LOOKING INWARD - LOOKING OUTWARD: THE ACADEMY AFTER 133 YEARS

A Speech by Bruce Alberts, President
National Academy of Sciences
Presented at the Academy's 133rd Annual Meeting
April 29, 1996

Good morning and welcome. In this, my third annual address to the members, I have decided to attempt a rather ambitious task. I will try to answer — both for myself and for you — two important questions concerning our identity and our future.

1) What exactly is the National Academy of Sciences? What does it stand for, and what fundamental purpose does it serve?

2) What can we expect our organization to be like 30 years from now? How can it play an even larger, more central role in society than it does today?

I view these as much more than academic questions. We cannot hope to harness our resources effectively unless we are very clear in addressing the questions of who we are and where we want to go.

When the Academy started in 1863, it was very much an experiment. We can now emphatically declare the experiment to have been a success. That this is so, is due to the accumulated wisdom of the members of the Academy and its past leadership. As for science itself, where we are today could never have been predicted by our 48 original members. Our institution has evolved through a long process of trial and error. At each step along the way, wise decisions have been made that have improved the institution and its connections to society. It is important that this process of experimentation continue so that we, as scientists, can become increasingly relevant to the nation and the world.

Bruce M. Alberts, president, National Academy of Sciences

What has emerged from our long evolutionary process is an institution with four types of functions. These are:

1) **validating** scientific excellence,
2) **maintaining** the vitality of the scientific enterprise,

3) **applying** the judgments of science to public policy, and

4) **communicating** the nature, values, and judgments of science to governments and to the public.

Let me briefly describe each of these functions in turn.

Validating Scientific Excellence

I begin with our validation role. What is excellence in science? Excellence is measured in part by the prizes and awards that are given to scientists. In particular, our 2,100 members are living examples of how we define excellence in science. Each of us serves as an important role model — both for younger scientists and the public. For this reason, election to the Academy is a responsibility, as well as an honor.

Very often, election to the Academy provides a recognition that will thrust the selected scientist into a new leadership role. This is particularly true for institutions that contain few Academy members, or in places where the scientific base is relatively weak. Like it or not, the election of the new members tomorrow will profoundly affect many future resource allocations for science across the United States. In short, who is — and who is not — a member of the National Academy of Sciences is a matter of considerable importance for the future of science in our nation. We can not dismiss this very important fact. It is therefore appropriate that we take our election process very seriously, and that we devote considerable time and energy to the annual election of new members.

Maintaining the Scientific Enterprise

Our second major role is in maintaining the vitality of the scientific enterprise. As you know, because of our history, the entire Academy complex is formally overseen by the Council of the National Academy of Sciences. The 17 members of the Council are individually elected by a vote of the membership. There are 12 members who are not officers, each serving for a non-renewable term of 3 years. These members of the Council for 1995-96, and their sections, are:

William F. Brinkman, AT&T Bell Laboratories
Donald D. Brown, Carnegie Institution of Washington
Michael S. Brown, University of Texas, Southwestern Medical Center
Ellis B. Cowling, North Carolina State University
Edward E. David Jr., Edward E. David Inc.
John E. Dowling, Harvard University
Gertrude B. Elion, Burrough Wellcome Co.
Mary-Lou Pardue, Massachusetts Institute of Technology
I.M. Singer, Massachusetts Institute of Technology
Robert M. Solow, Massachusetts Institute of Technology
Joan A. Steitz, Yale University School of Medicine
Richard N. Zare, Stanford University

This is a wonderfully talented group, and I view the Council collectively as the leadership for science in the United States. In addition to meeting together six times a year, for a total of about nine days, we often work in smaller groups on specific issues. A list of the present Council committees, and their chairs, follows. Each committee is chaired by an officer of the NAS.

