ENGAGING IN A WORLDWIDE TRANSFORMATION

OUR RESPONSIBILITY AS SCIENTISTS FOR THE PROVISION OF GLOBAL PUBLIC GOODS

A Speech by Bruce Alberts, President
National Academy of Sciences
Presented at the Academy's 139th Annual Meeting
April 29, 2002

Our organization includes not only the National Academy of Sciences but also the National Research Council, plus our sister organizations: the National Academy of Engineering and the Institute of Medicine. Collectively we refer to ourselves as "The National Academies."

The National Academies have a critical role to play in the public-policy arena. In our nation, every side in most political debates wants to claim that its position is supported by "the best science." This is fortunate, reflecting a remarkably high regard for science among the people in the United States.

It is this respect for science and scientists that makes the work of the National Academies so effective. Thus, when our Committee on the Science of Climate Change concluded last June that human-induced global warming is a serious issue, President Bush quickly accepted this conclusion in a major public address. When our Committee on Arsenic in Drinking Water reported in September that low levels of arsenic are even more hazardous for humans than previously thought, the Environmental Protection Agency immediately acted.

The national press pays close attention to what the National Academies say, which supports our science-based recommendations and helps to drive the national agenda. A particularly striking example comes from a tragic day — the front page of the *Washington Post* on the morning of September 11, 2001. While all eyes were focused on the horrendous events of this day, the Academies had both headlines — one on our arsenic conclusions and the other on our stem cell report.

Many of our reports deal with issues that are either so complex or so politically contentious that it can take a decade or more for our nation to create the consensus — and sort out the politics needed to "do the right thing." Both the stem cell report and a more recent report on human reproductive cloning are prime examples of such issues currently in the news. Two other critical reports released during the past year in this

Bruce Alberts, president, National Academy of Sciences

category were a seminal report from the Institute of Medicine on the quality of health care and a report from the National Research Council on automobile fuel efficiency standards (Figure 1). These reports received tremendous publicity, being discussed for weeks in the press and on news and talk shows.

Despite all the publicity, for issues of this kind, significant change will take time. But history shows that the large amount of wisdom distilled by our many committees, dealing with tough problems, will eventually provide the basis for major improvements in public policy. As Winston Churchill is famous for saying, "The Americans will always do the right thing … after they've exhausted all the alternatives."

I am pleased that the National Academies are being asked by our government to answer difficult questions of increasing importance to the nation. In part, this reflects the greater role that science and technology are playing in our society. But it also seems to reflect an increased respect for the ability of the National Academies to make timely, critical contributions to the national debate.

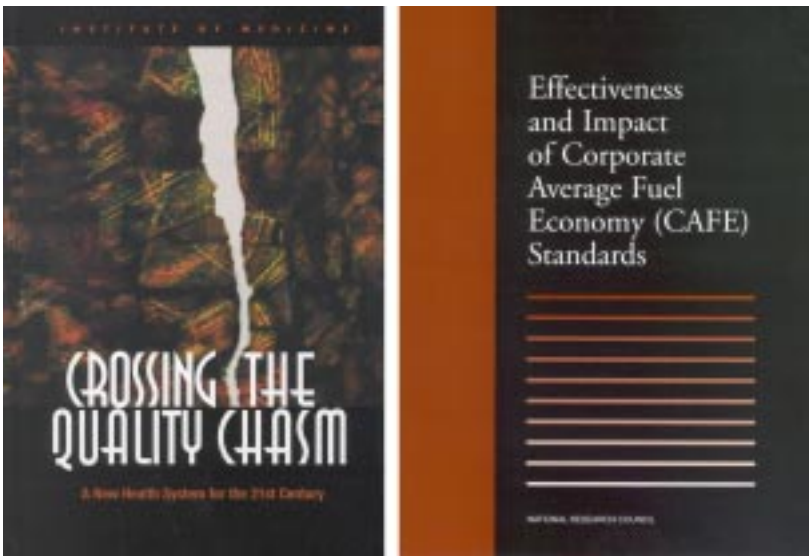


FIGURE 1

Institutions for Science

I have emphasized the strengthening of our own institution because much stronger institutions for science are needed throughout the world. Most of us take successful institutions for granted, and we vastly underestimate their value. I have met many talented scientists who live in nations that lack strong institutions for science. These scientists are very frustrated, because they feel unable to make the contributions they should to their own society.

