Science and Human Needs

Bruce Alberts
President
National Academy of Sciences

137th Annual Meeting
Washington, D.C.
May 1, 2000

At this first annual meeting of our Academy in the new century, I want to dramatically increase your expectations for the work of scientists around the world. This is a propitious time for such a talk, because in just two weeks 80 Academies of Science will be meeting in Tokyo. There we shall be developing a very ambitious agenda for science — aiming to engage scientists everywhere more deeply with their own governments and societies.

Those of us who have spent most of our lives in science often make the mistake of taking our scientific culture as a given — embodying a system of values that have always existed. At the World Science Congress in Budapest last June, Partha Dasgupta — chair of the economics department at the University of Cambridge spoke of the special conventions, which he called "contrivances," that encourage scientists to disclose their findings for public use. He went on to say that:

"The social contrivances I am referring to, namely, peer-group esteem, medals, scrolls and the like, are remarkable precisely because they don't involve much resources.

To enable the contrivances to be effective has required that a considerable part of a scientist's education involves developing a taste for non-monetary rewards. Thus, the Institution of Science embodies a set of cultural values in need of constant protection."

Much of this protection has come from Academies of Science. Scientific excellence is defined by whom we elect to membership and invite to our scientific colloquia. We take very seriously the awarding of our "medals and scrolls."

Scientific values are reinforced by our continual insistence on openness and the sharing of research tools, by expert peer review, and by publications such as our On Being a Scientist — which has been translated into multiple languages and widely used to inform students of the values and ethics that we share. One of the earliest Academies of Science, England's Royal Society, was founded during a time of spectacular scientific progress — Kepler, Galileo, Newton.

Shortly after its founding in 1660, the Royal Society began to publish scientific findings in its journal, Philosophical Transactions, establishing an ethic and tradition of public disclosure in science. Scientific openness blossomed, as publication became the way for scientists to gain formal recognition by their peers for the origin of ideas and discoveries. This exposed scientific claims to public scrutiny and produced a strong and effective tradition of independent confirmation. The result has transformed our world.

As scientific knowledge was combined in unpredictable ways, humans learned how to manipulate the natural world for human benefit to an extent previously unimaginable. This, as you know, is

the central message that is made repeatedly in our expanding series of brief reports prepared for the public, called Beyond Discovery.

By the mid-20th century, mathematician and philosopher Bertrand Russell would write, "Almost everything that distinguishes the modern world from earlier centuries is attributable to science." The impact of scientists on society has expanded proportionate to society's increasing reliance on, and ability to use, scientific knowledge. But many of us still fail to recognize that our success now requires us to take on a set of new, broader responsibilities — both in our own nation and the world.

There is one task close to home that needs our immediate attention. Let me remind you that by 2050 the United States will become a nation that is "majority minority." If we are to be effective in spreading an understanding and appreciation for science throughout our society, both our scientists and our science leaders must reflect the diversity of this great nation. This means that we must develop an education system that does a much better job of preparing all students, starting with our 5-year-olds, in science.

In addition, we need to encourage and reward all those with an interest and ability in science, regardless of their gender or cultural background. Through targeted programs of "affirmative development," those with special talent should be provided with enriched programs that bring them into contact with scientists and other mentors at an early age. Making this happen is a task worthy of this Academy.

Science and Democracy

Scientists, as practitioners, teach important values. These include honesty, an eagerness for new ideas, the sharing of knowledge for public benefit, and a respect for evidence that requires verification by others. These "behaviors of science" make science a catalyst for democracy. Science and democracy promote similar freedoms. Science and democracy accommodate, and are strengthened by, dissent. Science's requirement of proof resembles democracy's system of justice. Democracy is buttressed by science's values. And science is nurtured by democracy's principles.

