Originally Processed With FOIA(s):
2005-0336-F

FOIA Number:
2005-0336-F

FOIA MARKER

This is not a textual record. This is used as an administrative marker by the George Bush Presidential Library Staff.

Record Group/Collection:	George H.W. Bush Presidential Records
Collection/Office of Origin:	Science and Technology Policy, Office of (OSTP)
Series:	Van Cleave, Michelle, Files
Subseries:	Speech Files

OA/ID Number:	62114
Folder ID Number:	62114-004

Folder Title:
Speeches/Testimony [4 of 5]

Stack:	Row:	Section:	Shelf:	Position:
	0	0	0	0

(F)

SCIENCE AND TECHNOLOGY IN THE BUSH ADMINISTRATION

JAMES B. WYNGAARDEN

ASSOCIATE DIRECTOR FOR LIFE SCIENCES

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

EXECUTIVE OFFICE OF THE PRESIDENT

An address to the annual meeting of the

American Association for the Advancement of Science

New Orleans, Louisiana

February 16, 1990

I would like to begin by extending Allan's deepest apologies for not being able to attend this year's annual meeting. He has an illness in the family, so he asked me if I would be willing to stand in on short notice. Because the decision was made just a few days ago, much of what I will be saying will be drawn from the remarks that Allan had been preparing for this evening's address. But no government official can pass up the opportunities of a podium, and I'm sure that some of my own observations will slip in, too.

Eight years ago, as he was stepping down as President of the AAAS, Allan gave the presidential lecture at the AAAS annual meeting in Washington, D.C., on the external frontiers of science--the interfaces between science and the federal government, the educational establishment, the private sector, international science and technology, and U.S. society itself. What he had planned to do tonight was to revisit those frontiers, now that he is on the other side of one of them, and see how the situation has changed in the eight years since his original talk. Coincidentally, 1982 was the year that I crossed over one of the frontiers myself and came to Washington, D.C., from the Medical School at Duke. So I, too, have had eight years to observe the workings of science policy firsthand

and note how both elements in that marriage of convenience, how both science and policy, have changed.

Allan sent me down here with a story that he thought might convey a sense of our intentions. It seems that a father was visiting his son at Yale during the last few days of the semester, and he decided to sit in on his son's philosophy final, because he had taken the same philosophy class from the same professor 25 years earlier and he wanted to see how things had changed. As the final exam was handed out in the lecture hall, the father was astonished to see that the questions were exactly the same ones that had been on his final exam 25 years earlier. As soon as the last blue book had been turned in, the father marched up to the professor and said, "You lazy old fraud. Do you mean to tell me that in 25 years you haven't been able to come up with a single new question?" To which the professor replied, "It's true, I'm using the same questions. But I expect different answers now."

Many of the questions we are asking today <u>are</u> the same ones we asked in 1982, but the answers are not necessarily the same. The world is a different place than it was just eight years ago. On the positive side, the U.S. economy has grown nearly a third larger in real terms. Average personal incomes per capita in the United

States, after correcting for inflation, have gone up nearly 20 percent. Real support for research and development by both the public and private sectors has gone up over 30 percent. In absolute terms, if I might use a unit of comparison popularized in the last few Presidential elections, we are obviously better off than we were eight years ago.

But the last eight years have also seen some very troubling developments. The national debt is nearly two and a half times larger than it was in 1982. The United States has gone from being the world's largest creditor nation to the world's largest debtor nation, seemingly in the blink of an eye. The scientific community is caught up in what some have described as a "crisis of purpose," marked by disputes between the advocates of large projects and the advocates of small, individual investigator projects and even between disciplines. There is a vague sense of unease in the air, as though things are about to turn sour.

Quite rightly, people tend to look to Washington for leadership in solving these problems, and, limiting my comments for the moment to science and technology, I believe that there is considerable reason for optimism. The Bush Administration has been committed to scientific progress and technological development throughout its time in office, and lately that commitment has begun to pay real dividends.

One of the first signs of that commitment was the elevation of Allan's position to Assistant to the President. That made him a member of several of the important policy-making bodies within the White House, including the Domestic Policy Council and the Economic Policy Council. It also enabled him to work closely with some of the other Cabinet-level groups within the White House, such as the National Security Council and the Competitiveness Council.

Several of these groups are looking specifically at issues of science and technology, and OSTP has been able to become involved in these deliberations in ways that it has not in the past. For instance, the Council on Competitiveness, which is headed by the Vice President, has chosen biotechnology as an area of special focus and plans to play a very active role in shaping government policy toward the emerging biotechnology industry. In fact, I am the head of a Working Group on Biotechnology for the Council that will be looking at the scientific, regulatory, and financial dimensions of the industry.

Another very positive sign for science and technology is the establishment of the President's Council of Advisors on Science and

Technology or PCAST, which the President announced a couple of weeks ago. PCAST held its first meeting earlier this month at Camp David, and for over three hours, while a torrential rain fell outside, the Council, the President, and several of his top advisors discussed important issues in science and technology. The Council is a very distinguished, as well as a very forthright, group, and I think we can be assured that the President will be well-advised about both the promise and the problems of science and technology.

THE FY 1991 BUDGET

Some might contend, however, that all the councils and working groups and policy committees in the world won't necessarily do any good, so let's turn to the hard numbers. As I. F. Stone has noted, in Washington "the budget is the message," and in general our office is quite pleased with the budget that President Bush sent to Capitol Hill last month. I don't know how many of you have seen the 1,569-page book that Budget Director Richard Darman and OMB prepared this year, but the chapters on research and development are preceded only by a chapter on increasing the national savings rate. This is an important expression of the high priority accorded science and technology by this administration.

The administration is committed to supporting science and technology because of its firm belief that the federal government must increase its investments in the future. Essentially, all of the expenditures of the federal government can be divided into three broad categories: (1) outlays for obligations made in the past, such as commitments to veterans or to Social Security, (2) current needs, such as health care or the war on drugs, and (3) investments in the future.

The current budget, and indeed the entire outlook of the Bush Administration, emphasizes investments in the future, while maintaining commitments to the past and the present. There are several ways of investing in the future--some of which I'll return to in a moment--but certainly one of the most effective is by supporting research and development. Edwin Mansfield, an economist at the University of Pennsylvania, has conducted a study, which is now in press, of the return society receives from investments in university research and development. According to his analysis, the rate of return from academic research in the physical and life sciences is at least 28 percent.

To put this in perspective, suppose you invested $100,000 in a house, and that house appreciated in value at the rate of 28 percent annually. By the end of 12 years that house would be worth over a million dollars. In other words, that house would be worth almost as much as a standard three-bedroom Colonial in Washington, D.C.!

The Bush Administration's FY 1991 budget proposals call for funding for research and development to go up 7 percent, a healthy increase in this otherwise tight budget year. But our office is even more encouraged by some of the trends within that overall amount. Civilian R&D would go up 12 percent, from the $23.8 billion that was enacted in FY 1990 to $26.7 billion in FY 1991. Basic research would rise $1 billion, from $11.4 to $12.4 billion, an increase of 8 percent. At a time of declining real defense expenditures, basic research by the Defense Department would go up by about 6 percent.

Despite the overall advances in the budget, there are a few areas of concern. One very serious problem involves the funding rate for grants at the National Institutes of Health and the National Science Foundation. Despite nearly a decade of funding increases at those two agencies, the money available for new, young investigators is very tight. Last year, for the first time ever, the fraction of excellent, peer-reviewed, new proposals that were actually funded by these two agencies fell below 30 percent. The discouragement caused by a lack of funding is particularly unfortunate at a time when the nation has a very serious need to recruit more young people into scientific careers.

There are several reasons for this distressing state of affairs. One is that the rate of inflation for research in the physical and life sciences is higher than the consumer price index, and the nonearmarked dollars available to NIH and NSF have not kept pace. There is a "sophistication inflation" that drives costs upward as the problems under investigation grow more complex and detailed.

We must also recognize that, to some extent, we are the victims of our own success. It has been a remarkable decade in science. The increased funds devoted to research during the 1980s have produced a wealth of advances, which in turn have created an exponentially increasing number of exciting opportunities throughout the scientific disciplines. The number of high-quality applications is growing steadily. The peer review system no longer has the power to distinguish among the fine points of these many proposals. We must find some way of dealing with the remarkable progress that we have made.

There is a widespread feeling in the scientific community that funding pressures on individual investigators will increase as several of the large or "mega" projects in science--such as the Superconducting Super Collider, Space Station Freedom, the human genome project, the National Aerospace Plane, and the Compact Ignition Tokamak--scale up during the 1990s. We at OSTP are very cognizant of this problem. As Allan has repeatedly stated--and this is a point I would like to emphasize myself--small science comes first. Individual investigators are now and will continue to be the heart of American science. We will do everything that we can to protect and nurture this font of scientific creativity.

We are now heading into the season of budget hearings in Washington, when Congress looks at the administration's requests and decides what it wants to appropriate. This is a time when your support for science and technology is most needed. OSTP is not and cannot be an lobbyist for the scientific community, although of course we share the administration's enthusiasm for increased R&D support. I shall return to this point later, but for now I want to say that your voice can make a real difference in the appropriations process.

EDUCATION

Another way in which this country invests in the future is through the education of its young people. In an age of information, human capital is just as important as physical capital, and in many sectors it is more important. Yet if current trends continue, we will soon be running this country on the human equivalent of baling wire and scotch tape.

It was 1983 when the National Commission on Excellence in Education, in its report A Nation at Risk, warned of a "rising tide of mediocrity" in our elementary and secondary schools. Yet in the seven years since then, despite a wave of school reform efforts, standardized tests show very little improvement in student achievement. Countries are like companies in that they may be able to absorb a few years in which output is not up to prevailing standards. But if many years go by in which the students of this country are not being given the skills they will need to compete in a global marketplace, the United States will inevitably enter a period of decline.

As with science and technology, education has been a focus of special concern for this administration. Last September, Allan accompanied the President to the Education Summit in Charlottesville, where the President met with the nation's governors to work on this issue. Although a great deal of skepticism surrounded that meeting, Allan came away considerably heartened. Many of the states have taken great strides forward in improving their educational systems, even if those strides have not yet been reflected in national measures of achievement. That meeting also served a very real catalytic function. It focused the attention of the nation on education, and several governors have since told Allan that they are finding it much easier to get legislation through their statehouses because of the impetus provided by the education summit.

The goal that President Bush outlined in his state of the Union message--and it is admittedly a very ambitious goal that will require the combined efforts of everyone in this room--to have American students be first in the world in science and technology was not made lightly. For one thing, the budget for FY 1991 proposes to increase funding for science and mathematics education by 26 percent, to a total of over $1 billion. These funds would be distributed among the Deparment of Education, the National Science Foundation, NASA, the Department of Energy, and the National Institutes of Health, allowing those agencies to expand current programs and initiate new ones.

Our own Office of Science and Technology Policy is also very involved with precollege education. For instance, we are currently in the process of reviewing the relationship between the educational programs of the Department of Education and those of the National Science Foundation to help improve the coordination of these activities.

But I am sure that everyone here knows that the federal government alone cannot solve our problems with precollege education. Education will remain predominantly a state and local responsibility, as it should be. What the federal government can do is act as a catalyst and monitor of change.

It has been said that "every problem that exists in education has already been solved somewhere." The federal government can monitor and identify the very innovative programs that originate at the state and local level and help to disseminate those programs to other locations. The federal government can also exert a leadership role that is not necessarily tied to funding, as it is in the process of doing in setting national goals and implementing ways of monitoring achievement relative to those goals.

The real innovation in education is going to come from the states and localities, and from the national organizations that represent those localities. In this respect, we at OSTP, and many other observers of science in Washington, are very encouraged by the AAAS's Project 2061. We highly commend your efforts to define an agenda for national scientific literacy, and we are very much looking forward to the next phase of the project, when the agenda will be implemented at select school districts around the country. These are the kinds of efforts, combining national oversight and local action, that can make President Bush's goal of American preeminence in science and mathematics education a reality.

Education is also a vital consideration of the third frontier Allan and I wanted to discuss tonight, that between science and the private sector. It is often easy to forget how radically the world in which American business now operates has changed. Today, over 70 percent of the goods manufactured in America are subject to foreign competition. Of every dollar we spend, an average of 27 cents nationwide goes to imports. Furthermore, the internationalization of the American economy has not yet run its course. With the increased unification of the European community in 1992 and the continued economic expansion of the Pacific Rim countries, competition is only going to intensify.

The American economy is already part of a global marketplace, yet all too often the institutions of this country are still geared toward the notion of a relatively insulated, national economy. For example, American companies are often reluctant to engage in cooperative research and development, in part because they fear that antitrust considerations may raise roadblocks to their efforts. Legislation has been enacted to greatly reduce these roadblocks, but the influence of previous restrictions still has a powerful hold.

One piece of legislation designed to increase cooperation among industry, government, and academia was the Technology Transfer Act of 1986. This act offered incentives to scientists in national laboratories to collaborate more actively with industry in research and development. Much progress has come from this act. But we still face a major challenge in adjusting our institutions and attitudes to realize more fully the intent of this legislation.