Executive Committee; **Bruce Alberts,** *chair*
Budget and Internal Affairs; **Mildred S. Dresselhaus,** *chair*
International Affairs; **F. Sherwood Rowland,** *chair*
Membership Affairs; **Peter H. Raven,** *chair*
Scientific Programs; **Jack Halpern,** *chair*

Your Council increasingly has been taking leadership roles on issues of special importance to the scientific enterprise. It was this group that initiated the important changes in our scientific journal — *Proceedings of the National Academy of Sciences* — overseeing a review by an expert outside consultant, separating the business and editorial functions, and then selecting Nicholas Cozzarelli from the University of California at Berkeley as the new editor in chief. More recently, the Council has carefully analyzed a major report on the regulation of scientific conduct that was prepared for the Department of Health and Human Services. We found this report to be deficient in several critical aspects, as explained in our letter to the department which was also mailed to each of you in March. And, in the next few months, the Council will be putting the finishing touches on a white paper on merit review. This paper presents a set of important questions that should be asked by all in government who are responsible for allocating funds for scientific research. The goal is to support the best possible science for the nation in these times of tight budgets.

Since 1981 the Committee on Science, Engineering, and Public Policy — informally known as COSEPUP — has been a major voice for both science and engineering. Skillfully chaired by Phil Griffiths, head of Princeton's Institute for Advanced Study, this group in 1993 issued *Science, Technology, and the Federal Government: National Goals for a New Era*. This report presents a powerful rationale for the public support of science and engineering research in the United States, and it attempts to answer a question that we are often asked by Congress: How much science is enough? COSEPUP published two reports in 1995 that emphasize our concern for the talented young people who represent the future of our enterprise: *Reshaping the Graduate Education of Scientists and Engineers*, and *On Being a Scientist: Responsible Conduct in Research*. In 1996 these important documents were supplemented by *Careers in Science and Engineering: A Student Planning Guide to Grad School and Beyond*. Associated with this guide is a newly developed electronic site on the Web that offers online career advice and mentoring to beginning scientists and engineers.

One of the more rewarding prerogatives of the president of any organization today is having the final say with regard to the design of the organization's home page on the WorldWide Web. Our home page (accessible at <www.nas.edu>) directly displays our concern for young scientists and engineers by placing the button for their site at the very top of the page. Our aim is to make our Academy as useful and well known to these young people as are the federal agencies that offer them training and research support.

No discussion of our recent efforts to maintain the scientific enterprise could fail to emphasize a major report from the Academies and the Institute of Medicine titled *Allocating Federal Funds for Science and Technology*, published last November. This report was produced in response to a request from the Senate Appropriations Committee to address "the criteria that should be used in judging the appropriate allocation of funds to research and development activities, the appropriate balance among different types of institutions that conduct such research, and the means of assuring continued objectivity in the allocation process." A blue-ribbon committee that was skillfully chaired by Frank Press produced a 40-page report with 13 recommendations, which has become the centerpiece of a lively science policy debate in Washington. The report is direct and honest: It pulls no punches, which is why it is being taken so seriously, and why it is hard to find anybody who agrees with absolutely *all* of it. The important point to me is that most people in Washington seem to agree with most of the recommendations, and they are willing to engage in a spirited debate about the recommendations that they disagree with. I predict that this report will have a major impact on the way that science funding decisions are made by our government within a few years.

Applying Science to Public Policy

Our third major function is applying the judgments of science to public policy.

As you all know, our original 1863 charter called upon the Academy to "whenever called upon by any department of the government, investigate, examine ... and report upon any subject of science or art" without compensation for these services. This early "unfunded mandate" began a long and distinguished tradition of volunteer service to the nation. Today, 6,000 volunteers are serving on some 600 committees of the Academies and the National Research Council. To give you a quick snapshot of the type of advice that we provide, a list of the major reports to be released between March and May of this year, is appended.

In advising our government in this way, the Academy could have followed two different models. According to one model, panels composed entirely of Academy members could have decided the matter, like the justices on the Supreme Court. But as things turned out, our predecessors discovered a better way. Our judgments are not formed by committees composed entirely of Academy members. Instead, we mix scientists with engineers, lawyers, teachers, and service providers — according to the particular expertise required on each committee.