Consider the words of the Israeli statesman, Shimon Peres: He said,

> "Science and lies cannot coexist. You don't have a scientific lie, and you cannot lie scientifically. Science is basically the search of truth — known, unknown, discovered, undiscovered — and a system that does not permit the search for truth cannot be a scientific system. Then again, science must operate in freedom. You cannot have free research in a society that doesn't enjoy freedom. … So in a strange way, science carries with it a color of transparency, of openness, which is the beginning of democracy…"

Last year, we completed a major report requested by Madeleine Albright, our secretary of state and neighbor across the street. This report, titled The Pervasive Role of Science, Technology, and Health in Foreign Policy, calls for a transformation in the attitudes and capabilities of the State Department with respect to science and technology — and it details how the department can best accomplish this goal. In two of its many recommendations, it calls for a science adviser to the secretary and for a minimum of 25 carefully selected science counselors in our embassies around the world. I am pleased to say that our report has been very well received by Secretary Albright. And in a major address responding to our report, she said: "I want to forge a truly active

partnership with the science and technology community. Science, perhaps even more than diplomacy, carries with it the hopes of people everywhere who seek a future better than the past."

In our meeting to brief Secretary Albright on the report, I stressed the following points: First, in order to prosper economically, every nation will need to build up its own scientific capacity to allow it to benefit from the world's valuable store of scientific and technical knowledge. Second, the United States, with its vibrant and idealistic scientific community, is ideally positioned to lead such a capacity-building effort; and third, doing so will not only increase the respect and influence that our nation enjoys in the rest of the world, but also produce a strong force for openness and democracy through the empowerment of local scientists and the spread of their scientific values. All of this sounds wonderful, but is it realistic? There have been many attempts in the past to build strong scientific institutions in developing countries — including efforts by the United States and other industrialized nations — but in most of the poorest nations, these efforts have not been sustainable.

I believe that there are two major differences today that should produce a better result this time around. The first of these is the globalization of the economy, in which nearly every nation is competing for massive amounts of private investment capital. As elegantly explained by journalist Thomas Friedman in his recent book, *The Lexus and the Olive Tree*,

> "…In the era of globalization knowledge is the key to economic growth, and if you close your country off in any way to either the best brains in the world or the best technologies in the world, you will fall behind faster and faster. That's why the most open-minded, tolerant, creative and diverse societies will have the easiest time with globalization, while the most closed, rigid, uptight, self-absorbed and traditional companies and countries, which are just not comfortable with openness, will struggle."

For the long-term success of a nation, free markets need appropriate regulation, with the best science being used to inform the pathway of development. Every nation needs its own scientists to provide the sonar that detects the pitfalls that lie ahead.

In our first joint meeting with the Chinese Academy of Sciences in Beijing in 1997, some of our Chinese colleagues were heard to complain that "their country had gone from Marx to Adam Smith" in the course of a few decades — meaning that China now believed that freeing their markets would solve all problems. But China then received a wake-up call from its devastating floods of 1998, which were magnified by ambitious over-logging. Perhaps as a result, when we met again in Beijing last August, our Chinese colleagues seemed to have a much larger voice in guiding markets through government policies.

Scientists often have the very tools societies need to understand the implications of shortsighted actions and avoid them. By using our understanding of natural and social systems, we can help reverse unwise policies and improve the economic and social decision-making in every nation.

Connecting the World's Scientists

The second major development favoring the universal empowerment of scientists is the computer and telecommunications revolution. As I emphasized in my address last year, we shall soon have the technical ability to connect all of the world's scientists together through low-cost, two-way electronic communications.

Last month, the secretary-general of the United Nations, Kofi Annan, announced a new health network for developing countries. This network is to establish and operate 10,000 Internet sites in hospitals, clinics, and public health facilities. He went on to portray information technology as a frugal and useful tool for the progress of underdeveloped nations. In his words: "Information technologies can be used without having vast amounts of hardware or financial capital,… What you need above all is brains, which are the one common commodity equally distributed among the world's peoples. So for a relatively little investment — in education for example — we can bring all kinds of information in reach of poor people, enabling poor countries to leapfrog some of the long and painful stages of development that others have had to go through."

This is a good start, but only a start, of one of the great adventures of our time — to bridge the vast information divide between rich and poor. We urgently need to learn how to use our knowledge to create a more just and sustainable world, for we live in a time when more than 1 billion people lack access to a safe water supply, and where more than 160 million children are seriously malnourished.