What the federal government, industry, and universities must do is to find ways of encouraging cooperative efforts in areas of research and development that are of importance to the economic and military health of this nation. These cooperative efforts can take place entirely within one sector--as in the case of industrial consortia--or they can involve elements from all of the sectors.

An important example of cooperation between government and industry is SEMATECH, the consortium of semiconductor companies that is focusing on precompetitive research and development. It does not make sense for the government to require U.S. companies within a given area, such as semiconductors, to each work separately on the generic technologies that underlie their products. Companies in other countries are certainly working cooperatively, and it is time for us to follow their example.

The role of the federal government in such consortia will vary. In some areas, the federal government needs to do no more than to make clear that it will not oppose a proposed cooperative effort. In other cases, the government can act to catalyze state and local activities, to leverage its own funds through nonfederal mechanisms. In still other areas, it may be appropriate for the federal government to provide support to consortia, as it is doing in the case of SEMATECH.

The Office of Science and Technology Policy is heavily involved in the issue of competitiveness. For the first time, OSTP has an Associate Director for Industrial Competitiveness, William Phillips, who for the last several years has been President of the Missouri Advanced Technology Institute and Science Adviser to the Governor of Missouri. Bill's confirmation hearing before the Senate is scheduled for February 28, and as soon as he is confirmed he will be working closely with the Department of Commerce, with other federal agencies, and with Congress to foster and coordinate federal activities in this area.

THE GLOBAL ENVIRONMENT

International competitiveness will be one issue that consumes a significant fraction of our attention. Another issue with which we will undoubtedly spent much time--in fact, it has already consumed quite a bit of our time--is global change.

For a variety of reasons, including a string of warm years during the 1980s and the resurgence of a strong environmental movement around the world, global change has boiled to the top of the national and international political agendas. I notice, for instance, that there will be a number of sessions on the topic at this meeting, and I'm sure they will be well attended.

One major way in which the Office of Science and Technology Policy is involved with this issue is through the Committee on Earth Sciences. This committee is one of several committees under the Federal Coordinating Council for Science, Engineering, and Technology, or FCCSET, which Allan chairs. FCCSET, which was established by the same legislation that created OSTP, is the entity within the Executive Branch that is charged with overseeing and coordinating R&D that cuts across the missions of more than one federal agency. The members of FCCSET committees are representatives from the agencies involved in a specific area of research. For instance, the Committee on Earth Sciences has members from the U.S. Geological Survey, the State Department, the National Science Foundation, the Environmental Protection Agency, NASA, and so on down the list of relevant agencies.

A couple of years ago the Committee on Earth Sciences organized all of the research being conducted by the different agencies into what has become known as the U.S. Global Change Research Program. This program is an integrated, government-wide effort to reduce key scientific uncertainties and to develop more reliable scientific predictions upon which to base public policy. It was Bertrand Russell who said, "The most savage controversies are those about matters as to which there is no good evidence either way." The U.S. Global Change Research Program is trying to produce that evidence, and perhaps in the process it will reduce the ferocity of the debate.

The information generated by the Global Change Research Program will feed in to the policy-making process within the White House, with which OSTP is also involved. Allan is the chairman of a working group on global change within the White House Domestic Policy Council. The working group provides Cabinet-level coordination on policy issues involving global change and is an important source of advice for the President.

One of the first actions of the working group was to commission three studies by federal agencies to examine the economic and legal aspects of the issue. The first report was on the economic costs of global change and the costs of possible responses to it. The second covered the concerns and activities of the private sector regarding global change. And the third looked at legal precedents for international agreements and conventions on the environment. These three studies, which have now been presented to the working group, will complement the scientific input of the Global Change Research Program. Thus, the working group will have input not only on the science, but on the economic, social, and legal aspects of global change.

In addition to the heading the working group, Allan has been asked by the President to cochair, along with the chairmen of the Council of Economic Advisers and the Council on Environmental Quality, a White House meeting of the three senior officials in science, economics, and the environment from a number of countries this spring. The meeting will examine the data and analytical tools needed to understand global change and will highlight gaps that need to be filled.

Finally, a subgroup of PCAST is going to be looking at this issue. This subgroup will in many ways parallel the Committee on Earth Sciences. In this way, the Global Change Research Program can take advantage of the experiences of the private sector in this area, and vice versa.

On the international front, the United States continues to support the work of the Intergovernmental Panel on Climate Change, which is sponsored by the United Nations and the World Meteorological Organization. There are three working groups of the IPCC, which met in plenary session last week in Washington, and their final papers will be presented to the entire panel in August, shortly before the Second World Climate Conference in November.

The IPCC process, as well as the domestic policy-making taking place in the White House and on the Hill, will all provide input to an International Framework Convention on global warming that will begin sometime next year. At that point, the United States expects to be able to consider quantitative proposals for stabilizing greenhouse gas emissions, something it has not been able to do in the past. At the Malta Summit last December, president Bush proposed that the United States will host the first negotiating session for a Framework Convention, and he reiterated that offer to the IPCC last week.

I have gone through this long list of committees and policy-making bodies to make a relatively simple point. It is hard to accuse the Bush Administration of ignoring or belittling this issue. If the computer models now being used prove accurate, global change is going to be a very difficult and costly problem to solve. The United States does not want to embrace policies that it ultimately cannot observe or that prove counterproductive. National and international policies must be based on the best scientific and economic advice that is available. Providing that advice is OSTP's foremost legislative responsibility; it is also the only reasonable approach to take with an issue of this importance.

Global change is an excellent example of the last subject I would like to discuss tonight: the inextricable involvement of the American public with issues of science and technology. By definition, global environmental issues affect everyone. By the same token, everyone will be part of the solution. Changing emissions of greenhouse gases will involve countless decisions that people make every day: about their use of energy, about the products they buy, even about the kinds of food they eat. Global change demonstrates as much as any current issue how science and technology have linked the small scale with the large scale, the individual with the planetary.

In his speech eight years ago, Dr. Bromley talked about the necessity of creating an informed, interested public prepared to recognize and understand, at least in outline, the vital roles that science and technology play in almost every aspect of modern life. Whether we are closer to that goal now is debatable. The boom in popular science magazines during the first part of the decade has faded. Measures of scientific literacy remain as mired in the doldrums as do school achievement scores.

But I also see several positive signs of an increasing public interest and understanding of science. Science museums are the most popular of all museums. Science sections are now a regular part of newspapers and general audience magazines. Moreover, I do not sense the antagonism toward science that has occasionally surfaced in this country, such as during the 1960s and shortly after the development of recombinant DNA.

Last week the National Science Foundation released its most recent science and engineering indicators report, and it includes a chapter that speaks directly to this topic. For instance, national surveys reveal that 88 percent of the U.S. public believes that science makes our lives healthier, easier, and more comfortable. Perhaps even more encouraging, 80 percent of the public believes that government should support scientific research even when it brings no immediate benefits.

Surveys also show that scientists rank second only to physicians on a list of professionals in which the American public has confidence. As usual, Congress and the media rank near the bottom. One wonders where public speakers might rank.

These are very encouraging numbers to the scientific and engineering communities. They indicate that the American public is unlikely to oppose continued support for these enterprises. But of course these numbers do not have much tangible influence in Washington. Washington policymakers answer to a different kind of message.

There is always much talk around the country of the isolation of Washington, of the "inside the beltway" mentality that separates us from the rest of the country. For instance, you might have heard that Washington, D.C., has been defined as 69.2 square miles surrounded by reality. Or that Washington is the only place where sound travels faster than light.

But Washington is not as isolated as it sometimes seems. I can tell you from my experience that most Washington officials are very responsive to their constituencies. I have often been amazed, during my time at NIH, at the influence relatively small groups can have on policy. Unfortunately, that influence has often been of the negative variety. For instance, the ardent believers in animal rights constitute a very small fraction of the American public. Yet through their skillful use of the media, the schools, the Congress, and the courts, they have had a disproportionate influence on local and national legislation.

The most dedicated constituencies for science and technology are the people in this room, the other members of the AAAS, and the 4.6 million scientists and engineers employed in the United States. You are the ones from whom Congress must hear as it makes decisions affecting the future of your fields. Science budgets in Washington are now in direct competition with many other social needs, many of which have powerful and vocal advocates. Many Congressmen have been very generous and enlightened in supporting the growth of research and development. They need our backing if that support is to continue.

Eight years ago, Allan concluded his speech with a simple suggestion: get together with your representative or senators, or write a letter to them, and talk about the issues that concern you. That piece of advice is as relevant and as effective today as it was then. Over the past four decades, science and the federal government have become increasingly interdependent. Many scientists need the support of the federal government if they are to pursue their research. By the same token, the federal government needs your support if the scientific enterprise is to continue to prosper.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

GOALS AND OBJECTIVES OF THE CONFERENCE

D. ALLAN BROMLEY

Assistant to the President for Science and Technology

Executive Office of the President

White House Conference

on Science and Economics Research

Related to Global Change

Washington, D.C.

April 17, 1990

I would like to add my welcome to those of Secretary Brady and President Bush. Working together with you, we look forward to very real accomplishments over the next two days. In a moment, I will describe what the President views as some of the objectives of the conference.

GLOBAL STEWARDSHIP

But first let me elaborate briefly upon the conferences's theme, that of Global Stewardship. As President Bush has stated, Global Stewardship is not a fixed state. It is a process of continual change that balances environmental and economic values to meet human needs and expand human prospects.

Global Stewardship is a complex, multifaceted concept, yet I believe that it can be summed up in remarkably succinct fashion. On December 22, 1968, as the crew of Apollo 8 became the first humans to leave Earth orbit and head toward the Moon, they turned their frail spacecraft back toward the Earth and took the first photographs of our planet from deep space. I firmly believe that thousands of years in the future perhaps the one most lasting thing for which our age will be remembered will be those photographs. They show the Earth as a beautiful blue and white sphere floating quietly in the immense blackness of space. They emphasize that this planet is mankind's common heritage. It is ours to cherish; it is ours to destroy. We are all truly in this together.

We will achieve Global Stewardship in the same way that we achieve scientific knowledge -- through careful study of the environment and of ourselves, coupled with effective and timely action. We must come to understand the extent and limits of the resources available to us on this planet. And we must come to understand how humans can use those resources in a sustainable fashion to achieve a more prosperous and productive future.

We are not here to make a global warming policy. That will emerge from the broad array of research and policy reviews now ongoing. Rather, we are here to try to determine what will be required in order that such policies be based on sound scientific understanding and that they be both technologically and economically feasible.

THE LINK BETWEEN SCIENCE AND POLICY

Much has been written and said during the past few months about the scientific understanding of global change and about policy responses to global environmental concerns. But conspicuous by its absence in almost all of these discussions has been a careful and detailed analysis of the economic causes or consequences of global change. For example, we will talk at length over the next two days about various ways of taking out insurance policies against possible adverse effects of global warming. But there are good insurance policies and bad ones, and we very much need the input and expertise of economists to discriminate between them.

In a very real sense, we should perhaps look on economics as the glue that binds scientific understanding of global change phenomena to the policies -- both national and international -- that we adopt to address this issue.

In general, the social sciences -- economics, psychology, sociology -- must be an integral part of any approach to the understanding of global change. Even when the physical and biological aspects of a problem are understood, all too often agreement is lacking on the underlying social, behavioral, and economic causes and consequences of an action. This conference will focus as much on these aspects of global change as on the purely scientific aspects. In this way, we hope to add a new dimension to the international dialogue on global change.

GOALS OF THE CONFERENCE

As President Bush noted, the foundation of this conference is what we do know and what we do not know about the science and economics of global change. At a more detailed level, we seek to determine which uncertainties might be reducible in the foreseeable future and which are not, and to understand how scientific uncertainties affect our economic modeling and vice versa.

The conference is designed to achieve several other objectives. Among them are the following:

- To increase the mutual understanding and sensitivity of the scientific and economic research communities to each other's needs and to the needs of the policy makers who look to them for guidance.

- To foster a solid and well-implemented international research effort that can address the scientific, economic, and policy questions of global change, drawing on the expertise, experience, and data of all the world's nations.

- To forge a worldwide communications network among the researchers and policymakers concerned with global change.

REVIEW OF THE AGENDA

To achieve these objectives, the conference is organized around three themes.

- The science and economics research challenge.
- Integrating science and economics research in the policy process.

- o Building a partnership for science and economics research.

Later this morning, I shall speak on the first of these themes. My cochairmen Michael Boskin and Michael Deland will speak on the second and third.

Following those presentations, the agenda calls for us to divide into three Working Groups that will then meet in four sequential sessions. Each of the Working Groups will have about 25 members, with roughly equal representation from the three disciplines of science, economics, and the environment.

The first three Working Group sessions will be devoted to the three themes of the conference. The fourth will be devoted to integration of the discussions and preparation of a summary report of each Working Group's deliberations.

These summaries will form part of a Cochairmen's report, which we would suggest as the primary product of the conference. In this report, we would expect to outline the deliberations of the conference and set forth agreed-upon common actions designed to expand research and cooperation among nations.

