.

Where could the IPASS framework go wrong and unreasonably disrupt the basic workings of research universities? I would suggest the following potentialities as troubling or inappropriate:

- Moving beyond criteria that are based rather narrowly on weapons of mass destruction.

[1] "Homeland Security Presidential Directive—2", October 29, 2001, President George W. Bush.

- Expanding criteria to cover academic courses and classes, rather than very specific research and development activities.
- Applying new academic restrictions to students after they have begun to study at the institution for which they were properly granted a visa.

Indeed, the MIT Ad Hoc Committee on Access to and Disclosure of Scientific Information, chaired by former U.S. Secretary of the Air Force Sheila E. Widnall, in its report *In the Public Interest*, recommended that "No foreign national granted a visa by the U.S. government should be denied access to courses, research or publications generally available on campus."[2]

This Committee further stated, "The well-being of our nation will ultimately be damaged if education, science, and technology suffer as a result of any practices that indiscriminately discourage or limit the open exchange of ideas.

"We recommend that no classified research should be carried out on campus; that no student, graduate or undergraduate, should be required to have a security clearance to perform thesis research; and that no thesis research should be carried out in [intellectual] areas requiring access to classified materials."

Scientific Materials and Information

Terrorism to date has been decidedly low-tech, although its worst instances have been very sophisticated organizationally. Truck bombs, commandeering of commercial aircraft, and credit card fraud appear to have been the primary tools used by those who have done us great harm. The materials they used have been things such as fertilizer, diesel fuel, and off-the-shelf chemicals. None of this has involved scientific or technical information that is advanced, or difficult to obtain. This is an important observation, although no guarantee of the future course of events. Indeed, the as-yet undetermined origin of anthrax attacks in the U.S. gives rise to important concerns.

The nebulous, diffuse nature of terrorism makes a simple prescription for the responsibilities of academic institutions impossible. Nonetheless, let me suggest a basic framework for thinking about it, by parsing the issues among the most commonly discussed mechanisms for terrorist attacks of a technological nature.

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This framework reflects the nature of the information and materials required:

- The use of ***nuclear weapons and missiles*** is a singular matter. The information required to construct a nuclear weapon is acquired over many years. It is generally not the stuff of classroom learning; rather it is largely sophisticated know-how developed by experience, testing, and advanced computational simulation. Most nations can only acquire the critical components and materials required for construction of a nuclear weapon by illegal means.
- ***Cyberterrorism*** is the use of computer and communication technology to disrupt, corrupt, or disable our military or commercial IT systems. Potentially it could directly weaken our national security, or it could bring havoc to our economy. The information required by a cyberterrorist can be presumed to be of varying degrees of sophistication, but generally available. It is largely the stuff of hacking. The materials, in this case, are computers and access to the Internet. Having said this, cybersecurity is an urgent issue in all domains of industry, education, and government. It imposes additional administrative burdens and regulatory costs on all organizations, and it calls for more computer scientists and mathematicians who are U.S. citizens, trained to protect our information infrastructure.
- ***Bioterrorism*** could involve the propagation of disease and the defeat or disruption of therapies to counter it. The information required is likely to be available in published literature. Some experientially gained know-how might be involved, but it could generally be obtained by a wide variety of experiences in laboratories, medical establishments, or pharmaceutical companies. Some specialized equipment or facilities might be required, but they would likely have widespread applicability to legitimate activities. This situation is distinctly unlike the case of nuclear weapons and poses some of the most vexing issues. The needed biological materials may or may not be readily available.
- ***Chemical or explosive attacks*** are somewhat less commonly discussed, but are, in my view, among the things we should be most worried about. The information required for many forms is readily available, even to the layperson. Some dangerous agents are difficult to obtain, but others can be purchased off the shelf. The terrible destruction of lives by an angry American at the Alfred P. Murrah Building in Oklahoma City and the use of Sarin gas in Tokyo are prime examples.

Having reviewed these categories, I would say that nuclear weaponry seems to be an almost singular case. Critical knowledge and know-how should be, and is, highly restricted by the normal security classification processes of the Department of Defense and the Department of Energy. These are not things that students should be required to access in the conduct of university research; they cannot be taught in a normal classroom. It is an area that, in my view, is appropriate for reasoned decision-making by IPASS. But we should depend primarily on our well-established classification and security mechanisms.

[2] *In the Public Interest*, Report of the Ad Hoc Faculty Committee on Access to and Disclosure of Scientific Information, Massachusetts Institute of Technology, Sheila E. Widnall, Chair, June 12, 2002, page 15; subsequent citations at pages ii and iii.

I do not believe that cyberterrorism, bioterrorism, or the use of chemical explosives pose threats that could in a meaningful way be countered or avoided by restrictions on what is taught in our university classrooms, or on the country of origin of our students. This is basic knowledge, and as in most instances in life, basic knowledge can be used for good or ill. The knowledge of what makes a virus virulent is also the key to medical therapies and disease prevention. This may be an uncomfortable reality, but it is a reality.