Africa poses especially urgent problems, and I want you to hear the words of a highly respected South African woman, Mamphela Ramphele, the vice chancellor of Cape Town University. Speaking in Washington last February, she emphasized that,
"The insights, methods, and ways of thinking attendant on scientific inquiry hold, I believe, the key to personal and national development in much of the developing world. … The characterization of science as 'Western' by some social scientists is unfortunate: It serves to delegitimize scientific inquiry and the application of science to everyday problems. It finds resonance among elites in the developing world who see the entrenchment of a science culture as a threat to their power over the poor and marginal."
In spreading a science culture through the world, we must be sensitive to local cultures, and have the patience and wisdom to respond carefully to the needs expressed by those with whom we are trying to work. This is a primary reason why local scientists — male and female and from all levels of society — must be cultivated and supported in every nation, as these are the people who can best create this critical bridge.

Our efforts must empower women, who have been neglected in so many societies. Although this change will be opposed in some traditional cultures, the education and empowerment of women must nevertheless be a major goal, and it is widely recognized as an expedient way to transition toward both local and global sustainability.

Reducing the gap between rich and poor is a moral imperative. It is also in our self-interest, since the results will profoundly affect our own grandchildren. In the long run, they cannot prosper in a world with such gross inequities.

There is one simple thing that we scientists in industrialized nations can do immediately as a first step — we must promote the electronic connectivity of scientists. As I travel around the world, I am dismayed to see how desperate other scientists are for access to the scientific literature that I take for granted. To help these colleagues, the Academy is providing free access to the Web version of our own scientific journal, the Proceedings of the National Academy of Sciences, after a brief delay. More than 50 scientific journals now have such policies, most using delays of two to 18 months to protect their subscription base.

I urge each of you — as the leaders in your disciplines — to help spread science around the world by doing everything you can to ensure that your own journals are also made available in this way.

Also relatively easy, but requiring a more organized effort, is making our young scientists much more aware of the wide range of opportunities for science in developing nations. When I was in India last year, I met with several groups of graduate students. These young Indians were painfully aware that most U.S. graduate students have no idea of what life is like for most of the world's peoples. They therefore suggested that we develop a special program to encourage our graduate students and postdoctoral fellows to spend one or two months in an Indian research laboratory of their choosing, hosted by a university or research institute.

This idea has been endorsed by many senior scientists in India, and our Academy has offered to work with federal agencies to make it happen — in India and elsewhere.

In this new world of the Internet, even such a brief real-life experience could go a long way toward productively engaging a new generation with their fellow scientists around the globe.

A Need for Activist Academies

But none of this is enough. The world's scientific community needs a much more effective voice. With a "Frankenfood" scare currently sweeping Europe, the president of South Africa implying that AIDS may not be caused by a virus, and the Kansas State Board of Education suggesting that the Earth may be only 10,000 years old, I fear that our powerful electronic communication networks may end up spreading more misinformation than information. In this respect, it is sobering to remember the misplaced optimism that accompanied the introduction of the television, which many thought would create a major breakthrough in education.

How, then, can the world's scientists ensure that rationality, rather than misinformation, forms the basis for decision-making in this ever more confusing world? It is not enough to recognize that every nation today needs its own scientific capacity — both to address local issues and to access the vast resources of world science. This science capacity also needs to be organized in a way that gives it a powerful voice — both with the public and with national policy-makers.

This brings us back to the subject of Academies. The people in this room should be the first to recognize that the world's Academies of Science can be uniquely important institutions. Because Academy members are elected for life and select their successors, these institutions are self-renewing ones that are relatively insulated from the twists and turns of political systems. And, increasingly, nations are recognizing that the striking advances in worldwide scientific knowledge are important for their own economic development.

The combination of these factors ought to give each science academy a special status in the eyes of its own nation. But because the opportunities for national service have been poorly exploited to date, most Academies of Science have had relatively little influence on their societies. Thus as I go around the world promoting "activist" academies, I encounter many skeptics.*

This Academy has of course been an exception, owing to the very special charter we received from our government in 1863. Today, through the National Research Council, we publish more than 200 reports every year on matters of science and policy, and they are used to influence a wide range of vital issues.