CONCLUSION

This conference is only one of many national and international actions being taken to address issues of global change. We must therefore seek to integrate the accomplishments of the next two days into these ongoing efforts -- and, in particular, into the deliberations of the IPCC, the international research programs of the World Meteorological Organization and International Council of Scientific Unions, and the programs of individual countries focused on the global environment. At the same time, we will work to coordinate the many activities now going on in the United States and abroad. They will all be stronger if carried forward in a unified, coherent fashion.

We want to emphasize that the President has instructed us from the outset of our planning to design this conference with a primary goal of complementing, strengthening, and supporting the entire IPCC process, which he considers to be the central and appropriate forum for our joint efforts toward understanding of, and responding to, the questions of Global Stewardship.

Louis Pasteur wrote that, "Science knows no country because knowledge belongs to humanity and is the torch which illuminates the world." We will be the carriers of that torch for the next two days. And we must keep it burning as we leave to face the great challenges that lie ahead.

UNCERTAIN CHANGE:
THE SCIENTIFIC AND ECONOMIC RESEARCH CHALLENGE

D. ALLAN BROMLEY
Assistant to the President for Science and Technology
Executive Office of the President

White House Conference
on Science and Economics Research
Related to Global Change
Washington, D.C.
April 17, 1990

The global environment has been changing throughout human history, and indeed throughout the entire history of our planet. At the peak of the last ice age 18,000 years ago -- just a few thousand years before the first substantial human civilizations came together in the river valleys of the Middle and Far East -- a glacier over two kilometers high covered much of the northern United States and Europe. Sea level was 100 meters lower than at present, so that the future sites of many of today's port cities were perched on the edges of deep ravines. Then, rather abruptly about 10,000 years ago, the world warmed, the ice retreated, and sea level rose to about its present level. These natural changes in the Earth's climate have occurred throughout its history, and they will continue to occur in the future.

During the past century, human society has entered into a new and momentous relationship with the global environment. For the first time in history, we have become a geological agent capable of influencing our entire planet. We have altered the face of the Earth by clearing forests, building cities, and converting wild lands to agriculture. We have changed the composition of the Earth's atmosphere by burning fossil fuels, expanding agriculture, and producing and releasing industrial compounds. We have embarked on an enormous, virtually unplanned, planetary experiment that poses unprecedented challenges to our wisdom, our foresight, and our scientific capability.

The first theme of this White House Conference is the scientific and economic research challenge related to global change. Properly speaking, global change encompasses not only global warming but such issues as ozone depletion, the adequacy of food and water supplies, changes in sea level, deforestation, levels of biodiversity, and population change. Indeed, any of these issues could turn out to be more serious in terms of human impact than global warming. Yet much of the world's attention has focused on the possibility of increased global temperatures, and that will inevitably be the main topic of discussion at this conference.

SCIENTIFIC KNOWNS AND UNKNOWNS

In light of the Earth's daunting complexity, it is easy to be overwhelmed by how much we do not know about the Earth's components and how they interact. But it is always important to keep in mind how much we do know about the Earth and our influence on it.

We know, based on a sophisticated set of chemical measurements, that humans have raised the level of carbon dioxide in the atmosphere by 25 percent since preindustrial times. This is the single largest impact that our species has had on the planet. We know that atmospheric levels of methane have doubled over the same period. We know that chlorofluorocarbons produced by human beings are catalytically destroying ozone in the atmosphere above Antarctica and possibly elsewhere around the globe.

By analyzing sediments and ice cores, geoscientists have traced levels of atmospheric gases and temperatures many thousands of years into the past. Using large computers, researchers have modeled the complex eddies and flows of the global atmosphere with considerable accuracy. These are all remarkable accomplishments.

Based on this work, scientists now generally agree that continued loading of the atmosphere with greenhouse gases could lead to global warming. However, neither computer models nor paleoclimatic data have been able to specify with any certainty the magnitude, rate, or timing of any future warming.

General circulation models will continue to improve in the future as computer power increases, as the modeling of the Earth system becomes more sophisticated, and as more complete data inputs become available. For example, coupled ocean-atmosphere models will shed more light on the possible regional effects of climate change. Also, an important example of better data inputs is the very recent demonstration that satellite measurements are capable of providing precise temperature data over the entire globe at various levels in the atmosphere.

We will also learn more about Earth's past climates by continuing to study the geological and paleoecological record. But in general we should probably expect incremental rather than revolutionary advances in our understanding of global change over the next 10 years.

Another area of consensus concerns global temperatures: scientists now generally agree that the planet has warmed up by about 0.5 C during the past century. But very few scientists would claim that they are yet able to determine whether any of that warming can be attributed to an enhanced greenhouse effect or whether it represents a natural fluctuation. We are also only beginning to understand what the impacts of a potential warming might be on agricultural productivity, sea level changes, biological productivity in the oceans, shifting vegetation patterns, storm patterns and severity, droughts, and the like.

Furthermore, we are totally unable, with present models, to make reliable climate predictions on the regional and local bases that are essential to improved understanding of these impacts. This difficulty arises partly from the fact that we have, at present, neither the computer capacity and speed, nor the resources, necessary to reduce the grid size and increase the number of model levels in the atmosphere, both of which are essential to regional predictions. Current grid sizes inevitably average over the climatic effects of mountain ranges and of such oceanic features as the Gulf Stream.

THE SCIENTIFIC RESEARCH CHALLENGE

There are several other outstanding difficulties in understanding and modeling the Earth's climate. Perhaps the most notable involve the Earth's clouds, oceans, and ice. Until recently, geoscientists did not even know whether clouds warm or cool the

Earth. It is still uncertain whether the increased cloudiness associated with a warmer Earth would augment or counteract a greenhouse effect. It depends on the nature and altitude of the clouds.

Regarding the oceans, we know that only about half of the carbon dioxide released through fossil fuel combustion and deforestation remains in the atmosphere. For many years, essentially all researchers assumed that the rest was being sequestered in the oceans, but recent studies indicate that no more than a quarter probably ends up there. Where does the rest go? We appear to have lost 25 percent of our anthropogenic carbon emissions. We still have not located this missing carbon, although some suggest that it is in temperate latitude biomass.

Finally, we still do not fully understand how the world's ice caps and other major bodies of ice would respond to greenhouse forcing. Present models predict that warming should be intensified at high latitudes, leading to some melting of ice and a higher sea level. But recent observations indicate instead an increase in ice accumulations.

It has not escaped notice that six of the hottest years in the last century in the United States occurred in the 1980s, and some have associated this with the greenhouse effect. But over this same decade, precise satellite temperature measurements have shown that away from the actual surface, where a number of perturbations are expected, there was no change whatsoever in global average temperatures. While the northern hemisphere showed a slight increase in temperature, the southern one showed a corresponding decrease, and the major fluctuations globally were associated with the El Nino phenomenon in the Southern Pacific. We need to understand these surface temperature perturbations much better than we do at present.

There is growing suspicion from the paleoecological data -- but as yet no more than that -- that the atmosphere-ocean interface may harbor the possibility of surprises. It bears emphasis that the top 3 meters of the ocean surface contains the same thermal energy as the entire atmosphere. If it should turn out that relatively small, and not as yet understood, mechanisms could trigger ocean circulation patterns from one stable configuration to another, the potential impacts could be large. We need a careful program of observing and monitoring the Earth to detect any such surprises caused by our emission of greenhouse gases.

In general, we must remain aware of the potential for surprises. The development of the ozone hole over Antarctica was such a surprise. The hole develops through a mechanism that was not included in earlier models of ozone destruction, although scientists quickly came to understand how it formed and have incorporated that understanding into their models.

What the ozone hole has demonstrated beyond question, however, is that, contrary to long-held assumptions, our atmosphere is not so large, nor its inertia so great, that human activities cannot affect it on human time scales. Human release of chlorofluorocarbons, combined with unique meteorological conditions, has indeed created the ozone hole in only a few decades at most.

In recent years, a number of scientists have compared the Earth, in its complexity, to a living organism. The comparison is certainly apt in this regard: as much as we still have to learn about the nature of life, about how it developed and where it is going, we have as much to learn about the nature of the Earth.

THE ECONOMIC RESEARCH CHALLENGE

The comparison is apt in another sense. The behavior of human beings, economically and politically, will be a major determinant of future changes in the global environment. My cochairmen will be speaking in a moment about some of the work that has been done on the economics of global change and about the many economic questions that remain to be answered.

But I would emphasize that in many cases these economic questions are of even greater importance -- and much farther from resolution -- than the scientific questions. Science-based models of global change need economic trends as inputs. Yet these economic inputs are often so uncertain that they hamstring the model results. For example, one recent analysis was able to conclude only that emissions of carbon dioxide in the year 2050 are likely to be between 1.5 and 12 times what they are today. We must find ways to reduce such uncertainties or, if they are unavoidable, to accommodate them in our projections.

A major influence on future economic trends is the state of technology. To take the case of emissions, for example, the development of more efficient power plants, biomass and solar energy, inherently safe nuclear reactors -- even something as mundane as lower cost and more efficient insulation -- could both reduce emissions and increase our flexibility when deciding on policies related to global change. In essence, we can hedge our bets on the possibility of future global warming by investing in these technologies today.

Technology development is also crucial if we are to be fully prepared for the possibility of global change. Basic and applied research on ecosystems, agriculture, water supplies, and other important environmental and societal systems can demonstrate both the ability of society to adapt to different climates and the pressure points where adaptation becomes prohibitively expensive. Furthermore, the technologies that emerge from such research -- such as plants that grow under a wider variety of climatic conditions -- will have great benefits even if the climate does not change.

The future of technology is as difficult to forecast as economic trends. Yet new technologies will inevitably reshape our world in the coming decades -- just as they have throughout the twentieth century -- and we must explore the possible ways in which this will affect the global environment.

One way to increase the reliability of economic and technological forecasts -- and I see this as a major goal of this conference -- is to increase the sensitivity of both scientists and economists to each other's data needs. We must agree upon the uncertainties in our scientific understanding that cause the greatest uncertainties in our economic models, and vice versa. In this way, resources can be focused on reducing the uncertainties of greatest importance.

By working together to understand both the scientific and economic aspects of global change, we will be better able to assess the costs not only of action but of inaction. We will enable all nations to respond sooner and more effectively to the possibility of different climates. And we will build a flexibility into our environmental stewardship that will serve us well no matter how climate changes.

U.S. RESEARCH PROGRAMS

Returning for a moment to our scientific understanding, the U.S. government is now engaged in a large-scale, integrated program to develop the scientific knowledge that will guide our future policy decisions and contribute to those of all nations. That program is known as the U.S. Global Change Research Program and was established through a working group of our interagency Committee on Earth Sciences.

As the President noted earlier, his Administration has requested over $1 billion in funding for this program during our next fiscal year. Such a request for what is admittedly a long-term and complex research program demonstrates the President's very real commitment to dealing decisively with the possibility of global change.

CURRENT ACTIONS

It is clear that we and other nations are accelerating research in the face of uncertainty. But what bears emphasis as being even more important is decision making in the face of uncertainty. We are not -- despite our best efforts -- going to achieve scientific certainty about global change in the near future. Yet we must move forward on the basis of the information available to us.

The Bush Administration has already instituted a number of policies that will reduce greenhouse emissions while being fully justified for other reasons. I think of them as an "insurance policy" against possible adverse effects of global warming. Among these policies are the following:

- The United States is committed to phasing out the manufacturing and use of CFC's by the year 2000 to protect the stratospheric ozone layer -- ahead of the requirements of the Montreal protocol -- provided safe substitutes are available. If not controlled, CFC's would account for as much as 25 percent of the enhanced greenhouse forcing over the next century.

- o The Clean Air Act now being debated in Congress will provide for substantial reductions in the emissions of greenhouse gases by fostering more efficient use of energy. It has been estimated that the acid rain provisions of this legislation alone will have an effect comparable to that of removing fully one fifth of the U.S. automotive fleet (22 million automobiles) from our highways for a period of 10 years.

- o The U.S. Department of Energy is developing a National Energy Strategy that will focus, in particular, on an aggressive commitment to energy conservation and on the development of non-fossil-fuel sources of energy.

These initiatives address the source component of the greenhouse gas question; turning to the sink component, this country is again taking concrete steps.

- o The U.S. Department of Agriculture is proposing to plant a billion trees on private land across America, trees that will eventually absorb 13 million tons of carbon annually.

- o Diplomatic discussions are being conducted aimed at protecting the remaining tropical forests through such mechanisms as debt-for-nature swaps.

An underlying theme in all of the United States' policies related to global change is that they be based on the best possible science and that they be technically and economically sound. These are criteria that we will continue to apply as we consider policies in the future. We will do ourselves a great disservice if we adopt premature policies that later prove to be unnecessary or counterproductive.

INTERNATIONAL RESEARCH PROGRAMS

As I mentioned in my opening remarks, the President has instructed us to design this conference to complement and support the Intergovernmental Panel on Climate Change by emphasizing the importance of economic as well as scientific considerations in the development of global change policies. The United States supports the IPCC process as an appropriate international approach to the global understanding and response to a question that knows neither national nor political boundaries.