On average, only 17 percent of the members of our committees are members of the NAS, NAE, or IOM. Academy control over the process is instead maintained by determining what projects are undertaken and who is appointed to committees, and by deciding when the final report meets our standard of high quality. This last step is managed by a Report Review Committee [RRC], composed entirely of members from the three organizations and led by the NAS Home Secretary, Peter Raven, director of the Missouri Botanical Garden. During 1995 the RRC supervised the review process for 216 reports and expanded its membership to 31 NAS/NAE/IOM members.

As I see it, there are two major advantages in forming committees the way we do — composed of scientists mixed with people of other expertise.

The most obvious of these advantages is that it enables the Research Council to bring the values and methods of the scientific community to bear on the widest possible range of societal issues.

As an example, consider one of our real triumphs of the past year, the publication of the final version of the *National Science Education Standards* for grades kindergarten through high school. This gigantic task involved more than 40 Academy members, and it was led by Rick Klausner, director of the National Cancer Institute. But it also involved more than 100 others — including outstanding teachers, science educators, and administrators. The result is a document that contains much more wisdom than could have been provided by any one group alone. For example, only the scientists could have distilled the core knowledge that should be learned by all students in the physical sciences, life sciences, and earth and space sciences.

But only those who work with children and study their learning could have told us what type of understandings are possible for most students by the end of 4th grade or 8th grade — or what a classroom should look and feel like in order to maximize student learning. Moreover, the participation of teachers as equals in the development of the Standards has created a sense of ownership that is essential for school systems to embrace them.

The second advantage of our mixed committees is less obvious. Often the interaction between scientists and others on the committee gives rise to new types of alliances that persist long after the committee disbands. This is certainly true for the *National Science Education Standards*, since the process of their development caused many scientists to establish close links with both the science education and the teaching communities. A new respect and mutual understanding was created between these otherwise isolated groups, which will allow us to work together closely to implement the Standards in the future. This synergism must continue throughout the decade, if we are to use the Standards to revitalize our schools — and prepare our children and grandchildren for the 21st century.

What happened during the development of the Science Standards is not unusual for Research Council committees. In the behavioral sciences, for example, we pay special attention to mixing academic researchers with those on the front lines: police chiefs, social workers, state welfare officers, federal housing officials, and big-city mayors. In this way, we are helping to bring the rich intellectual resources of our universities to bear upon the central problems of society — probing to see how far we can go in meeting the challenge of Congressman George Brown of California, and others, to extend science to our major societal needs.

Using the Research Council to create these new contacts is good for those on the front lines, but it is also good for the intellectual life of our universities. Ernest Boyer, the late president of the Carnegie Foundation for the Advancement of Teaching, was an articulate spokesman for the reinvigoration of our universities. He pointed out that, "America's colleges and universities are now suffering from a decline in public confidence and a nagging feeling that they are no longer at the vital center of the nation's work," and he challenged these institutions to reaffirm their historic commitment to what he called the "scholarship of engagement." In an address to the American Academy of Arts and Sciences two months before his death last December, Boyer said that "the scholarship of engagement means connecting the rich resources of the universities to our most pressing social, civic, and ethical problems, to our children, to our schools, to our teachers, and to our cities.... [T]he scholarship of engagement means creating a special climate in which the academic and civic cultures communicate more continuously and more creatively with each other, helping to enlarge .... the universe of human discourse and enriching the quality of life for all of us."

The scholarship of the Research Council is very much the scholarship of engagement, and with each of our committees we are helping academia to meet Boyer's challenge to our universities.

At this special moment in time with regard to NAS-NAE relationships, it is important for me to emphasize one intellectual alliance that is absolutely crucial for the work of the National Research Council: that between scientists and engineers. In 1973 the NAS and the NAE joined together to oversee the National Research Council. The wisdom of the leaders who made this happen has been abundantly proven by succeeding events. Not only do an equally large number of NAS and NAE members serve on Research Council committees, but many of our most important and successful activities derive their uniqueness from a synergistic combination of these two central disciplines.

Consider, for example, our Water Science and Technology Board and our Computer Science and Telecommunications Board. Each of these boards consists of an approximately equal number of scientists and engineers.