My predecessor, Frank Press, began an effort to spread this tradition of national service to other Academies — beginning with a joint study carried out with the Mexican Academy on Mexico City's water supply, published in both English and Spanish. This effort has continued through an energetic program of joint and multilateral studies with Russia, China, India, Brazil, Germany, the United Kingdom, France, Mexico, Israel, Jordan, Japan, the Palestinians, and the Third World

Academy of Sciences. Here is one example — an important study chaired by our Public Welfare Medalist, Gilbert White.

This enterprise — of encouraging other Academies to become more "activist" — entered a new phase with the formation in 1995 of a confederation called the InterAcademy Panel or IAP. Co-chaired by NAS Foreign Secretary Sherry Rowland, this is the group of 80 world Academies of Science that will be meeting in two weeks in Tokyo.

One of the IAP's major goals is to increase the visibility and policy-making role of scientists everywhere, with a focus on helping each academy become more effective as an objective and independent adviser to its own government. Here is where the nature of science, with its universal system of knowledge and values, confers such an advantage. Every nation, for example, needs to educate its children, protect its water supplies and soil from degradation, and improve the health of its people. The scientific basis for the many decisions that need to be made is no different in the United States than in Nigeria, Chile, or Bangladesh.

To take just one example, the work that we do in education — such as analyzing how people learn and transferring that knowledge to schools, or on teaching science as inquiry — is as relevant to the rest of the world as it is to the United States. Likewise, we can learn a great deal from other nations about how to make a science out of education, so as to create a continually improving education system. Perhaps this has always been true, but a new information-sharing tradition, catalyzed by the Internet, is beginning to dramatically change the quality of the dialog on these issues between all of the science academies of the world.

A second goal of the IAP is to encourage the world's scientists to focus more attention on what we might call "sustainability science." The world population is expected to increase from 6 billion to 9 billion in the next 50 years, leveling off at perhaps 10 or 11 billion by the end of this century. How can the Earth accommodate even the most basic needs of these people — providing enough food, water, energy, and materials — without destroying the natural resources on which we all depend?

This was the question addressed in a study by our 25-member Board on Sustainable Development, which issued its landmark report Our Common Journey late last year. In an analysis led by NAS member Robert Kates, the board concluded that a successful transition toward a more sustainable world will require a renewed engagement of the world's scientists and engineers. In 363 pages it framed a challenging, broad agenda, with three priorities for research and six priorities for action. One of the central conclusions concerns integrating knowledge and action: "Because the pathway to sustainability cannot be charted in advance, it will have to be navigated through trial and error and conscious experimentation. The urgent need is to design strategies and institutions that can better integrate incomplete knowledge with experimental action into programs of adaptive management and social learning."

Academies of Science, as institutions that strongly support experimentation and the honest evaluation of evidence, are perfectly positioned to help guide a transition toward sustainability in this century. The upcoming Tokyo Conference is entirely devoted to this issue, with sessions on population and health, food, energy, water, consumption patterns, education and knowledge.

A major statement will be issued, challenging each of the attending academies to leave the conference with a focused agenda for its individual efforts. In addition, collaborative work will presumably begin on a small set of critical global issues, heading for another major conference in 2003.

A Greater Role for Scientists in World Affairs

In the past year, we have made progress in developing another major mission for the world's science academies. The IAP is seriously considering setting up an international version of our National Research Council. This special device would be reserved for studies that require the prestige of the academies.

Examples of the kinds of global issues that might usefully be explored include intellectual property rights in modern biology, assuring the safety of genetically modified foods, or world standards for science and math education in the 21st century. The planning for an InterAcademy Council began three months ago in Davos, Switzerland, where 14 academy presidents were invited to participate in the annual World Economic Forum.

The Academies or equivalent organizations that were represented are shown here. Over the course of several days, the academy presidents spent nearly 20 hours meeting together — framing a possible constitution for the new Council, as well as a list of 10 major challenges for science and technology in the 21st century that our academies might work on together. You might be amused to know that five of these hours were very productively spent on a chartered bus, travelling from Zurich to Davos and back. At the back of the bus was a small area designed for playing cards, through which sets of Academy presidents cycled to improve the drafts of each previous group. Once we arrived in Davos, we worked through every breakfast, lunch and dinner. Even though the snow was fantastic, none of us did any skiing. And on the way back to the airport, the bus stopped for breakfast at 7 a.m., where we celebrated our success at a true symbol of globalization — a Swiss McDonalds.