At the same time, we would like this conference to be a contributing factor to the development of an international research program that can provide us with the knowledge, both scientific and economic, needed to understand and respond to global change. The first of the three Working Group sessions will give us an opportunity to explore the dimensions of the scientific and economic research challenge and sketch the outlines of an international program of science and economic research related to global change.

CONCLUSION

We face a great challenge in the next two days. We must merge science and economics with policy to a degree that has not been done before. The uncertainties that surround us are daunting. But humans have never been hindered -- at least not for long -- by uncertainties. The explorers who we know from history did not let uncertainties stand in their way. Rather, they saw uncertainties as opportunities, and in following those opportunities they opened new worlds.

Let me close with a brief vignette about one of those explorers. The year after next we will be celebrating the 500th anniversary of Columbus's discovery of the new world, an event of unsurpassed importance in world history. As might be expected, Columbus was an astute observer of the natural world. While he was anchored off the coast of Jamaica, Columbus noted in his journal that it rained for about an hour every afternoon. Columbus also pointed out that the same thing used to occur in the Canary and Azores Islands, but that the rain had stopped since the trees on those islands were cut down. In other words, Columbus was one of the first people to observe the effects of human beings on climate.

I think it very appropriate that Columbus should have done so, because he was engaged on a great voyage of discovery, and today we find ourselves engaged on a similar voyage. We are changing the world in ways that it has never been changed before. And yet human beings, by their very nature, cannot help but change the world.

We have no reason to fear such changes. But we must keep our eyes open, and try to understand where we are going, and change course when we have good reasons to do so. We need not sail blindly into our future. But we must keep moving forward if we are to achieve the complementary goals of an economically healthy and environmentally sound world.

D

OSTP-JTR-1990-3

MEETING THE CHALLENGES OF THE 1990's

J. THOMAS RATCHFORD
Associate Director for Policy and International Affairs
Office of Science and Technology Policy
Executive Office of the President

Keynote Address to the
National Technical Information Service Users Conference
Washington, D.C.
March 29, 1990

Unlike the Atomic Age or the Space Age, it is hard to say exactly when the Information Age began. But the explosion of information that we face on a daily basis is undeniable. Whenever I have any doubt of that, I just look at my in-box.

The National Technical Information Service and its predecessor agencies, dating all the way back to the Publication Board of the Office of Scientific Research and Development in 1945, have played a key role in managing and disseminating the ever growing volume of scientific and technical information. Today the NTIS is in the process of change, as it has been throughout its history. That is appropriate in a way, both because the NTIS acts as an agent of change and because the products and services that it provides are themselves constantly changing. The question then becomes, What kind of NTIS will emerge from this process? And in general, How does the Federal Government plan to handle the generation and distribution of scientific and technical information?

I will not be able to answer those questions today. Rather, I thought I would explore some of the institutional structures that are in place to deal with them and some of the challenges we will face in the 1990s. A number of entities are now considering STI issues -- building on the several excellent reports that have been produced in recent years -- and at the end of my talk I'll discuss some of the directions in which we might go.

One of the bodies that will be heavily involved in STI issues is the Office of Science and Technology Policy, for which I am one of four associate directors. OSTP was established in 1976 by the National Science and Technology Policy, Organization and Priorities Act, which, by the way, also includes a number of provisions concerning STI. The office is designed to serve two main functions. The first is to provide the President and the rest of the Executive Branch with the best possible information, analysis, and advice about how science and technology influence national and international policy. The second is to help maintain the health and productivity of science and technology in this country. Allan Bromley, the Director of OSTP, refers to the first of these responsibilities as science and technology for policy and to the second as policy for science and technology.

A number of changes have recently been occurring within OSTP that have greatly enhanced our ability to carry out these responsibilities. The first was that Allan was named Assistant to the President for Science and Technology, which is a higher position than all previous science advisors have held. That elevation of status made Allan a full member of the several important policy-making bodies within the White House, including the Economic Policy Council, the Domestic Policy Council, and the National Space Council, and he works closely with the Competitiveness Council and the National Security Council. When combined with the interest that Dick Darman and John Sununu have in science and technology, it is obvious that science and technology are much closer to the center of White House thinking than they have been in the past.

So far, Allan has gotten high marks for the job he has been doing. A long article in Chemical and Engineering News earlier this month noted that Allen has brought a "breadth, coherence, and visibility to science and technology of a sort never before seen in Washington." It also said, "The opportunity has never been grander in the science office, and [Bromley] and his staff are under pressure not to fail." Damning with great praise is what I might call that!

Fortunately, we now have enough staff to spread the pressure around. For the first time in its history, the office is about to have all four of the Presidentially nominated and Senate-confirmed Associate Directors called for in its founding legislation. James Wyngaarden, the Associate Director for Life Sciences, was confirmed last November at the same time as I was. Within the next few weeks, we expect Eugene Wong, former Professor of Electrical Engineering and Computer Science at the University of California at Berkeley, to be confirmed as Associate Director for Physical Sciences and Engineering, and William Phillips, who has been Science Advisor to the Governor of Missouri and Senior Vice President of Science and Technology for Mallinckrodt, Inc., to be confirmed as Associate Director for Industrial Technology. Together, Allan expects the four associate directors to work collegially with him and with the rest of the staff in addressing issues of science and technology that rise to the presidential level.

Besides OSTP, there are two other important groups that influence federal science and technology policy within the White House. The first is the President's Council of Advisors on Science and Technology, or PCAST. This group consists of 12 distinguished representatives of private industry and academia, with Allan as its chairman, and reports directly to the President. PCAST held its second meeting last week, after holding its first meeting in February at Camp David with the President. One of the main subjects it discussed last week was high performance computing and communications, and specifically the importance of a broadband national network that could carry not only STI but other forms of information. It looks very much as if PCAST is going to be a vigorous addition to the federal science and technology policy scene.

The other important policy body is the Federal Coordinating Council for Science, Engineering, and Technology, or FCCSET, which was created by the same 1976 legislation that created OSTP. Its charge is to review and coordinate science, engineering, and technology activities that cut across the missions of more than one federal agency.

In the past, several FCCSET committees--such as the Committee on Earth Sciences and the Computer Research and Applications Committee--have demonstrated the great advantages to be derived from effective coordination of cross-cutting issues in science and technology. For example, over the past several years, the Committee on Earth Sciences has organized all of the formerly disconnected research on global change into the U.S. Global Change Research Program, which is now a coherent, government-wide approach to the scientific understanding of the global environment.

By the way, the Committee on Earth Sciences has recently endorsed the activities of the Interagency Working Group on Data Management for Global Change, which is addressing some of the key STI issues in the earth science area. In particular, the working group has already begun to investigate the technical standards needed to facilitate the exchange of data among agencies and to the world's scientific community over a variety of electronic networks, regardless of host computer for the data. The Interagency Working Group is also attempting to bring to the attention of other national and international groups the necessity of network coordination, so that the dissemination of environmental data and information can be accomplished in a cost-effective manner.

We are now in the process of reorganizing and revitalizing the FCCSET structure. We had the second meeting of the full FCCSET--chaired by Allan--a couple of weeks ago. At both that meeting and the first meeting we had excellent representation from the agencies, with Cabinet secretaries and heads of independent agencies constituting the majority of those in attendance. In general, we foresee a substantially altered and enhanced role for FCCSET within the government. For the first time since the FCCSET was created, it should be functioning as it was designed to function.

FCCSET is now in the process of establishing and populating several umbrella committees in such areas as the physical, mathematical, and engineering sciences and education and human resources. Various subcommittees will be formed under these committees in areas such as high-performance computing.

We are now considering the most appropriate position and role for STI issues within this committee structure. I will come back to this subject at the end my of talk, because I believe it offers the possibility of real change in federal STI approaches and because I would like to get your input on how best that change might occur.

First, though, I thought I would discuss some of the characteristics of STI and the emerging issues that the federal government will have to confront.

SCIENTIFIC AND TECHNICAL INFORMATION

The emerging Information Age and the explosive growth of the technologies underlying that information are forcing rapid change for STI. To take NTIS as an example, sales of print and microfiche documents have declined 50 percent since 1980, while sales of computer products and online searching of NTIS databases via private vendors are growing. These changes will bring new problems, but they also offer a number of new opportunities.

Scientific and technical information (STI) has several unique characteristics. First is the character of the information, comprising three broad types--traditional bibliographic information, numeric data such as that arising from physical measurements or computations, and graphic images such as those produced by space-based observing systems. All of these types generally have distinct sources, separate formats, and often completely separate processing systems, but the trend is clearly toward electronic or optical systems that will store and transmit all three types.

A second distinguishing characteristic of STI is its audience. Scientific and technical information is used primarily by specialists. Relatively little STI is directly of interest to a broad audience, although summary conclusions or findings based on that information may be. Thus the patterns of dissemination and the issues and needs regarding access to STI are rather different than those arising with, for example, census data.

A third distinguishing characteristic of STI is its sheer volume and growth rate. STI is the primary product of a major Federal activity--research and development--in which the government invests over $70 billion per year. As a result, the Federal government is the world's most prolific generator of STI.

The magnitude of science and technology information is generally unappreciated. According to a recent report by the Office of Technology Assessment, the bibliographic Federal S&T information base includes an estimated 4 million technical reports, a volume that is expanding at the rate of 200,000 new technical documents per year. Added to that are rapidly proliferating databases containing, in the earth sciences area alone, about 100 terabytes of numeric and graphic data--or over 10 times as much data as in the entire Library of Congress.

By comparison, the database of the Social Security Administration, one of the largest non-technical databases in the nation, comprises just 1.3 terabytes, or somewhat over 10 percent of the total information in the Library of Congress. The U.S. Bureau of the Census estimates its 1986 digital database at 2.6 terabytes. Thus the volume of STI is already one to two orders of magnitude larger than the volume of other kinds of archived materials.

Moreover, this staggering amount of information is a mere trickle compared to the flood of STI that is expected in the 1990's. Between now and 1998, a key NOAA database is expected to add some 200 additional terabytes of STI. Space-based systems are expected to send NASA ground stations more than 5,300 terabytes of STI. Overall, STI is expected to increase by two orders of magnitude--a hundredfold--during the 1990's.

Present STI budgets and technology do not even allow for such a quantity of data to be stored, much less efficiently managed or made available to intended users. Coping with a flow of such unprecedented volumes of information is clearly a monumental task.

If we are to gain the full return on the federal government's investment in research and development, we must meet the challenge of storing, managing, and disseminating STI on a far larger scale that we do today. And that return is vitally important. In an increasingly competitive world, our economic fortunes as a nation are closely tied to our success in translating new knowledge promptly into new products and services. To survive in the Information Age, we must learn to be information efficient--both in generating new information and in disseminating and using it.

USING SCIENTIFIC AND TECHNICAL INFORMATION INTERNATIONALLY

More than ever, scientific and technical information is now a global resource--one that will be essential to cope with the global challenges ahead. There are an estimated 80,000 S&T journals published around the world, and perhaps 10,000 key, front-line journals. Yet with emerging, broad-band communication networks, it is entirely possible to share this enormous volume of information--and the far larger volumes of graphic and numerical data--around the world.

New forms of scientific journals are emerging, as various disciplines experiment with electronic publishing. In the field of crystallography, for example, it is now becoming accepted--even required--for an investigator to deposit an electronic file of the primary diffraction data on which a proposed crystal structure, published in the conventional way, is based. In the field of DNA base sequencing that is intimately linked to the human genome project, investigators turn over newly determined base sequences to one of several electronic repositories. And my former institution, the American Association for the Advancement of Science, is starting a new and totally electronic journal to "publish" research such as the voluminous graphic and numeric output of supercomputers that simply does not fit within the format of traditional journals. These examples are enough, perhaps, to establish that we are looking at a new trend in the scientific literature, a trend that can only accelerate.

Another trend that will influence the international use of S&T information is the growth of megaprojects, which by their very nature must collect, manage, and disseminate large volumes of information. Some of these projects are inherently international, with widely distributed sources of data. The Global Change Research Program is one example. The Human Genome Project is another. But even where the source of the data is not dispersed but centralized, as in the SSC, the users of the information will be international.

I think it important to point out, however, that making data available internationally is not as simple as we might wish. One group of barriers are technical--a lack of standards and common formats in the way we store, communicate, search, and manipulate data. As I mentioned earlier, the Interagency Working Group on Data Management for Global Change is already addressing these problems within the Federal government, and that is a start. One solution may be the creation of specialized data centers around the world that are equipped to interact with and help many different users. But it is clear that we have some ways to go before we have unbuilt the current Tower of Babel. Given a very fast-moving set of technologies and a very competitive commercial environment, an agreed-on, universal STI system is still far off.

In addition to technical barriers, of course, there are also policy barriers to the free international flow of S&T data in electronic form. One is concern about the implications of such data flows for national competitiveness. Clearly, there will have to be improved reciprocity before such concerns will disappear. A second policy issue touches on national security and national sovereignty. In the Earth Science area, for example, much of the data is gathered by satellites--and some countries are very concerned about the gathering and use of data about their country by third parties. There is also the PTT problem--the tendency of national Postal, Telephone, and Telegraph monopolies in some countries to want to tax trans-border information flows. In effect, they want to charge by the bit instead of by the wire or the channel.