Some recent reports from the Water Science and Technology Board, and their date of release, are:

- *Wetlands: Characteristics and Boundaries* (1995)
- *Alternatives for Ground Water Cleanup* (1994)
- *Restoration of Aquatic Ecosystems: Science, Technology and Public Policy* (1992)
- *Flood Risk Management and the American River Basin* (1995)
- *Use of Reclaimed Water and Sludge in Food Crop Production* (1996)
- *A New Era for Irrigation* (expected fall 1996)
- *Improving Service of Small Water Supply Systems* (expected winter 1996)

Two of the Board's more highly visible reports — one characterizing wetlands and another exploring alternatives for ground water cleanup — have served as key references in debates over important environmental laws, such as Superfund and the Clean Water Act. When we take on difficult, controversial issues and produce conclusions and recommendations that then serve as the basis for policy discussion and legislation, we are indeed making our mark. In addition, as I emphasized last year, the impact of our work goes far beyond our borders: Recall that the Water Board's successful joint study with the Mexican Academies of Sciences and

Engineering on Mexico City's water supply last year led the Mexican government to support the establishment of a Mexican National Research Council, much like our own.

The reports from the Computer Science and Telecommunications Board have influenced public policy in a variety of domains. Recent reports include:

◆ *Evolving the High Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure* (1995)
◆ *Continued Review of the Tax Systems Modernization of the International Revenue Service* (1995)
◆ *Information Technology for Manufacturing* (1995)
◆ *National Cryptography Policy* (expected May 1996)
◆ *Evolution of Untethered Communications* (expected 1997)
◆ *Innovations in Computing and Communications: Lessons from History* (expected 1997)

The report *Evolving the High Performance Computing and Communications Initiative* recently moved congressional debate away from dissolving the federal high-performance computing program to a discussion instead over the need to extend its funding. Very soon we will be releasing the board's major report on national cryptography policy that both the reviewers and I consider to be enormously important.

In summary, our nation benefits greatly from the innumerable productive collaborations between engineers and scientists that are made possible by the National Research Council.

Communicating Science

The fourth function of the Academy in my outline is the communication of science to government and the public.

The problem I would like to discuss is not a new one. Shakespeare even wrote about this issue in *Henry V*.

"Our houses, and ourselves, and children
Have lost, or do not learn for want of time,
The sciences that should become our
country."

In the 400 years since Shakespeare, the world has been utterly transformed by science and technology. It is staggering to recall the myriad of inventions that have eradicated diseases, eliminated the heavy reliance of the world of work on manual labor, and provided means of communication and transportation that Shakespeare could not even have imagined.

But there is more. Science and its values have also transformed our attitudes about the world and our political systems. To quote from Jacob Bronowski's *Science and Human Values,* published in 1956: "The society of scientists is simple because it has a directing purpose: to explore the truth. Nevertheless, it has to solve the problem of every society, which is to find a compromise between man and men. It must encourage the single scientist to be independent, and the body of scientists to be tolerant. From these basic conditions, which form the prime values, there follows step by step a range of values: dissent, freedom of thought and speech, justice, honor, human dignity and self respect....

Science has humanized our values. Men [and women] have asked for freedom, justice and respect precisely as the scientific spirit has spread among them."

There is every reason to expect the pace of science and technology to accelerate in future years. The dramatic increase in our understanding of nature in the 20th century has produced a foundation for discoveries in science and technology in the next century that we cannot even begin to imagine. We need only look at the unpredictable way in which the communications and computer revolution has impressed us all in the past 20 years to be utterly humbled about our ability to forecast the future. For this reason, the distinguished committee of our Computer Science and Telecommunications Board that was asked by Vice President Gore to forecast the next five years for the National Information Infrastructure entitled their recent report, "*The Unpredictable Certainty.*"

Our country now faces an incredible dilemma. Those who understand science and technology recognize that the current world leadership position of the United States in these areas has been the source of the vitality of this nation. How else does one explain how a nation of 260 million people can retain such a strong leadership position in a world with a population of 5.6 billion?