How does one build effective institutions for science? This type of effort has occupied a great deal of my time for the past 30 years — first at universities and then at the Academy — and I can try to give a partial answer.

First, one must focus on excellence and reward it. Those of us who try to manage scientific institutions are fortunate because excellence in science is pretty unambiguous when you see it. For the fields that I know the most about, scientists can generally agree on what is good and what is not. This is largely because science is based on evidence and the confirmation of one's work by others. Thus, for example, there are not two or more competing schools of cell biology, each valuing only its own work. An honest, even ruthless process of frequent merit review of both people and programs is essential, and the outcome must be seen as fair.

A second essential element of any science institution is its eagerness to engage in the process of continuous self-improvement. This implies both a willingness to change, and an eagerness to experiment and learn from experience. The culture of the

institution must encourage taking risks, with an acceptance of occasional failure. This is a natural approach for a scientist. Any scientist who relies on safe, sure-bet experiments is unlikely to make a major contribution to his or her field.

But this rationality that is so highly valued by scientists is not shared by all.

The Post-September 11th World

After September 11th, we must now face the fact that there are skilled people who, if they could acquire an atomic weapon, would gladly blow themselves up in a major U.S. city. It is even more disturbing to think that a substantial number of people in the world would cheer them on, viewing the perpetrators of such a monstrous crime as heroes.

But the changes since that day are not all bad ones. September 11th above all else may have once and for all removed our sense of a "fortress America" — a nation that can remain complacent while a billion or more people across the globe live in desperation, out of sight and therefore out of mind.

Of course, the immediate response of the National Academies has been to help our nation harness the best of our science and technology resources, for both understanding and defending against terrorism. More than 50 different efforts of this type are well under way, ranging from an in-depth study of what terrorists value, to our Committee on Science and Technology for Countering Terrorism, co-chaired by NAS members Lewis Branscomb and Richard Klausner (Figure 2).

This committee is engaged in a remarkably intensive effort that should direct the attention of the public to the great service that science and engineering can provide to a nation facing new types of threats. Most importantly, it will provide sound, expert advice to Congress and the Administration on how best to mobilize the nation's great scientific and technical resources, so as to take advantage of many opportunities that it has identified. The committee includes eight subpanels (Figure 3), and the effort has involved more than 100 volunteer scientists, engineers, and security experts. Its report was requested by President Bush's science adviser, Jack Marburger, and is expected to be released in late June.

Committee on Science and Technology for Countering Terrorism

Lewis M. Branscomb*; *co-chair*
Richard D. Klausner*; *co-chair*

John D. Baldeschwieler*
Barry R. Bloom*
L. Paul Bremer
W. F. Brinkman*
Ashton B. Carter
Charles B. Curtis
Mortimer L. Downey
Richard L. Garwin*
Paul H. Gilbert
M.R.C. Greenwood
Margaret A. Hamburg
William Happer*
John L. Hennessy
Joshua Lederberg*
Thomas C. Schelling*
Maxine F. Singer*
Neil J. Smelser*
Philip M. Smith
P. Roy Vagelos*
Vincent Vitto
George M. Whitesides*
R. James Woolsey, Jr.

**NAS Member*

FIGURE 2

Counterterrorism Panels

- Biological
- Chemical
- Nuclear and Radiological
- Information Technology
- Transportation
- Energy Facilities, Cities, and Fixed Infrastructure
- Behavioral, Social, and Institutional Issues
- Systems Analysis and Systems Engineering

FIGURE 3

The public symposia to be held here this afternoon and tomorrow will deal in-depth with many of the issues just raised.

In this talk, I want to emphasize another, even more ambitious role for science and technology in countering terrorism over the long term. To set a context for this discussion, I begin with a quote from Kenneth Quinn, our ambassador to Cambodia from 1995 to 1999, whom I was fortunate to meet recently.