Finally, there are economic and human barriers. It costs money to operate electronic data centers, and someone must pay. However, it is my guess that the people problem--training vast numbers of people to interface with the technology of the data bases and resolving intellectual property and related market issues, for example--are much more intractable than the purely technological barriers. Lack of agreement on such issues has the capacity to hinder international dissemination of S&T data in electronic form.

Despite such problems, it is clear that we are entering in a real way and at an ever more rapid rate into a digitally-based, Information Age. How we cope with the challenges of the 90's in the STI field will help to shape that world, both because of the catalytic effect of S&T information, and because the sheer volume of S&T data--if we can learn to manage it so that it is information and not just bits--will help to forge the techniques on which the Information Age will depend.

CONCLUSION

In this period of rapid change for STI, the management of scientific and technical information must keep pace. We must vigorously explore the emerging new technologies and reexamine our institutional structures for STI. We must increase our flexibility to respond to new needs and new opportunities. We must give adequate support to the planning and maintenance of our critical data repositories. And, finally, we must seek to improve access to STI wherever possible.

As part of the restructuring of FCCSET mentioned earlier, a new FCCSET committee is being established called the Physical, Mathematical, and Engineering Sciences Committee. This committee will have a subcommittee underneath it that deals with high performance computing and communications.

One option for STI would be to create a parallel, free-standing subcommittee on STI to deal with standards, dissemination, access, and related issues. Another might be to create or expand such working groups as CENDI (for Commerce, Energy, NASA, NLM, Defense Information) or the Interagency Working Group on Data Management that I referred to earlier.

Whether through these mechanisms or some other, we must address the issues posed by the special character and explosive growth of Federal scientific and technical information. If we do not, we risk failing to reap the benefits of the emerging Information Age.

The challenge I would leave with you is to let us know at OSTP what you think would be the best way to organize and carry out the federal government's STI activities. As the users of products from NTIS and other governmental information sources, you are in a unique position to gauge the successes and failures of federal efforts. Allan Bromley runs an Office of Science and Technology Policy that is receptive to your input. You should take advantage of that.

OSTP-DAB-1990-11

BIOMEDICAL RESEARCH: CRITICAL ISSUES FOR THE 1990'S

D. ALLAN BROMLEY
Assistant to the President for Science and Technology
and Director, Office of Science and Technology Policy
Executive Office of the President

Remarks at the Public Affairs Symposium of the
Annual Meeting of the Federation of American Societies
for Experimental Biology
Washington, D.C.
April 2, 1990

It may seem incongruous for a lifelong physicist to be addressing a group of biologists about critical issues in biomedical research, though I should emphasize that I am an experimental physicist. Still, I have no doubt that some of the traditional arrogance of physics has preceded me into this hall. I once heard a biologist refer to a physicist as someone who, when he sees something that works in practice, wonders if it will work in theory.

Still, I find it interesting that as the two disciplines evolve, they are becoming more and more similar. The impact of physics on biology is well known, from Max Delbruck and the phage group to Francis Crick and DNA to all of the new imaging techniques that are now available. But biological thought has also had a strong, though less well recognized, impact on physics. Many of the first instances of chaotic behavior were found in biological systems; in general, the theory of chaos has revealed an indeterminacy in large-scale physical systems that was once thought more characteristic of biological systems. More broadly, biology has produced ideas about hierarchical structure and evolutionary processes that have subtly but powerfully shaped the way we think about the physical world.

THE DECADE OF THE BRAIN

One of the best examples of the convergence of physics and biology can be seen in the theme of this year's meeting: the function of the nervous system. If we are ever to understand the brain and its disorders, we will have to draw on disciplines from throughout the sciences: neuroanatomy, molecular biology, computer science, psychology, to name just a few.

It is propitious that you chose the nervous system as the theme of this conference, because, as you might know, this is a subject on which the federal government has also focused its attention. Through a joint resolution passed by

Congress and signed by the President, the 1990s have been designated the Decade of the Brain. This declaration serves two complementary functions. It looks to the past in recognizing the dramatic advances that many of you have made in understanding the brain and its disorders. And it looks to the future in highlighting the formidable challenges that face us in understanding basic processes like learning and behavior and in developing ways to prevent and treat diseases of the nervous system.

As many as 50 million Americans--one in every five of our citizens--suffer each year from disorders and disabilities involving the brain, including mental illnesses, Alzheimer's disease, AIDS-related dementias, addictive disorders, and traumatic injuries. Great progress has been made in understanding and treating these afflictions. Drug treatments and behavioral therapies have improved the lives of many millions of people. Yet we still have a long way to go in dealing with this source of great human suffering.

Currently, the federal government spends over a billion dollars on research in the neurosciences. During the 1990s, this funding should grow in parallel with funding for other high-priority areas of biomedical research. At the same time, the Decade of the Brain should increase public awareness and understanding of the brain and its disorders and galvanize the scientific community in exploring existing knowledge and promising directions in the neurosciences.

The Office of Science and Technology Policy is taking the lead in planning and coordinating the Decade of the Brain. In consultation with the House Committee on Appropriations, OSTP has created a panel to plan the effort. We are also consulting with the many government agencies, academic and other extramural scientists, and voluntary health organizations involved in the research. As such, we are engaging in OSTP's traditional function of reviewing and coordinating areas of science and technology that cut across more than one federal agency.

FUNDING FOR BIOMEDICAL RESEARCH

OSTP also has the charge of working closely with the Office of Management and Budget in reviewing the distribution of federal funding for research and development, including biomedical research. I am working closely with budget director Richard Darman to ensure that the staffs of OSTP and OMB collaborate at all stages of the budget process. Lou Sullivan has already discussed many of these subjects in his remarks, but I thought that I would touch upon them again in the context of OSTP's role in the Administration.

I know that many of you are quite concerned about the funding rates for grants in the life sciences. But I should point out that this problem is not limited to biomedical research. Last year, for the first time ever, the fraction of excellent, peer-reviewed, new proposals that were actually funded fell below 30 percent not just at NIH but also at NSF. This problem is particularly acute for new investigators, although programs like the First Individual Research Award Since Training (FIRST) program at NIH provide at least some measure of support for beginning researchers.

Being denied funding is a great misfortune not only for young investigators. It is also a great misfortune for a nation that desperately needs to recruit more young people into scientific careers.

There are several reasons for this state of affairs. The most obvious is a stabilization of the growth of federal support for biomedical research. Between 1982 and 1989, the NIH budget doubled, going from $3.5 billion to $7.1 billion. The total number of research project grants funded increased from about 15,500 to about 20,000. However, since 1987, the rate of growth of nonearmarked funds has slowed--though total funding has continued to grow and the total number of grants will increase in FY 1991. Nevertheless, as a result of decisions made in the mid-1980s to increase the number of new and competing grants, the number of new and competing awards has hovered around 5,000 for several years.

Much the same thing happened in physics in the 1970s. Throughout the 1960s, federal funding rates increased dramatically, and many new people entered the field. Then, in the 1970s, funding not only quit growing but declined. This caused a great deal of hardship for people already in the field and convinced a generation of young people not to pursue physics as a career. Only in the latter part of the 1970s and the 1980s did the field again recover.

Another reason for the tight funding situation derives from the traditional practice of making multiyear awards. These awards generate outyear commitments that NIH feels it must meet before new awards are made. However, when the rate of growth of the budget slows, such commitments limit the ability to make new awards.

NIH is making adjustments to try to keep the level of new awards up, such as reducing the size of its outyear commitments. But this, too generates problems, and it has to be done outside the traditional peer review system.

The peer review system is also having trouble discriminating among the many proposals received. As recently noted by Congress, approval rates by peer review groups have risen from 67 percent in 1970 to 95 percent today. This trend, along with a dramatic increase in the number of applications received, has reduced award rates by raising the denominator in the approval fraction.

Finally, we must recognize that, to some extent, we are the victims of our own success. It has been a remarkable decade not only in biomedical research but throughout the sciences. The increased funds devoted to research during the 1980s produced exactly what they were designed to produce: a wealth of exciting new opportunities. The number of high-quality applications is growing, as is the number of applicants. We must find some way of dealing with the remarkable progress that has been made.

THE ROLE OF OSTP

Many factors enter into the allocation of funding across scientific disciplines, and not all of them strictly scientific. There are many national needs clamoring for attention--including the federal budget deficit, the AIDS epidemic, drug addiction, and education--and some very difficult calls have to be made. That is why we elect a

President--to make those difficult calls--and President Bush, in the budget he sent to the Hill, has made the hard decisions that were needed.

But I know that I speak for the President in saying that this Administration places a very high priority on science and technology, and particularly on the efforts of individual investigators. As I have said many times in the past, small, university-based, individual-investigator research is the heart and backbone of American science. Funding for "small science" must be guaranteed if American science, as a whole, is to flourish.

OSTP is not a large office; we have only about 40 full-time personnel. But we sit at an important crossroads in American science: at the intersection of the Executive Office of the President and the scientific community, and in the crossfire between the President and Congress on matters of science and technology. One of our legislated responsibilities is to ensure the health of the science and technology base in the United States. Without adequate funding for individual investigators, that base cannot remain healthy.

OSTP's Associate Director for Life Sciences, Jim Wyngaarden, has devoted considerable time to this issue and has brought it to the attention of a number of people within the Administration. Funding for biomedical research has also been a topic of discussion among the President's Council of Advisors on Science and Technology, which includes both Dan Nathans and Bernadine Healy from the biomedical community. The second meeting of PCAST was held the week before last, and at both that meeting and the first meeting at Camp David the President and several of his top aides listened with considerable interest to the topics being discussed. As the funding cycle for Fiscal Year 1992 gets under way, I can assure you that your concerns and recommendations are making themselves heard.

THE USE OF ANIMALS IN RESEARCH

There are a couple of other areas of biomedical research in which OSTP is particularly active, and even though Lou has already discussed them I thought I would mention them briefly. We, too, strongly support the use of animals in biomedical research and condemn the illegal activities of those radical animal advocates who would seek to disrupt this research.

No reasonable person can deny the tremendous impact that research using animals has had on human health and well being. A hundred years ago, the leading cause of death in the United States was tuberculosis, and a quarter of all people born died before their 25th birthday. Today, the leading causes of death are heart disease and cancer--diseases predominantly of old age--and fully 97 percent of all people born live past the age of 25.

Some of this increase in health was due to better sanitation and nutrition, but animal research has eliminated many formerly terrifying diseases as significant causes of death and illness. It has also brought us much new understanding of ourselves and of the world we live in. Over two thirds of the research projects that led to the Nobel Prize in physiology or medicine directly involved animal experiments, and nearly half of the biomedical investigations carried out in the United States use laboratory animals.

Jim Wyngaarden and I are both personally on record supporting legislation that would bring federal sanctions to bear on those who engage in illegal and violent acts against animal researchers and their work. In our view, such legislation would strengthen the resolve of scientists to go forward with their essential work. It would also encourage young people to enter research careers who may now be deterred by the prospect of harassment from animal activists and the ever-present possibility of their life's work being destroyed by a night of violence.

INTEGRITY IN RESEARCH

Another area in which OSTP is active involves the integrity of scientific research. In the last several years, the impression has grown that scientific misconduct is a serious problem in our research enterprise. I believe that impression to be entirely mistaken, yet the impression itself must be dealt with.

The Office of Scientific Integrity at NIH has recently been gathering data on this subject to provide a basis for possible actions. Over the past 10 years, the Public Health Service, including NIH, has supported perhaps 50,000 different scientists. Out of that total, there have been somewhere around 50 confirmed cases of misconduct. So trouble has surfaced in something like one in a thousand cases. That, I would submit, is a better ratio than in virtually any other profession.

Nevertheless, no responsible member of the scientific community questions for a moment the obligation to account for support received from the taxpayer. Even though the rate of misconduct is very low, the public deserves to know that research is being conducted honestly and that problems are dealt with quickly and fairly.

To help provide these assurances, OSTP has held a series of meetings with representatives from the various agencies that support research and development. The ultimate goal of these meetings is to develop a common policy statement designed to foster scientific integrity and deal with misconduct in science. The policy statement would not specify a unified set of policies to be followed by all federal agencies. Rather, it would set out common principles that could be incorporated into the policies developed by individual agencies.

CONCLUSION: A CONSTITUENCY FOR THE FUTURE

This issue of misconduct relates to the final topic I want to mention today, that of fostering a constituency for science and technology in this country. Because of the committee structure on Capitol Hill, funding for research and development is in direct competition with programs that have very active and vocal constituencies.

Funding for NIH is dictated by the same appropriations committees that handle the Departments of Education and Labor. Funding for NSF comes through the same appropriations committees that handle Veterans Affairs, Housing and Urban Development, and a number of independent agencies. If funding for research and development is to be increased in any given year, it can only be at the expense of these other programs.