It is clear that we cannot hope to maintain this position of strength in the world through the next century, unless we retain our current world leadership in the science and technology enterprise. Yet, as we speak, the federal budgets proposed by both the Democrats and the Republicans portend cuts of 25 percent to 30 percent in the budgets for research and development by the year 2002. Many of the other nations with which we compete seemed to have a much clearer vision of the importance of science and technology for their future than we do. For example, a recent paper by the Council of Economic Advisors estimates that Japan's total federal investment in science and technology research may exceed that of the U.S. government in absolute dollar terms within two years. As Neal Lane, the director of the National Science Foundation, pointed out in his stirring address to the American Association for the Advancement of Science last February, "This nation is getting ready to run an experiment it has never done before — to see if we can reduce the federal investment in non-defense R&D by one-third and still be a world leader in the 21st century."

To most of us this seems like a very risky experiment. One of the absolutely crucial things that we may lose in this experiment is the desire of our most talented young people to enter science and technology fields. Already there is a fear in our community that the present emphasis on "alternative careers" for young scientists may severely deplete our future research talent pool. As we all know, the entire future of science depends on the continual influx of these energetic and ambitious young people into all parts of the R&D enterprise.

As those of you who attended the congressional briefing on Saturday recognize, the future decisions about science funding in this country will be made by a Congress whose members are inexperienced, and for whom the workings of science and the scientific enterprise remain shrouded in mystery.

There's even a story going around Washington about a congressman who suggested that the federal government should stop supporting scientific research, inasmuch as all of the universities were doing it anyway!

There is an urgent need for each of us to take on the responsibility of educating both Congress and the American people about science and the research that we all do. This needs to be done locally, in each congressional district. We must invite members of Congress and their staff to visit the places where scientists and engineers work and offer our assistance in helping them to deal with the many scientific and technical issues that they face as legislators. We should not, and we must not, vie for their attention only when scientific budgets are being threatened. One of our goals should be to have our local congressperson and staff know us by sight — not only our names, but enough of our background to know how we might be useful to them when they have specific needs.

As [National Science Foundation Director] Neal Lane emphasized, this new image of a "civic scientist" will also require that we become much more public in communicating what we do. In the past, the scientific community, including this Academy, has on occasion tended to disparage those of our colleagues who spend much of their time in communicating science to the public. We can, however, remember with pride our award of our Public Welfare Medal, this Academy's highest honor, to Walter Sullivan.

Mr. Sullivan, the science editor of the *New York Times* until his official retirement in 1987, died last month. His prolific explanations of science to the public set an example for both journalists and scientists to follow. We need to take the time to explain the excitement and the purpose of what we do. As Mr. Sullivan said, "The discovery that there is order and logic in the seeming randomness of nature can be a quasi-religious experience. There is great beauty to be found there, and the successful teachers and writers are those who, having glimpsed it, are driven to share it with others."

In the last few years, the National Research Council and the Academy have been placing an increased emphasis on communicating the nature, values, and judgments of science to both the public and the federal government. We have increased the resources devoted to our Office of News and Public Information, energetically strengthening our interactions with the press. But too often we have succeeded in getting tremendous attention from both the press and from Congress at the time a new report is released, only to have this information sink into oblivion several years later when the relevant policy decisions are finally being made. For this reason, both our news office and our Office of Congressional and Governmental Affairs have been working to develop better mechanisms for using the wealth of information from the thousands of reports that were previously published by this institution. Our goal is to be able to recall this information rapidly, as needed, and use it to inform both press and policy-makers whenever an issue suddenly bubbles to the surface so as to make our previous advice relevant.

These efforts will benefit greatly from a powerful new tool: electronic publishing. Although we developed a strong presence on the WorldWide Web only six months ago, our Web site already has 45 full-length reports available online. By this July, our goal is to have a thousand such reports available free to anyone with Internet access. We presently are working out ways of indexing and searching it that will make our Web site a convenient and useful tool for anyone seeking information about science and technology.

I am convinced that the WorldWide Web provides a revolutionary way of disseminating information to the public that will only increase in value as technology advances. This tool is especially valuable in an organization like ours, whose aim is to spread scientific information and advice with no need to charge for these services. I urge all members to spend time at our site and to give us the benefit of your ideas for making it more useful. By so doing, you will each play a part in helping us to better disseminate science and policy advice to our nation and the world.