> The Khmer Rouge, the most murderous terrorist organization of the past quarter century, was not destroyed by military force, but rather by roads, radios, and agricultural science. From 1979 to 1990, 180,000 Vietnamese troops could not rout them out of their jungle hideouts, and 25,000 Khmer Rouge remained in control of much of Cambodia's countryside. But by 1999, the organization had been broken apart, and the last general surrendered, thanks to the strategy of using rural roads to penetrate the Khmer Rouge zone, and an unleashing of the forces of information, trade, and education. They did what no military force could accomplish.

He concludes:

> The most effective weapon America possesses in the war on terrorism may not be its military capacity, but rather rural roads and access to technologies.

Ambassador Quinn's experiences, which include similar stories from his earlier work on rural development in Vietnam, provide evidence that supports a response to September 11th by David Hamburg, one of our Public Welfare Medalists, who wrote in 2001:

> A determined international effort to foster democratic socioeconomic development … can do much in the long run. …Young people can then see a basis for hope, can acquire constructive, useful, marketable skills and take advantage of tangible opportunities for a better life. Then, perhaps their need for scapegoats will diminish and their susceptibility to hate-inciting demagogues would be less.

In his new book, *The Paradox of American Power*, Joseph Nye distinguishes between "hard power" and "soft power." Hard power is economic power or military power, which can be used to coerce others to change their position. Soft power is different. In Nye's words, "a country may obtain the outcomes it wants in world politics because other countries want to follow it, admiring its values, emulating its example, aspiring to its level of prosperity and openness. … [Soft power] co-opts people rather than coerces them."

Soft power is becoming an increasingly potent tool in national policy-making as the cost of electronic communications falls, and bandwidth and connectivity across the globe rise dramatically. It is especially important to this Academy, because the U.S. scientific and technical community must be at the center of a new vision for U.S. leadership in the post-September 11th world.

An Ambitious Agenda for International Science

In recent years more and more of my time has been devoted to international science. This is not the type of international science that I knew as a university professor for 30 years, where all of my interactions were with a small number of outstanding scientists from other nations who were leaders in my own field of DNA replication and recombination. My attention is now focused on a much more ambitious agenda. Since January 2002, this agenda has already taken me to the United Nations, Tokyo, New Delhi, Amsterdam, Brussels, and Manila — as well as to high-level meetings in the United States with leaders of science from Russia, Pakistan, Egypt, Israel, Jordan, Palestine, Hungary, Ghana, and Brazil. If it were not for the preparations for this annual meeting, I would have been in Europe last week for our important collaboration with the Iranian science and medical academies.

What is our new agenda? Briefly stated, it focuses on working closely with those institutions that best represent science in each nation to help them build the capacity they need to help their own societies and governments make wise, science-based decisions.

The United States is universally admired for its science and technology — not only by scientists and political leaders throughout the world, but also by average citizens. I have been particularly struck by a recent poll of the attitudes toward America in Iran, Pakistan, and Arab countries. In this survey by Zogby International, a well-known polling group, by far the most positive reaction was to "American science and technology" (Figure 4), with 10 other aspects of America, including American education and American democracy, being rated considerably lower.