Agencies representing groups like Veterans or Labor have natural constituencies that can be expected to provide strong support for the programs affecting them. Research and development have no such constituency. I was talking with Barbara Mikulski about this very issue not long ago, and she pointed out that she hears from advocates for the veterans and the homeless--two groups in direct competition with funding for NSF--on a daily basis. But she said that she very rarely hears from scientists.

The people in this room are part of the core constituency for science and technology, as are the approximately 5 million other individuals employed as scientists and engineers in the United States. But I also want to mention another, much broader, constituency for science. We must foster an appreciation and concern for science among the general public. This will require, first, increasing the level of scientific literacy among the public, so that they are able to appreciate the vital role of science and technology in almost every aspect of daily life. It will also require a substantial outreach program by the scientists and engineers of this country, to explain how your research affects them and how it can contribute to the national interest.

I believe that we now have a unique opportunity to foster this kind of constituency. There is a great deal of concern in this country about the position of the United States in the global economy and our loss of competitiveness in key industries. By demonstrating the ever increasing importance of science and technology to economic competitiveness, we can forge the link between investing in research and development now and our future economic prosperity. We can forge a constituency for the future, a collective sense for the great advances in science and technology that are yet to come.

SCIENCE AND TECHNOLOGY IN THE BUSH ADMINISTRATION

D. ALLAN BROMLEY

ASSISTANT TO THE PRESIDENT FOR SCIENCE AND TECHNOLOGY

EXECUTIVE OFFICE OF THE PRESIDENT

Duke University

Durham, North Carolina

January 25, 1990

Thank you Dr. Brodie. It's a great pleasure to be here in North Carolina, and particularly here at one of our nation's foremost universities, because now I can experience for myself the North Carolina hospitality I've heard so much about back in Washington. You might know that two of my office's four associate directors consider themselves Tarheels first and foremost. Dr. James Wyngaarden, OSTP's Associate Director for Life Sciences, was Chairman of the Department of Medicine here at Duke until he left to become the head of the National Institutes of Health. I notice that when he went to the Senate for his confirmation hearings he still gave his legal residence as Durham, North Carolina.

And OSTP's Associate Director for Policy and International Affairs, Thomas Ratchford, who is with me here today, grew up near Charlotte, graduated from Davidson College, and even married the daughter of a Davidson faculty member. In fact, one of Tom's classmates at Davidson was Governor Martin, and the two of them remained friends in Washington, when Jim became a Congressman and Tom was working on the Hill. I'm not sure that I understand all nuances of the relationships between North Carolina institutions of higher education, but it is interesting that the governor and his science adviser, Earl MacCormac, were members of the Davidson faculty as well. So the links between our office and the North Carolina statehouse are very strong, and I expect to draw heavily upon the expertise here in North Carolina in doing my own job.

One of the reasons why I've come to North Carolina today is to learn more about some of the initiatives that you are undertaking in the area of science and mathematics education, and I've just finished a very interesting tour of the North Carolina School of Science and Mathematics. Tom has told me that North Carolinians tend to think of their state as a valley of humility between two mountains of conceit, but there is no reason for humility when it comes to the School of Science and Mathematics. It is a superb, unparalleled institution that has a great deal to teach the rest of the country about how to train and inspire the scientists and engineers of the twenty-first century. I firmly believe that one of the most important responsibilities facing the Office of Science and Technology Policy lies in the area of science and mathematics education, and we expect to devote a considerable portion of our time to the subject.

I would like to come back to education in a few moments, because the federal government is now considered some very promising initiatives in this area, but first I thought that I would describe the Office of Science and Technology Policy and some of the activities that we have initiated. OSTP was established by Act of Congress in 1976 to serve two major functions. The first is to provide the President with accurate, objective information on science and technology as it affects public policy--in short, science and technology for policy. This provision of advice on science and technology has become ever more important as science and technology has increased their influence on national and international policy. Nearly half of the bills that are introduced in Congress are estimated to entail a substantial component of science and technology, and I can tell you from personal experience that many important decisions affecting the Bush Administration require a careful consideration of science and technology input.

I might note, in this regard, that the states have long recognized the importance of science and technology to policy. Over 40 of the states now have positions equivalent to that of science adviser. For that matter, the first state science adviser position to be established in the country was established here in

North Carolina, in 1963, the Earl MacCormac now holds. I might hope that the preeminence of North Carolina in science and technology could be attributed, in no small measure, to the existence of such an adviser.

OSTP's first priority is to provide advice to the President, but the office was established by Congress and has the additional responsibility of coordinating its efforts with initiatives coming from the Hill. We are now in the process of rebuilding our bridges with Congress and expect close cooperation between our office and the Hill in the years ahead. I have accepted an invitation from Senators Gore and Danforth to meet for informal breakfasts on a regular basis with seven to ten Senators to discuss science and technology, and I have already started meeting with Congressional staff to express OSTP's position and hear from them about the issues they consider important.

OSTP's second major task is to work to maintain the health and productivity of science and technology in this country--in short, to establish policy for science and technology. One important aspect of this task is our coordination of R&D within the federal government. This can be an extremely difficult function, with science and technology as pervasive as they are in the federal government.

But let me describe a recent project that I see as a model for our coordinating efforts. Last summer the Committee for Earth Sciences, which consists of representatives from all of the federal agencies conducting research on the global environment, released a working group report on the federal government's research plan for global change during fiscal year 1990. The report sets up a coordinated national strategy and implementation plan for all federal research on global change. The President's FY 1991 budget, which will be released next Monday, is going to call for a substantial increase in research on global change, and because of the coordinating efforts of the Committee on Earth Sciences this funding will be much more effective than if each agency were acting independently. This is the kind of coordination that I would like to extend to a number of different areas of science and technology, such as materials science, energy policy, biotechnology, and education.

The coordinating activities of OSTP are carried out largely through an entity known as the Federal Coordinating Council for Science, Engineering, and Technology or FCCSET. The members of

FCCSET are appointed by the head of each agency with substantial R&D funding. Typically, these members are the top science administrators at each agency, so the FCCSET member from the National Science Foundation is the director, and the FCCSET member from the Department of Energy is the head of energy research.

We held the first full meeting of FCCSET under the Bush Administration yesterday afternoon, and we have ambitious plans to reorganize and revitalize the FCCSET structure. We are setting up a number of committees under FCCSET, including a Committee on Human Resources, a Committee on the Social Sciences, and so on. Like the Committee on Earth Sciences, which is a FCCSET committee, each of these committees will be charged with overseeing and coordinating large areas of R&D funding that cut across agency mandates. In this way, FCCSET will be able to bring a new level of cohesion and organization to federal funding of science and technology.

One problem with the FCCSET mechanism, however, is that it makes no provision for input from the private sector to decision making at the highest levels of government. To that end, the President will, very soon, announce the membership of the

President's Council of Advisers on Science and Technology, or PCAST, which the President has asked me to chair. This will be a group of 12 distinguished, broadly based individuals from academia and industry who will report directly to the President and, at his request, examine a broad range of issues in science and technology.

In addition, PCAST will have the authority to form ad hoc panels of private sector executives, researchers, and academics to parallel the committees established under FCCSET. By having the PCAST panels and the corresponding FCCSET committees focus on related issues, the private sector will be able to provide input to executive branch decision-making in a way that it never has before.

President Bush has told me that he plans to host the first PCAST meeting, on an informal basis, outside of Washington early next month and that thereafter he plans to participate personally in Council meetings to the extent that his schedule allows. This will give PCAST much more direct access to the President than has been the case in recent years.

Finally, I would be remiss in describing the structure of OSTP if I did not describe the roles of the office's four associate directors. I have already mentioned Drs. Ratchford and Wyngaarden, but for the first time in the history of OSTP we expect to have all four of the Associate Directors called for in the office's founding legislation. Last week the President announced his intention to nominate Eugene Wong as the Associate Director for the Physical Sciences and Engineering and William Phillips as the Associate Director for Industrial Technology. Dr. Wong has been Professor of Electrical Engineering and Computer Science at the University of California since 1962, and Dr. Phillips has been yet another science adviser, in his case to the Governor of Missouri, as well as President of the Missouri Advanced Technology Institute and Senior Vice President for Science and Technology at Mallinckrodt, Inc. I consider OSTP very fortunate to have attracted two individuals with such experience and knowledge, and I look forward to their speedy confirmation by the Senate.

My intention is that the four associate directors and myself will work together collegially to address the issues involving science and technology that have risen to the Presidential level. We will also keep a watchful eye on emerging issues in science and technology and, when necessary, develop recommendations for appropriate actions in those areas.

As I mentioned, we will be working on a wide variety of issues at OSTP over the next few years. For instance, since I was confirmed last August, much of our time has been spent on three subjects: the effects of science and technology on economic growth, the environment and global change, and science and mathematics education.

These three areas may seem quite different, but in fact they have at least one thing in common. They all entail investments in our future--investments in this country's science and technology base, in the protection of the environment, in the education of our young people. In general, the Office of Science and Technology Policy is the entity within the Executive Office of the President that focuses most exclusively on the future, and particularly on the long-term future. This development of longer-range strategies and their implementation, which is a major strength of our international competitors, is one of the greatest challenges facing our country today.

I want to use education as an example, both because it has the longest time frame, and because it is perhaps the most important of the three in determining our future national well-being. When giving speeches, I often lament the education that the precollege students in this country receive, but with this group I don't think that will not be necessary. If your students are like mine, you are already painfully aware of the educational gaps of even quite intelligent, highly motivated students. I once had a graduate student at Yale, who had been an undergraduate at Harvard and is now an internationally known physicist. However, the first sentence of his Ph.D. thesis, when I received it in draft, read: "This field of research is so virginal that no human eyeball has ever set foot in it."

At least that student made it to graduate school. Most students are lost to science and engineering well before that--in college, in high school, or even earlier. In fact, in reforming science and mathematics education in this country, elementary school has to be the first area of focus. In the very earliest grades, second grade and third grade, science and mathematics are among students' favorite classes. By high school, those same classes are among their least favorite. Somewhere along the way we are losing them, not only as scientists and engineers but as people who are interested and conversant in the science and technology that pervade our society.

I'm sure you are familiar with the statistics, but let me remind you of some that I find particularly alarming. Between 1980 and 2000, the population of 18 to 24 year olds will have declined by 19 percent, even as the need for scientists, engineers, and technical workers continues to grow. Furthermore, among college freshmen, interest in science and engineering has declined substantially. Over the past 20 years, interest in science and engineering has dropped by a third. Interest in mathematics has dropped by a quarter in the past 7 years. Interest in computer science, where the greatest shortages of trained personnel are predicted, has dropped by fully two thirds in the last 4 years.

This declining interest in science and mathematics could not come at a worst time for this country. Already, American students fail to meet the need for scientists and engineers in many fields, and if not for a substantial influx of foreign students who chose to stay in this country, shortages of these personnel would be acute.

Furthermore, an increasingly greater proportion of jobs in this country require people who are well-versed in mathematics and science and have greater facility with higher order reasoning skills than most high school and college graduates now have. If the schools of this country cannot produce the skilled workers demanded by tomorrow's workplace, our standing in the world economy will inevitably suffer.

Finally, the declining interest in science and technology parallels a much broader loss of scientific literacy among the general public. If the public cannot at least appreciate the nature of the issues involving science and technology, quite apart from contributing to their resolution, they inevitably will tend to become alienated from society. This is a trend that no nation can long endure.

The statistics are indeed grim, but there are many hopeful signs of change. I saw one of them this morning: if America can still produce schools like the North Carolina School for Science and Mathematics, we need never worry about completely running out of world-class scientists and engineers.

President Bush is also very concerned about education, and even though education will remain predominantly a state and local activity, the initiatives emerging from the White House have the potential to make a real difference. Last April he submitted to Congress his Educational Excellence Act of 1989, which would strengthen and reform education by rewarding excellence, encouraging flexibility, and requiring accountability.

In the area of science and mathematics education, the act would support the establishment of magnet schools in mathematics and science very similar to the North Carolina School of Science and Mathematics. It would also set up a National Science Scholars Program to provide college scholarships to high school seniors who have excelled in the sciences and mathematics, and I have no doubt that many of those scholarships would come to North Carolina students.

Then, last September, President Bush convened the Educational Summit in Charlottesville, which was only the third time in our nation's history that the President of the United States has gathered the nation's governors to address a single issue of national importance. I accompanied the President to Charlottesville, and even though a great deal of skepticism surrounded that meeting, I believe that it has had a truly remarkable influence. I recently returned from Hawaii--where it rained all week and I managed to catch a terrible cold--and in talking with governor Waihee he said that the Education Summit was the first time he could remember a President sitting down and actually listening to what the governors had to say. Since then, according to the governor, educational bills have been pouring into his office from the statehouse, largely because of the visibility and momentum given to this issue by the Educational Summit.

One of the most important decisions made at the Summit was to pursue the development of national goals in education--not national curricula, since these would imply a degree of coercion--but standards against which performance can be measured. In this way, not only students but teachers, the schools, the states, and the federal government can receive a report card documenting their progress in education. Our office is now working with the White House staff and with the governors on those goals and on ways in which the performance of our educational system can be measured.