The *material* (as distinct from the information) needed to cause terror by chemical or biological means is a different matter. It is a clear responsibility of universities to not be a *source* of such materials for use by those who would do harm. Access to pathogens and dangerous chemicals must be carefully restricted and monitored in the normal course of doing science. Inventories should be minimized. Location, quantities, and security should be maintained effectively and accurately. We are working hard to establish best practice in this regard at MIT.

It is the further responsibility of universities to educate all of their research and laboratory students about security issues regarding their materials and equipment. This should be integrated with education and training regarding the health, safety, and environmental responsibilities of laboratory practice. Things as basic as not working alone in chemical and biological laboratories must be reinforced.

Select Agents

The term "select agent" came into the scientific vernacular when, on June 12, 2002, the President signed into law the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (H.R. 3448, Pub. L. 107-188).

As a first step in this law, all researchers in the life sciences were required to report to their institution and to the government (Department of Health and Human Services) by September 10 their inventory of 40 "select agents" that might be used as bioweapons. Other provisions of the law will include similar reporting requirements for potentially lethal agricultural materials and security measures for laboratories that keep such agents. In addition, only those researchers determined to have a legitimate need will be allowed access to these materials, which will not be available to students or scholars from countries that are considered to be sponsors of terrorism or to people with histories of mental illness or felony or drug convictions.[3]

Science thrives in openness, and suffers in isolation.

By and large, the academic community has treated this as a reasonable approach and, of course, will comply with the law. But even this seemingly straightforward approach is not without a huge potential price to be paid in the advancement of science, and therefore in our health and welfare. The MIT Ad Hoc Committee on Access to and Disclosure of Scientific Information was deeply concerned about the path down which we may be starting, noting that the Secretary of Health and Human Services has the statutory power to expand the list of select agents. The Committee expressed the view that we could soon arrive at a level of restriction of access to materials by our students, faculty, or staff on the basis of their citizenship, for example—something that would be incompatible with our principles of openness, and would cause us to withdraw from the corresponding research topics on our campus.

Publication of Scientific Information

The most difficult challenge as we balance prudent measures to maintain our security with the openness that is so essential to America's basic principles, to the excellence of our universities, and to the conduct of science, is associated with publishing information in the life sciences.

Why is this so complicated?

Science is a collective endeavor. Science increasingly is an international endeavor. The weight of these two statements is compounding at lightning speed as the complexity of science increases, and because, like all of society, scientists are tied together through the Internet. Science progresses not just by singular discoveries, but also by the independent verification and interactive discussion of discoveries. Knowledge is honed through ongoing dialogue that takes unexpected twists and turns. It thrives in openness, and suffers in isolation.

Thus, in fields such as microbiology, the very nature of science, when combined with the dual nature of information—i.e., its use for good or for ill—presents a challenge in an environment filled with well-justified concern about terrorism.

I worry that the broad advance of biological science is open to compromise. Restrictions that have been or may be imposed by our government as it struggles to carry out its most fundamental mission of protecting its citizens are not the only issue. The politics of subjects such as *in vitro* fertilization and stem cell research have removed them from the sphere of federally funded university and government laboratory research, where the mission is to achieve basic scientific understanding. Former Director of the National Institutes of Health Harold E. Varmus, among others, has raised deep concern about distortions in the conduct of these and certain other areas of basic biological research that, as a result of such federal policies, can go forward *only* in industrial labs, where "commercial realities must be considered along with scientific progress, where full disclosure is not the norm, and where oversight is limited."[4]

[3]See Diana Jean Schemo, "September 11 Strikes at Labs' Doors," *The New York Times*, August 13, 2002, page F1; and David Malakoff, "Tighter Security Reshapes Research," *Science*, September 6, 2002, Volume 297, page 1630.

Three Suggestions

The resolution of matters of open publication when our security is challenged is not easy. A panel of the National Academy of Sciences has been established to provide guidance on this matter. It is chaired by MIT professor Gerald R. Fink, former director of the Whitehead Institute for Biomedical Research. While looking forward to their wisdom, let me offer three suggestions for the resolution of the issues of sensitive areas of study, select agents, and publication of scientific information:

- First, ***consultation*** by the Federal government with the academic and scientific communities is essential. This must be continuous and directly effective consultation at both the policy and operational levels. As pointed out with great clarity by John J. Hamre, former U.S. Deputy Secretary of Defense, all too often security professionals do not understand or trust scientists, and scientists may be quite unaware of some of the real risks associated with their work.[5] This has been a major problem within the nuclear weapons arena since its beginning. It will be even more complex as we worry about basic research in universities in the diffuse, little-understood context of terrorist threats. But there is no viable alternative to substantive consultation and mutual effort.