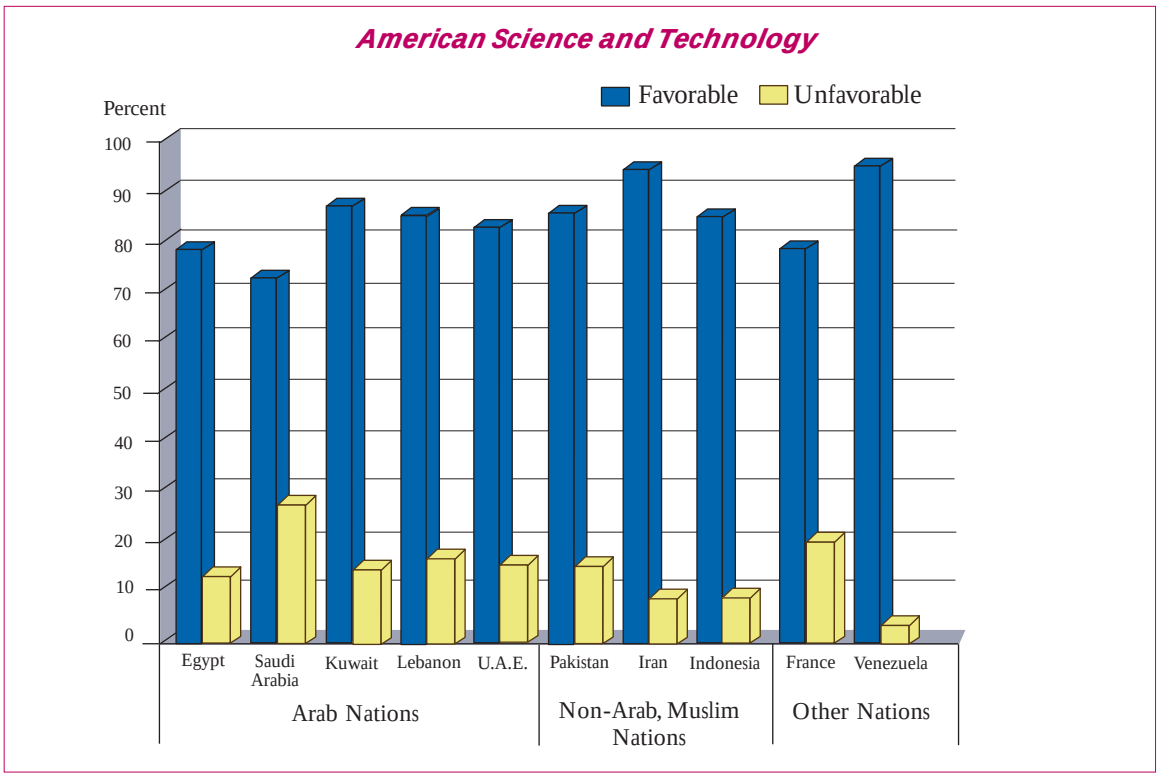


FIGURE 4

Clearly, the United States would be wise to more actively involve science and technology in its diplomacy. Now is the perfect time to begin. We are fortunate to have Secretary of State Colin Powell who clearly recognizes the opportunities, and he is supported by an outstanding science and technology adviser, Norman Neureiter.

I have just returned from the Philippines, where our new ambassador, Frank Ricciardone, wants to make strengthening science connections with the United States an important part of his agenda. Unlike some other Asian nations, strengthening science capacity is not seen as a priority for economic development by the Philippine government. While there are many outstanding individual scientists in the Philippines, their institutions are poorly connected to national policy-making. To take just one example, important decisions about improving air quality in Manila, a city of 10 million people, have apparently been made without an adequate scientific analysis. It is this type of issue that we plan to address with the Philippine National Academy of Science and Technology.

Every nation must have involved and effective institutions, run by the nation's own scientists and engineers, to benefit from a worldwide effort to spread the benefits of science for sustainable development. With this realization, the academies of science (and their equivalents) from 80 nations have banded together to work on an ambitious agenda with two complementary parts. The first part is to help each academy develop a larger role in its society, including becoming a respected adviser to its own government. The second, synergistic mission involves fully exploiting new communication technologies to share information and other resources that strengthen world science.

This agenda is being coordinated by a relatively new organization, called the InterAcademy Panel, which I have spoken about extensively in previous years (Figure 5). The IAP was co-chaired and guided