At the Summit, president Bush said that "We are here to put progress before partisanship, the future before the moment, and our children before ourselves." Bipartisan efforts will be crucial in reforming the educational system of this country, and in that light we in the administration are very interested in the educational initiatives that have been proposed in Congress. Congressman David Price, who will be joining us at a press conference in a few moments, has introduced a bill that would develop new curricula and technologies to teach science and technology and set up programs to train the technicians that will be in such short supply in the future. Congressman Tim Valentine, who is also here today, is similarly concerned with the state of science and technology in this country, and we expect to be working closely with both of these individuals on a wide variety of scientific and technological issues.

These are the kinds of effort we need to turn around the educational system in this country. We need to learn from the few stellar examples of educational excellence in this country and extend those lessons to children everywhere, from Research Triangle Park to downtown Washington, D.C.. We need to work together to renew our sense of the future, to promise our children and grandchildren that the educations they receive will be as good or better than the educations we received. There is much to be done, but we are headed in the right direction.

STATEMENT

BY

D. ALLAN BROMLEY,
ASSISTANT TO THE PRESIDENT FOR SCIENCE AND TECHNOLOGY, AND
DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ON

S. 324

NATIONAL ENERGY POLICY ACT OF 1990

WASHINGTON, D. C.
APRIL 5, 1990

STATEMENT

by
D. Allan Bromley,
Assistant to the President for Science and Technology, and
Director, Office of Science and Technology Policy

before the
Committee on Energy and Natural Resources
United States Senate

on

S. 324
National Energy Policy Act of 1990

April 5, 1990

Thank you for the opportunity to present the views of the White House Office of Science and Technology Policy (OSTP) on S. 324, the National Energy Policy Act of 1990. OSTP and the entire Administration share the committee's conviction that our national energy policy must be based on sound environmental, economic, and technical considerations. However, we believe that mechanisms now in place offer a significantly better chance of developing and implementing such policy than do the measures in the Act. The Administration, therefore, opposes enactment of S.324.

SCIENTIFIC UNCERTAINTIES REGARDING GLOBAL CLIMATE CHANGE

There is no question that human beings have significantly altered the composition of the atmosphere by burning fossil fuels, cutting down forests to greatly expand agriculture, and producing industrial chemicals such as chlorofluorocarbons. Over the past two centuries, the amount of carbon dioxide in the atmosphere has risen 25 percent. The level of atmospheric methane, a potent greenhouse gas generated by agricultural and industrial practices, has more than doubled.

Although scientists have predicted since the end of the nineteenth century that increases in atmospheric carbon dioxide would increase the temperature of the planet, our understanding of the relationship between greenhouse gases and global climate change remains imprecise and inadequate. The scientific challenge is great, and our inability to separate human impact from natural variability and the uncertainties surrounding temperature records compounds the problem. Nevertheless, few scientists would argue with the contention that if we continue to load the atmosphere with greenhouse gases, we will eventually experience some degree of warming.

Our general understanding of radiative forcing mechanisms in the atmosphere leaves unanswered the critical questions regarding how much warming will occur, the timing of any warming, impacts on sea level, rainfall and soil moisture, and the regional effects created by all of these factors. Those who are following the literature know that new, and sometimes conflicting results on the predictions for future global changes appear almost on a daily basis.

It is also important to recognize that developing an improved understanding of geophysical climate processes is only the first step in developing appropriate policies. Estimates of the human and social consequences stemming from actions that might be taken to curtail greenhouse emission, as well as those stemming from predictions on future warming and ancillary changes associated with it, must then be developed and used as the basis for policy formulation. Science and economics research aimed at developing necessary estimates and insights is a top priority for the Administration.

Our scientific research is making significant progress. Nonetheless, the state of the science remains highly uncertain. In fact, several recent studies suggest a move to more moderate predictions of the extent of global climate change and its potential impacts. For example:

- In January of this year, a National Academy of Sciences panel concluded that current climate change models predict a global warming closer to 2 degrees Celsius over the next fifty years, not the previous range of 1.5 degrees to 4.5 degrees Celsius.

- In December 1989, the American Geophysical Union revised earlier estimates of rise in sea level of between 20 and 120 inches by the year 2100 to a new estimate of between 0 and 30 inches.

- o Recently U.K. scientists have introduced a better representation of cloud processes in their global climate change model. The new estimate of warming for a doubling of CO_2 dropped to 1.9 degrees Celsius, down from the previous estimate of 5.2 degree Celsius.

- o In January of this year, NOAA reported new results from its global climate model, using more realistic ocean simulations. This model now predicts that even with a doubling of the current CO_2 levels there would not be warming in the Southern Hemisphere. Indeed, projections indicate some areas of the globe will be cooler.

Given this level of uncertainty in predictions about global climate change, it is clear we need to continue the aggressive research program being supported by various Federal agencies to understand more fully the ramifications of increased greenhouse gas emissions in the atmosphere and potential impacts that could be caused by global climate change. In the meantime, we should embark, on measures to reduce greenhouse gas emission only if those measures also serve other policy objectives. That is precisely what the Administration has done.

ADMINISTRATION ACTIONS FOR ENERGY AND THE ENVIRONMENT

I would like to now summarize several initiatives undertaken by the Administration that address some of the objectives of S.324. Then I will describe our recent progress toward establishing a comprehensive research program in the areas of energy and global climate change, as well as mechanisms -- both national and international -- that we have developed for formulating informed policy decisions and for implementing these decisions. These actions, in my view, constitute an effective response to the goals that we all share.

The Administration considers it imperative that we continue to develop, in cooperation with the Congress, a well-designed program for research into the effects of greenhouse gas emissions on climate. We must also evaluate the economic and policy aspects of potential responses. Such a program will provide the foundation essential for the development of a rational national energy policy that is economically and environmentally responsible.

I would also wish to emphasize the Administration's position that, pending the resolution of the significant scientific uncertainties surrounding climate change processes and their human and social impacts and concerns regarding economic and social dislocations stemming from efforts to limit fossil fuel use, our immediate focus should be on those actions that will reduce greenhouse gas emissions, but which can be fully justified for other reasons. For example, we have a commitment to phase out manufacturing and use of CFC's by the year 2000, ahead of the requirements of the current Montreal Protocol, provided safe substitutes exist -- these constitute 25 percent of our current greenhouse gas emissions. The Clean Air legislation currently under debate in the Congress will also provide substantial reduction in the emission of some of the greenhouse gases. A strong commitment to energy conservation is to be a major component of the Department of Energy's National Energy Strategy; and as an initial step in putting this strategy forward, the Department of Energy has already announced a series of conservation and renewable energy initiatives that are included in the President's FY 1991 budget request.

Turning from sources of these emissions to sinks, the Department of Agriculture's tree planting initiative (the planting of a billion trees on private land across America -- trees that could eventually absorb 13 million tons of carbon, annually) presented in the President's FY 1991 Budget, and our continued diplomatic discussions with countries such as Brazil aimed at protecting the remaining tropical forests, are key parts of our immediate response to this potential problem.

The Administration has already taken a number of additional steps that will enhance our understanding of, and response to, the potential effects of global climate change.

The President proposed in his FY 1991 Budget that funding for the U. S. Global Change Research Program be increased 57 percent over FY 1990, to $1.03 billion in FY 1991. The proposed funding would significantly expand research, data gathering, and modeling activities through a carefully balanced mix of ground-based and space-based research.

An underlying theme in all of the Administration's activities relative to potential climate change is that the strategy must be scientifically-based and technically and economically sound. It must also be dynamic -- responsive to new knowledge and ideas, and to global, environmental and international changes. A report on the wide ranging public hearings that represent a step in the process of formulating the National Energy Strategy, for example, has just been released.

FEDERAL RESEARCH POLICY AND COORDINATION

The Office of Science and Technology Policy is charged with reviewing and coordinating Federal R&D that cuts across the missions of more than one Federal agency, and with providing advice to the President on issues of science and technology policy that affect national and international policy. As Assistant to the President for Science and Technology and Director of OSTP, I chair two complementary councils -- one federal, FCCSET and one private sector, PCAST -- that provide information and advice. In addition, I chair working groups of the Economic Policy Council and the Domestic Policy Council related to science and technology issues. These groups, whose functioning I shall now describe, will accomplish the objectives -- and many more besides -- of the coordinating council proposed in S.324. Thus, the organizational changes proposed in S.324, I believe, are unnecessary. The establishment of a coordinating council proposed in S.324 would be duplicative and would not add significantly to the existing mechanisms.

S.324 also sets out specific R&D criteria that the propsed coordinating council is required to use as the basis for preparing "management plans" for the conduct of R&D in certain identified technologies. We do not believe the overly prescriptive nature of such an approach will be successful. The proposed approach does not adequately include the participation of the private sector technology developers and technology users. Most observers of R&D policy have found that successful government R&D occurs most frequently when the users or ultimate manufacturers of the technology are involved in the planning, conduct and testing of the applied technologies. S.324 does not provide adequate mechanisms for this critical private sector involvement.

Federal Coordinating Council for Science and Technology

The Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) was originally established in 1976 by Public Law

94-282, the National Science and Technology Policy Organization and Priorities Act, which also established the Office of Science and Technology Policy.

FCCSET is charged with providing more effective planning, coordination and administration of federal scientific and technological programs. This includes identifying research and development needs, and developing and reviewing in close cooperation with the Office of Management and Budget federal budget plans in cross-cutting areas of science and technology.

Research on global change is supported by a number of federal agencies and constitutes an exemplary case of common effort on a science policy issue. OSTP's coordinating function in global change research has been carried out largely through the Committee on Earth Sciences (CES), which is one of the committees under FCCSET.

The CES in turn has two subcommittees that deal with global change, the Working Group on Global Change, chaired by Robert Corell of the National Science Foundation, and a new Working Group on Adaptation and Mitigation Technologies, headed by John Knauss of the National Oceanic and Atmospheric Administration.

I would like to submit for the record a copy of the document "Our Changing Planet: The FY 1991 U.S. Global Change Research Program," which was developed by the CES Working Group on Global Change and which formed the basis for the President's FY 1991 budget request in this area.

The CES has integrated the efforts of the federal agencies conducting research on global change into the U.S. Global Change Research Program (USGCRP). The goal of the program is to reduce key scientific uncertainties and to develop more reliable scientific predictions upon which sound policy strategies and responses can be based. The CES expects to update the research plan annually and to change priorities as research results are obtained and as nonfederal groups provide input into the research process.

Among the many interesting and important science questions that need to be investigated, I would mention, in particular, the reliability of general circulation models, the earth's climatic history, the role of

clouds, oceanic influences on the atmosphere and climate, the hydrologic cycle, and changes in ecosystems.
This existing interagency coordinating mechanism is far preferable to the establishment of the committee directed in S.324, composed of directors of national laboratories who, after all, are contractors to the Department of Energy. In fact, the Committee on Earth Sciences, has done an excellent job in coordinating global change R&D. Having established an interagency process that works, it would be a mistake to replace it with a new mechanism which places contractors on an equal footing with cabinet agencies.

The President's Council of Advisors on Science and Technology

The President's Council of Advisors on Science and Technology (PCAST) was established by Executive Order of the President on January 19, 1990. The Council, which I chair, reports directly to the President and consists of 12 distinguished scientists and engineers from academia, industry, and other nonfederal institutions. This council provides an important ingredient that is missing from the FCCSET process -- views from outside the federal sector.

PCAST has already met twice with the President and his senior advisors. One of the topics discussed was global climate change, and I shall request PCAST to form a panel on environmental science and global change. This panel, with its private sector perspective, will complement the advice we receive from the CES subcommittee of FCCSET. The fact that I chair both FCCSET and PCAST insures good communications between the two groups.

The Domestic Policy Council Working Group on Global Change

President Bush also has asked me to chair a Cabinet-level Working Group on Global Change under the White House Domestic Policy Council. The Working Group provides Cabinet-level coordination on global change issues and is an important source of advice for the President.

The Working Group, when established last October, called immediately for three specific studies: (1) an analysis of economic costs of global change and responses to it, (2) an analysis of private sector concerns, activities, and issues on global change, and (3) legal precedents for international agreements and conventions on the environment.

Preliminary drafts of these reports have been presented to the Working Group for use in their deliberations. In addition, the Working Group has set up a number of briefings by top experts on the scientific, economic, environmental, and industrial aspects of global change.

Economic Policy Council Working Group on Science and Technology

Late last month an Economic Policy Council Working Group on Science and Technology was established to assist in formulation, coordination and implementation of Administration policies involving science and technology. The Working Group will also develop science and technology issues related to domestic and social policy for consideration by the Domestic Policy Council.

I will chair this Working Group, and members will include White House officials and senior representatives from all federal agencies and departments with substantial involvement in scientific and technological issues. This Working Group will analyze the scientific and technological components of economic and domestic policy issues.

INTERNATIONAL RESEARCH AND POLICY-MAKING MECHANISMS

Global climate change affects all nations and thus requires international study and cooperation. Within the international scientific community are a variety of informal mechanisms for planning science programs. Often these informal mechanisms are used to plan the detailed scientific elements of a more formal program, several elements of which are outlined below.