Having outlined our four central functions, I would now like to speculate for a few minutes about the future. I am intrigued by the title of the report *The Unpredictable Certainty*. It represents not only the exciting future for the electronic communications dealt with in that report, but also a bright future for the Academy itself. As science and technology become increasingly dominant as a source of power and the driver of change in the world, the National Academy of Sciences can and must assume a larger role in our society. To make this possible will require courage — the courage to experiment, as our predecessors have done, with new programs and new ways of connecting the scientific community to the rest of society.

What are some of our recent experiments? We recently have launched a new program for the Public Understanding of Science, an effort that is chaired by Dudley Herschbach, a Nobel laureate chemist from Harvard. We have founded a new Center for Science, Mathematics, and Engineering Education chaired by Donald Kennedy, the former president of Stanford University. And we have a vigorously expanding, new Board on Children, Youth, and Families — a joint project of our Commission on Behavioral and Social Sciences and Education with the Institute of Medicine — where we are energetically attempting to forge new types of links between academic scientists and those on the frontlines in our troubled communities.

I know from a few of the letters that I receive from Members that change is not always appreciated. But I urge you to remember that we are an institution of scientists. As for science, our institution can only prosper if we are willing to take risks. In order for there to be successful experiments that break new ground, there must also be experiments that fail. As scientists, I hope that you will continue to support my vision of the National Academy of Sciences as a dynamic, changing institution — one that is eager to try new ways of making science a more effective instrument for guiding our rapidly changing society.

Thank you.

— *Bruce Alberts*

Recently Completed National Research Council and Institute of Medicine Projects (with 1996 release dates)

March 1 *An Evaluation of the Electrometallurgical Approach for Treatment of Excess Weapons Plutonium*
March 4 *Mathematics, Physics, and Emerging Biomedical Imaging*
March 4 *Lost Crops of Africa: Grains*
March 6 *Archiving Microgravity Flight Data and Samples*
March 6 *Shipbuilding Technology and Education*
March 7 *Health Systems in an Era of Globalization*
March 8 *Food Chemicals Codex, 4th Edition*
March 8 *Simulated Voyages: Using Simulation Technology to Train and License Mariners*
March 8 *An Assessment of Techniques for Removing Offshore Structures*
March 11 *The Unpredictable Certainty: Information Infrastructure Through 2000*
March 12 *Primary Care: America's Health in a New Era*
March 12 *Nutritional Needs in Cold and High-Altitude Environments*
March 13 *Review of the Research Program of the Partnership for a New Generation of Vehicles*
March 14 *Veterans and Agent Orange: Update 1996*
March 15 *In Her Lifetime: Female Morbidity and Mortality in Sub-Saharan Africa*
March 15 *Carcinogens and Anti-Carcinogens in the Human Diet: A Comparison of Naturally Occurring and Synthetic Substances*
March 21 *The Navy and Marine Corps in Regional Conflict in the 21st Century*
March 21 *Research Opportunities and Priorities for EPA*
March 21 *The Preparation of Teachers of Mathematics*
March 28 *Improving the Performance of America's Schools*
March 29 *Report of the Roundtable on the Role of Academic Health Centers in Clinical Research and Training*
April 2 *Environmental Management Technology-Development Program at the Department of Energy: 1995 Review*
April 3 *Engineering Within Ecological Constraints*
April 3 *Toxicity of Alternatives to Chlorofluorocarbons: HFC-134a and HCFC-123*
April 11 *20/20 Vision: Health in the 21st Century*
April 15 *Beyond the Blueprint: Directions for Research on Head Start's Families*
April 23 *Maintaining Oil Production from Marginal Fields: A Review of the Department of Energy's Reservoir Class Program*
April 24 *A Plan for a Research Program on Aerosol Radiative Forcing and Climate Change*
April 26 *Effects of Double-Hull Requirements on Oil Spill Prevention: Interim Report*
May 1 *Understanding Violence Against Women*
May 2 *The Evaluation of Forensic DNA Evidence*
May 7 *Lead in the Americas: Public Health Issues*