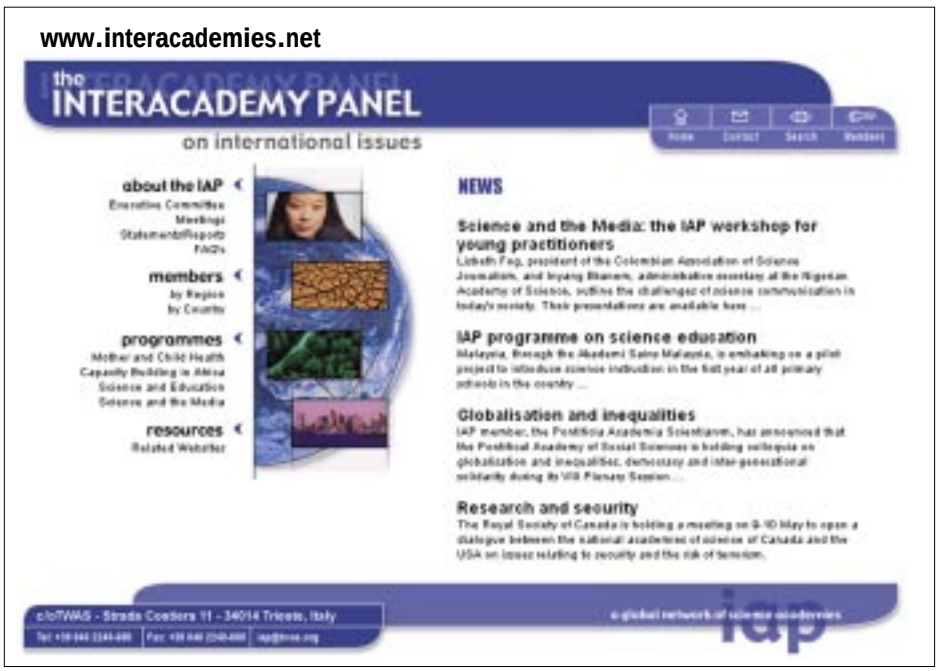


FIGURE 5

through its formative years by Sherry Rowland, our foreign secretary, and by P. N. Tandon, former president of the Indian National Science Academy. And it is now co-chaired by France and Brazil, with its secretariat at the Third World Academy of Sciences in Trieste.

Because of the strength of U.S. science, our Academy has a special role to play in both of these central missions for the world's science academies. We help to increase the influence of other science academies by sharing what we have learned about carrying out successful policy work, as well as by carrying out joint studies on central issues with them. There are many examples of past work and of work in progress, including an important energy study with the Chinese Academy of Sciences and the Chinese Academy of Engineering, published two years ago.

I want also to mention an example of cooperation of a third type, in my favorite area of science education. Through the National Science Resources Center (NSRC) — our very successful, joint program with the Smithsonian Institution that began in 1985 — we have been working closely with both the Mexican and Swedish science academies to share curricula and best practices for science education for children. In a new program coordinated through the IAP the NSRC will now be contributing to a series of 10 or so regional workshops. Each workshop will be sponsored by the leading scientists in that region of the world, and be designed to help the scientists and educators from each nation work together on inquiry-based science education for all, starting with children at age 5 (Figure 6).

On September 11th the director of the NSRC, Sally Shuler, and I were attending the first of these workshops, held in Monterrey, Mexico. Featuring presentations from the United States, France, Sweden, and Mexico, this workshop brought science leaders from Mexico together for three days with the leaders of education efforts in that country. As a follow-up the Mexican minister of education came with a delegation to meet with us in Washington, and major efforts to spread inquiry-based science teaching are now ongoing in Mexico.

Inspired by the challenges in China, the Philippines, Mexico, and every other country where we have partners, the National Academies will be working for many years