- Second, ***distinct boundaries*** must be drawn where it actually is possible and appropriate. It is the ambiguity and uncertainty of what is inappropriate to publish, or in the use by the government of ill-defined terms like "sensitive but unclassified," that creates danger for the scientific enterprise and invites bad decisions. Well before September 2001, difficult issues were arising regarding the application of export controls on the uses of computers and satellites for basic research, and even control of certain unclassified but export-controlled library documents. Productive collaborations with scientists in other countries and the work of non-citizen graduate students and scholars have been prohibited by increasingly broad interpretation of the International Traffic in Arms Regulations (ITAR).

  Similar problems with export control arose in the 1980s. The problem was settled effectively when President Reagan issued National Security Decision Directive 189 (NSDD 189). Basically NSDD 189 stated that scientific information is either classified or unclassified. It generally exempted fundamental research from security regulations. This distinct boundary was fundamentally clear and effective for many years. Then, over time, its interpretation by the bureaucracy became increasingly broad, and its effectiveness was diminished by application of other statutes— an opportunity afforded by the compromise insertion of one open-ended clause when it was drafted. NSDD 189 should be reaffirmed, and its spirit should be applied in other domains. The default in fuzzy areas should be to keep basic research open and unencumbered.

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- Third, we should not underestimate the power of ***voluntary agreements*** within the scientific community. The decisions about publication of detailed results faced by many scientists, especially biologists and biomedical researchers, simply do not lend themselves to decisions by security personnel. In the end, most decisions will be made by the scientists who perform the work being reported, because, given the dynamic evolution of scientific knowledge, they do not lend themselves to simple regulatory rules. We also must be keenly aware that regulations in the U.S. are limited in their effectiveness in an age when important frontier science is done in many nations around the world. (Indeed, the incident that first brought this issue to the public's attention occurred when an Australian group reportedly learned how to make a virus related to smallpox 100 percent virulent.) It may be that the most effective thing to do is to create a framework or forums from which scientists can gain guidance and advice from their peers as they wrestle with such daunting decisions.

  Here too there is precedent of sorts. In the war years preceding the development of the atomic bomb, allied scientists stopped publishing research associated with uranium physics, although they continued to discuss the topic privately among themselves. And when recombinant DNA first became possible, leading scientists, led by David Baltimore, established a moratorium on their work, pending open discussion among themselves and a wide range of laypeople to establish standards. Work and open publication proceeded smoothly thereafter. Neither of these examples provides a direct guidance for the less focused situation we face today, but the point is that the scientists themselves, in consultation with many others as appropriate, found an effective path forward.

[4] Harold E. Varmus, "The Weaknesses of Science for Profit," *The New York Times*, December 4, 2001, page A21.

[5] John J. Hamre, "Science and Security at Risk," *Issues in Science and Technology*, Summer 2002, Volume XVIII, no. 4, pages 51-57.

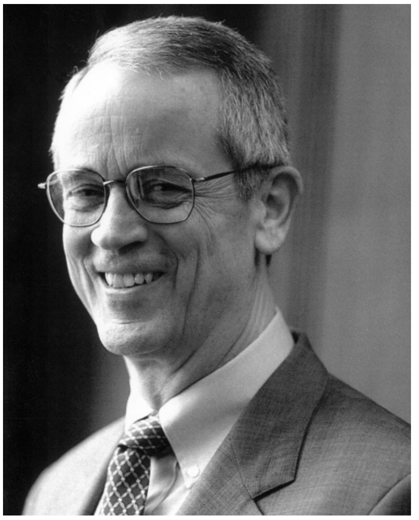
Traditional American values of openness in education and research must prevail. But this will be possible only if the Federal government and academia maintain a respectful, substantive, and effective dialogue between those who do science and those who are charged with protecting the nation.

In Conclusion

The debate about security and openness is not new. In 1958 Norbert Wiener opined, "To disseminate information about a weapon…is to make practically certain that it will be used."[6] As if in rejoinder, Edward Teller said in 1987 that "Secrecy is not compatible with science, but it is even less compatible with democratic procedure."[7] These statements by two brilliant scientists with experience in defense work reflect the fact that virtually all science and engineering knowledge, or most other knowledge for that matter, can be used for good or ill.

This certainly does not mean that we can wash our hands of the responsibility to address hard questions about the safety and security of our fellow citizens. But in an age when the "weapon" may be a truckload of explosives, a computer virus, a commandeered aircraft, or finely milled bacterial spores, "dissemination of information" is a nebulous matter. And in an age when the rapid advance of science and technology is essential to sustaining our health, economy, and quality of life, Teller's observation is of crucial importance.

Traditional American values of openness in education and research must prevail. But this will be possible only if we in research universities contribute our talents to maintaining the security of our homeland, and if the Federal government and academia maintain a respectful, substantive, and effective dialogue between those who do science and those who are charged with protecting the nation.



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[6]Norbert Wiener, quoted in Robert Jungk, *Brighter than a Thousand Suns*, Penguin Books, 1958.

[7]Edward Teller, *Better a Shield than a Sword: Perspectives on Defense and Technology*, The Free Press, 1987.