There is still a great deal of very hard work to be done before we will be able to tell whether an InterAcademy Council can make a difference in producing a more effective voice for science in world affairs. But the spirit of cooperation that we all experienced at Davos, bodes well for our future collaborations.

The Responsibilities of Scientists

What does all this imply for the future behavior of scientists? With an increased attention on global sustainability issues, science can play a critical role as a compass, guiding society in responsible and beneficial directions. But because political will is often short term, and misinformation about science abounds, we scientists ourselves must become much more engaged in the everyday life of our governments and our communities. The president's science adviser, Neal Lane, has used the term "civic scientist" to describe such a person.

It is comfortable, and safe, to remain in our labs, in our universities, in our Academies and other established institutions, to talk only to our friends and our scientific colleagues. But science has created this complex, advanced, and exciting society from centuries of accumulated knowledge.

We also know that the application of science and technology can be used to produce harm. Scientists have a deep responsibility to ensure that the results of science function and flourish responsibly for the benefit of humankind, while protecting us from destructive uses.

This requires that we become activists, which can sometimes be uncomfortable. One could generalize and say that, by nature, scientists are attracted to intense, highly cerebral, and not very social forms of work. But we have our differences too. British scientist Peter Medawar tells us that:

"Scientists are people of very dissimilar temperaments doing different things in very different ways. Among scientists are collectors; classifiers and compulsive tidiers-up; many are detectives by temperament and many are explorers; some are artists and others artisans. There are poet-scientists and philosopher-scientists and even a few mystics."

Now, more than ever, we are needed, in all our variety, on the ramparts of daily life. The everyday world is not only a science-powered world, it is a science-dependent world as well.

We live on a tiny planet, blue and shimmering when viewed from space. On this small place in the vast universe, we speak hundreds of languages, and are from different cultures with scores of unique customs. But we all share the same genome, and our DNA sequences dramatically confirm our common, indistinguishable humanity.

Jonas Salk was able to summarize in one small but powerful directive the task we have set for ourselves in our recent report, Our Common Journey. He said, "Our greatest responsibility is to be good ancestors." If we are to be genuinely good ancestors, we must carefully nurture and protect the natural wealth of our global home. We must provide for current generations but not at the cost of future generations. We must share our knowledge so that others can learn to care for themselves and prosper. And we will teach the ethics and values of generosity, openness, respect, and dignity.

In the 21st century, science and scientists will be judged on how well they help solve local and world problems, not only on how well they generate new knowledge. The impact of our research is everywhere, and we must step out and make sure that our work is understood and appropriately used by the world. We must do so with humility and take the time to interact and learn more about the systems we need to influence — not only education, political and legal systems, but also the very different worlds of commerce, entertainment and the media. We also need to be explicit about what is not known, and be clear about the questions that science cannot answer.

There are few people who believed more passionately in the positive power of science than Congressman George Brown. He died last summer and left a giant hole in our vision of how to use science to build a better world. In ending, I would like to pay tribute to him by citing a speech he gave in this auditorium in 1993. The remarks were titled, "A New Paradigm for Development: Building Dignity Instead of Dependence," and he said,
"This work must begin first by viewing developing nations as partners instead of as step-children.… Of all the many ways in which we can cooperate for the global good, the case for science and technology cooperation with science-poorer nations is perhaps the most compelling. To do so, we must abandon the instinct to judge others by their past accomplishments, or to judge our own accomplishments as the proper path for others."
We would be wise to revisit his lessons until we learn them well enough to truly spread science and its values around the world. George would have heartily approved of the Academy's plans for more active engagement and a more global vision. He was an optimist about the human spirit and a pragmatist about what it takes to make progress.

I urge you to join me as we take advantage of a good start to face the long and exciting road ahead.

Thank you.