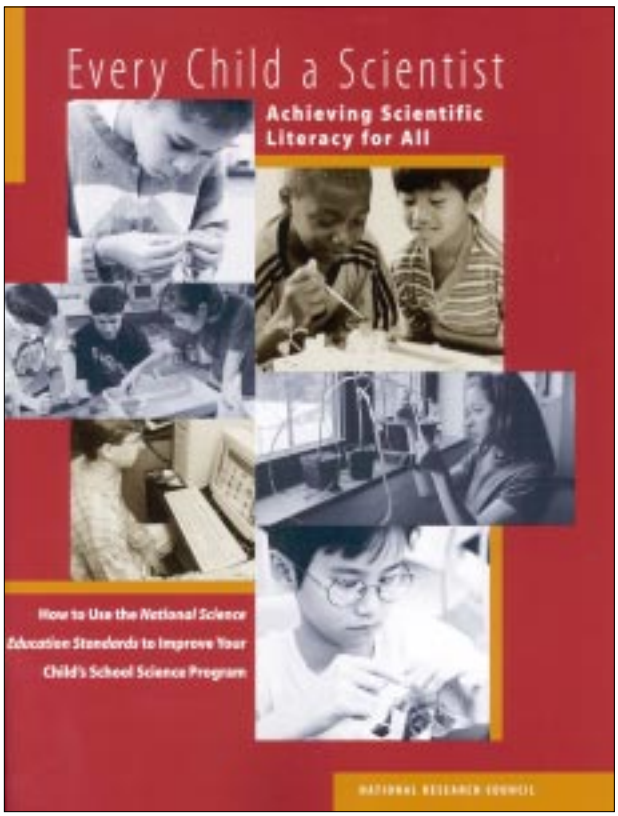
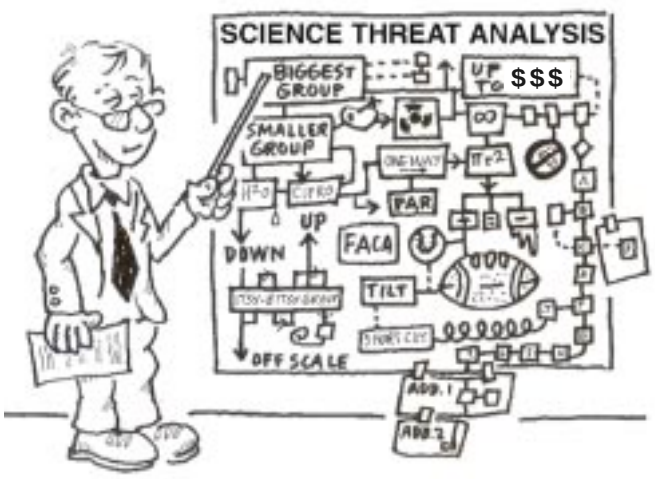


FIGURE 6

to enact the vision of our major report, *Our Common Journey*, published in 1999. The committee that produced this report emphasized that the world needs to vigorously harness new scientific and engineering talents to meet the challenge of feeding, housing, educating, and providing the energy, water, health, and environment for the 9 billion people expected on Earth in 2050. This will require intensive global cooperation between the world's scientists on what the committee termed sustainability science.

For real progress to be made on the ground, the scientific community needs to create new, powerful interfaces both with the private sector and with governments. I am convinced that by far the most effective way for U.S. scientists to aid other nations is by helping their scientists and engineers generate the institutions and relationships that they need to serve as an effective force for policy-making and economic development.

Threats to Science as a Global Public Good



Credit: Carlton Stoiber

FIGURE 7

Threats to Science as a Global Public Good

Unfortunately, the efforts that many scientists are making to strengthen world science by energetically disseminating both knowledge and research tools as so-called "global public goods" are being counteracted today by several forces. Major changes are needed that must be led by the United States.

As we all know, science has generated its own culture and values in order to maximize its effectiveness. Scientific knowledge is based on evidence, and a scientist's observations and conclusions must be tested and confirmed by others to be accepted. This requirement has generated an elaborate system of publication and peer review in scientific journals. It has also generated the ethic of sharing both materials and methods between investigators, because this is required for one scientist to repeat the observations of another scientist. We all take this ethic for granted, but in our increasingly market-oriented world, the culture of science is being threatened by our tendency to put a price tag on everything (Figure 7). Since September 11th, this culture is also being threatened by security concerns.

I am worried about a movement to restrict publication that has been proceeding quietly but quickly in Washington. Some of the plans being proposed could severely hamper the U.S. research enterprise and *decrease* national security. New administrative rules are being seriously considered for unclassified scientific and technological research including fundamental, basic research that deals with so-called critical research technologies. It is being suggested that every manuscript resulting from work supported by federal funds be cleared by a federal project officer before being published, with serious penalties for violations.

Another rule could prevent any foreign national from working on a broad range of projects.

We currently have an outstanding committee at work on at least part of this problem. The Committee on Research Standards and Practice in Biotechnology, chaired by NAS member Gerry Fink, will help our nation make wise decisions on these issues. Clearly, for the long-term protection of the nation, any new security regulations must keep science strong while guarding against real threats.

One of the problems created by the clash of our scientific culture with that of the marketplace became apparent when I spoke this year at an annual meeting of publishing executives. Any publisher of a scientific journal depends on the dedicated service of an editorial board plus a large community of reviewers — all of them scientists. But if a scientific journal is simply treated as a business, with the maximization of profit as the only valid criterion for most decisions, we will cripple the wonderful opportunity that we now have to energize science and scientists in every nation of the world.

The last section of this talk therefore consists of several calls to action. The first is to ask the editorial boards of scientific journals to insist that their journal be made freely available on the Web after a delay of not more than a year. I am pleased to say that a number of scientific journals already have such policies, including *Science* magazine published by the American Association for the Advancement of Science.

Most scientific journals have not yet opened up their archives in this way. These include not only many major journals published by private companies, but also the journals run by some of the most important U.S. scientific societies. It takes a substantial income to run any journal. Most of this income is derived from institutional subscriptions, and it is hard to imagine a library in the United States or Europe canceling a subscription to a journal of major value to scientists, because the users of the library can instead wait for a year to gain free access.

My travels as president of the Academy have taken me to many research institutions in the developing world. The cost of subscribing to our scientific journals is unaffordable to most of them. Imagine what it must be like to work as a scientist while being cut off from most of the world's scientific literature. We all believe passionately in strengthening science around the world. Therefore, we must do everything reasonable to provide the tools needed to support these scientists. Scientific knowledge should be recognized as a global public good, a strong force for sustainable development and wise decision-making. And remembering Ambassador Quinn's remarks about Cambodia: also as a tool in the battle against terrorism.

Making the electronic versions of U.S. journals accessible after a reasonable delay period will create enormous goodwill toward the United States around the world. As scientists we must make sure that our journals find a better balance between the drive for profits and the new opportunities we now have to energize the world scientific community.

Under the leadership of Nick Cozzarelli, our own journal, the *Proceedings of the National Academy of Sciences*, has of course been trying to set an example (Figure 8). The electronic version, with its more than 15,000 pages per year, is now made freely available to everyone after a delay of six months. In addition, we have just subscribed to a commercial service that allows us to make our journal immediately available for free to scientists who access our site from 81 less-developed nations (Figure 9). The same tool can in principle be extended to provide selective, free access to commercial textbooks. Such access to both scientific journals and other critical knowledge resources would empower our colleagues in developing nations and allow them to become much more effective partners in the global science community. The Academy plans to pursue these possibilities aggressively in the coming year.

A second aspect of my call to action concerns an opportunity to change the intellectual property protections that are

FIGURE 8

arranged by public-sector research institutions. In looking forward we must avoid the mess that we have created thus far with intellectual property protections in the field of agricultural biotechnology. The famous vitamin A-enriched rice produced by a public-sector scientist in Switzerland is said to be covered by at least 40 prior patents. Many of these are patented research tools that were developed at universities and licensed exclusively to a single company. Fortunately, patents are valid for only 20 years, and many of the crucial ones in agricultural biotechnology will be running out soon, but many more patents on research tools are still being awarded today.

The new Danforth Plant Science Center in St. Louis, headed by NAS member Roger Beachy, has an enlightened patent policy. Any licensing agreements from discoveries made at the Center "shall diligently and in good faith negotiate the terms of the exclusive worldwide license, making provision for preserving the availability of the Intellectual Property for meeting the needs of developing countries."

Is there any reason why a similar policy could not be adopted by all public-sector universities and research institutes? I suggest that the funders of public-sector research require this type of exclusion, and that they make it clear that the production of global public goods is a high priority for public-sector scientists.

My trip to the Philippines featured a visit to the International Rice Research Institute (IRRI), a pre-eminent member of the set of 16 international agricultural research centers dedicated to creating science public goods for food security and poverty alleviation (the CGIAR). With NAS member Ron Phillips I helped to inaugurate a building named after

Gurdev Khush, our distinguished foreign associate who led the Green Revolution in rice through his research there. But my main task at IRRI was to consider how the enormous energy and talent of the U.S. scientific enterprise could be harnessed to help the international scientific community meet the daunting challenges for agriculture in Africa, and in other less-developed parts of the world in the coming decades.

The need for work in this area remains invisible to most younger American scientists, who have never encountered what life is like for the nearly 1 billion people on Earth who go to bed hungry every night. For them, I quote from a recent speech given by Ismail Serageldin, formerly a vice president of the World Bank and now head of the new Library of Alexandria in Egypt.

> Some 40,000 people die from hunger-related causes every day. … Therein lies the challenge before us. Will we accept such human degradation as inevitable? Or will we strive to help the less fortunate? … It is inconceivable that there should be some 800 million persons going hungry in a world that has the resources to provide for that most basic of all human needs.

Conditions are expected to become even worse for the 70 percent of the African work force engaged in agriculture: For example, it is projected that in 2020 sub-Saharan Africa will be home to nearly 40 million malnourished children, an increase from about 33 million today.

How can scientists in the United States help? New technologies can be used to create plants for African crops such as cassava that are resistant to microbes, insects, and drought — but only if there is a concerted effort to connect the best of science from the United States and abroad to the most critical African needs — and only if new resources are devoted to funding visionary cooperative research programs. Recent history is dismal: In constant dollars USAID funding for international agricultural research declined by a factor of three between the mid-1980s and the late 1990s.

We can welcome the recent announcements by President Bush and Secretary of State Powell that our official development assistance will increase by 50 percent and that agriculture will be a top priority. But money is only the first step in restoring hope to the hungry. Now we as scientists have to commit some of our best young talent to assuring food security as a legacy to the world's deserving poor. If we are to make

FIGURE 9

long-term progress on our goal of producing a safer, more just world for our grandchildren, scientific capacity building and cooperative research programs deserve to be at the center of each of our international assistance programs. So far, we have only taken the very first steps.

In summary, I see four clear threats to science today, all of which should closely concern our Academy in the years ahead.

1. The possibility of excessive restrictions on scientific publication, motivated by security concerns

2. Limited access to the scientific literature

3. Excessive intellectual property protections

4. A system that fails to harness the idealism of young scientists, rarely connecting them to sustainability goals

Our Academy will not be alone in attempting to meet these important challenges. We are fortunate to have a vigorous new association of the world's scientific academies in the form of the InterAcademy Panel, as well as an even newer organization that the IAP has spawned in Amsterdam, called the InterAcademy Council (IAC) (Figure 10). The IAC was a major topic in my talk last year, and I am pleased to report that it is prospering: its first study on capacity building is well under way and a second project on enhancing agricultural productivity in Africa is just beginning, the latter in response to a direct request from U.N. Secretary General Kofi Annan.

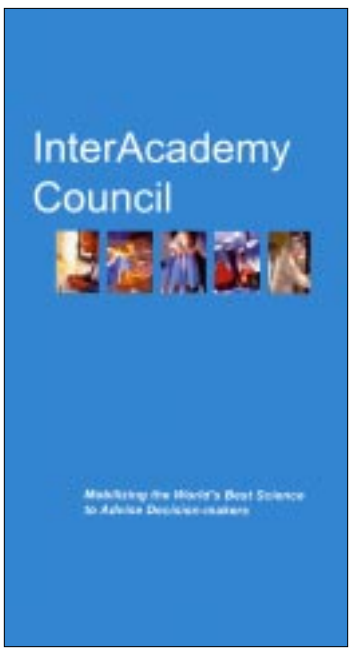


FIGURE 10

Like many scientists I have a dream about a different future. In my dream our universities are teaming with talented young scientists productively engaged in harnessing the power of modern science to produce public goods for poverty alleviation around the world. I know that many of the best of our young people will respond with excitement to such a challenge. But it is up to us — those who have enough seniority and prestige to influence both younger scientists and the leaders who will determine funding and policies — to make such an effort succeed.

This is the image that I, the grandson of immigrants who knew poverty, want for America. In a century that will be increasingly dominated by science and technology it is also an image of a nation truly worthy of leading the world.

NOTE: The text of this speech, with direct links to the full text of cited reports, is available on the Academy's Web site at <www.nas.edu/nas/2002address>.