Conference on Science and Economics Research Related to Global Change

The President has asked me, together with the Chairman of the Council of Economic Advisers and the Chairman of the Council on Environmental Quality, to organize a White House meeting of the three senior officials in science, economics, and the environment from a number of countries. This White House Conference on Science and Economics Research Related to Global Change will take place in Washington, D.C. on April 17-18, 1990.

The conference will be devoted to science and economics research issues relevant to policy on global change, including climate. The Conference is designed to address important next steps that substantially enhance and broaden international understanding of science and economics research issues, and to frame initial steps toward a strategy for implementing joint international science and economics research efforts. It seeks for the first time to join research issues central to both the science and the economics related to global change.

Intergovernmental Panel on Climate Change

The U.S. government was instrumental in establishing and continues to support the work of the Intergovernmental Panel on Climate Change (IPCC), which is sponsored by the United Nations and the World Meteorological Organization. The three working groups of the IPCC, which are studying the scientific aspects of global change, impacts, and response and mitigation strategies, respectively, met here in Washington recently to prepare their reports. The final papers of the working groups will be presented to the full IPCC in August, shortly before the Second World Climate Conference in October.

In an address to the IPCC Plenary Session here in Washington, President Bush commended their activities and reaffirmed the United States' strong commitment to the IPCC process. He said, "We consider it vital that the community of nations be drawn together in an orderly, disciplined, rational way to review the history of our global environment, to assess the potential for future climate change, and to develop effective programs."

The IPCC process is designed to provide input to an International Framework Convention on global warming. At the Malta summit last December, President Bush proposed that the United States offer a venue for the first negotiating session for this Framework Convention, and he reiterated that offer at the IPCC meeting.

CONCLUSION

A National Energy Strategy is currently being developed by the Administration that will respect the environment, meet our nation's needs for energy, and not damage our economy or international competitive position. The Administration has already taken specific actions to begin dealing with the potential problem of global change by taking the initiative on CFCs and Clean Air legislation that will have the effect of limiting greenhouse gas emissions. A vigorous structure of coordinating and advisory councils on global change is already in place and is functioning well.

Title I of the Act would unnecessarily duplicate, and thus complicate and hinder, aspects of both the National Energy Strategy planning process and the Executive branch committee structure we have just revitalized. I would have to oppose, in particular, formation of the proposed Federal Energy-Environmental Coordinating Council. More generally, I have a concern with requirements that would set goals or targets before we have reached agreement on how to evaluate total fuel cycle costs. Certainly, we should not do so unilaterally. These requirements could constrain our technical options, weaken our economy and threaten our competitive position with little environmental gain. The White House Conference later this month will begin to provide a basis for more considered actions.

Title II addresses energy efficiency. Increased efficiency and conservation are being closely considered in the formulation of the National Energy Strategy. The removal of market barriers to increased efficiency is relatively noncontroversial. Other steps to raise efficiency must be evaluated in light of their other impacts and benefits. The contribution of increased efficiency to lowering greenhouse gas emissions is clearly relevant. Our greenhouse gas emissions goals must ultimately be set with reference to the social and economic consequences of the actions required to attain them and those that would arise in a scenario where no such goals were adopted.

If significant greenhouse emission limitation over a relatively short time frame is ultimately judged to be desirable, increased efficiency alone will not suffice. In my considered opinion, massive fuel switching in our generation of electrical energy, greatly increased reliance on nuclear energy as well as other actions will be required. Consequently, to prepare for this possible policy direction, any long-term national energy plan should include research on advanced inherently-safe reactor concepts. These critical elements are missing from the Act. These very issues, however, are being addressed in a comprehensive fashion in the development of the National Energy Strategy and in the Intergovernmental Panel on Climate Change process.

Title III, in addressing energy research initiatives, would impose in several instances, detailed micromanagement that could be harmful to our development of an effective National Energy Strategy. I will defer to the Department of Energy for specific comments on individual technologies, many of which can play vitally important niche roles, but would again note my concern -- expressed above -- that research continue, with high priority, on advanced reactor concepts.

In summary, the Administration shares the Committee's commitment to address global climate change issues in a comprehensive manner based on sound environmental, economic and technical considerations. We believe, however, that the mechanisms currently in place are more than adequate to achieve this objective and we oppose the bill because many of its provisions are unnecessary, duplicative and overly prescriptive.

That concludes my prepared testimony. I would be happy to answer questions from the committee.

A SENSE OF THE FUTURE

D. ALLAN BROMLEY
Assistant to the President for Science and Technology
Executive Office of the President

Commencement Address
Rensselaer Polytechnic Institute
Troy, New York
May 18, 1990

President Schmitt, Distinguished Guests, Members of the Class of 1990, Ladies and Gentlemen:

Let me begin by adding my congratulations to the Class of 1990. You have worked hard and have earned the recognition that is yours today. But this is not just your day. As the parent of two college graduates, I can tell you that your parents have looked forward to this day much longer than you have. In a very real sense, this is their day, too. So let me, both personally and on behalf of all of us who are honored to be joining the Rensselaer family this morning, extend to you -- parents and students alike -- our warmest congratulations and best wishes on this most important day.

I plan to keep my remarks brief this morning. But because I didn't know quite how much time would be appropriate, I called up Roland and asked his advice. He told me, "Just keep it shorter than the wait for hockey tickets." That shouldn't be too hard.

President Bush has a story that he likes to tell about long-winded speakers. It's about the boy who is sitting in church with his parents and asks his mother why there are flags lining the walkway outside. "Those are for the young men who died in the service," his mother tells him. The boy replies, "Oh, the 9:00 service or the 11:00 service?"

Yet, in my own defense, I must add that there is a certain timeless quality about commencement day, and often a real sadness at having this time come to an end. You have had four sheltered years here at Rensselaer, though I doubt they have always been comfortable ones, and the friends you have made -- and the knowledge you have gained -- will last a lifetime. Now life gets more complicated. The stakes, the challenges, and the rewards all go up.

You are entering a world that is much more complex and fluid than the world I entered after getting my graduate degrees from another great New York institution, the University of Rochester, in the 1950s. It is a world in which the only given is that change is continual -- change in science and technology, change in political institutions, even change in society. Marshall McLuhan once said, "If it works, it's obsolete." The situation is not quite that bad, but it's getting close.

Think back for the moment to the 1950s and to what we know now that we didn't know then. The double helix structure of DNA was unknown at the beginning of that decade. Geologists thought the continents were immovable and permanent, despite the evidence of their own eyes in the match between the outlines of South America and Africa. No one had ever heard of quarks or black holes. The idea that we could put objects into orbit around the Earth was still considered science fiction. The greenhouse effect occurred in greenhouses, and if you wanted an ozone hole you had to make one in a laboratory.

One of the most appealing and yet confounding aspects of science is that we have very little idea what major developments will occur in the next 40 years. Yet we can be sure that they will be dramatic, and that the world of 2030 will be much different than the world today. I have often said that science and technology are the greatest adventure upon which humans have ever embarked. Those of you who will go on to become scientists and engineers are taking up that adventure at an exciting time. You are very lucky to be graduating when you are.

We tend to think of the 1950s as a time of optimism, and they were -- we were eager to tackle the scientific challenges of our day. But some analysts would claim that the situation is different today. There has been much talk in the last few years about the decline of America, about how this country is destined to be overtaken by its competitors. And, for some reason, this speculation has found a receptive audience: according to polls, over half the people in this country think that America is in decline.

Yet it is impossible to make a compelling case that this country is in fact losing ground. Since the mid-1970s, the U.S. share of the gross world product has risen slightly. Our economy has now been growing for eight consecutive years -- the longest peacetime expansion in the nation's history. The United States continues to have the highest standard of living in the world, and because of our wealth we have made at least as much progress as any other nation in controlling the pollution of our air and water.

It is always tempting to compare the bad aspects of modern life with the good aspects of years past and lament the difference, or to point to catastrophic problems that are right around the corner. You know what they say about economists -- that they have predicted seven out of the last three recessions. But the world is much more likely to enter a period of unprecedented prosperity and peace during the 1990s than a period of economic contraction or social decline.

In taking issue with the doomsayers, I do not mean to gloss over the very real problems that we face; in fact, I'll spend much of the rest of my time talking about a couple of these problems. But I want to emphasize that our problems are soluble if we can generate the national will to solve them and if we resolutely pursue the necessary solutions.

INVESTING IN RESEARCH AND DEVELOPMENT

These two conditions -- a national will and resolute action -- are tied up with a rather more subtle consideration. One of the most vital challenges we face in this country is to reinvigorate our sense of the future. The typically American characteristics of optimism, a willingness to take risks, and a sense of where we're going still thrive in this country, but they have lost their power to shape broad national goals. My colleague Richard Darman, the director of the Office of Management and Budget, calls this sense of the future a "realistic Romanticism," and despite the seeming contradiction in terms it is a very accurate description, because it describes the traits that have made America a great country.

One telling indication of how we view the future is how much of today's wealth we invest for tomorrow's gain. On a personal level, we invest by saving money or by going to college to learn new skills. On a national level, we invest by building up the nation's infrastructure of capital goods, scientific and technical know-how, and people trained to use that knowledge in productive ways.

In that sense, one of the most important national investments that we can make is research and development. Research and development build the base for tomorrow's economic prosperity, international security, and national well-being. The lessons of history are unmistakable on this point. Past support from the federal government, and from the American taxpayers, for research and development has given the United States the strongest scientific and technological enterprise that the world has ever seen. It is a national and a global resource; it is essential for our standing in the world.

Today, we still invest more money in research and development than does any other nation. But other countries are closing the gap, with what I believe are obvious effects on our international competitiveness. The United States now spends about 1.8 percent of its GNP on nondefense research and development. West Germany spends about 2.6 percent, and Japan spends about 2.8 percent. The world leadership that we have enjoyed for decades in science and technology is at risk. We shall lose this leadership only at our peril -- militarily, economically, socially.

I personally believe that we do not spend enough on nondefense research and development in this country. One indication of this underinvestment is that we are finding it very difficult to maintain balance among the three main categories of public and private R&D funding:

o The first is research and development that meets national needs, including development of the important enabling technologies that allow our industries to remain economically competitive.

o The second is the large scientific projects that take us to the scientific frontier and are an important source of national pride.

o And the third is the individuals and small groups doing basic and applied research, who remain the heart and backbone of American science.

If any one of these three categories receives too little support, all three suffer, because all three are interrelated.

How are we to find additional funds for research and development from a federal government strapped for resources and a private sector that faces stiff competition from abroad? It won't be easy. But as we lower the budget deficit in the next few years, as economic reforms are instituted, and as international tensions lessen, the need to invest in our national future must take priority.

I believe that the American public senses this need, not only in terms of research and development but also in terms of such actions as rebuilding the national infrastructure and protecting the environment for future generations. The problem is translating public understanding into political will.

The answer, of course, lies in the American system of government. Benjamin Franklin said that in America the people govern -- if they want to. In a democracy such as ours, things do not happen unless our leaders and legislators believe that you, our citizens, want them to happen. If you feel that investing in our national future is important, take the time to tell your Representatives and Senators about it. A thoughtfully written letter or a short meeting can convey a powerful impression -- and I can tell you from being in Washington that politicians do listen. You will have an effect far beyond what you think possible.

INVESTING IN HUMAN RESOURCES

Research and development are one important investment in our future, but there is another investment that is even more important. We cannot do forefront research and development if we do not have the scientists and engineers to do it. Nor can we remain at the forefront of high-technology industry if we do not have a workforce capable of performing high-technology jobs.

This is the one point on which I might agree with the "America is in decline" school. Each coming generation of bright young minds constitutes our edge in a fiercely competitive world. It is our young people who can make the difference in an international marketplace. If we are not able to produce a well-educated populace able and willing to take up the technical challenges of the modern world -- and not only at elite institutions like Rensselaer but broadly, throughout the country -- we face a cloudy and uncertain future.

President Bush and the nation's governors have embraced this challenge by establishing six goals in education to be achieved by the end of the century. Probably the most controversial goal is that American students should be first in the world in mathematics and science achievement by the year 2000, whereas international comparisons now show us to be virtually last.

But I think it was very important for the President and the governors to set this goal. It shows that they recognize the importance and seriousness of scientific literacy, and that they are willing to devote special attention to this issue. Already, their focus on science and mathematics education has led to several new initiatives in my own office, including an attempt to coordinate the actions of federal agencies that have previously pursued education in almost complete isolation.

Of course, the news is not all bad for those of you who plan to become scientists and engineers. Your timing -- over which I recognize you had remarkably little control -- is excellent. You will be in great demand, particularly given the projections that show serious shortages of scientists and engineers developing in the 1990s. What you can accomplish will be limited only by your vision, your imagination, and your willingness to keep up with the astonishing rate at which your fields are changing.

But it is also more fun to be working in fields that are thriving, fields that are full of new people and new ideas. You, too, will experience the pain of personnel shortages. And without an adequate level of scientific literacy among the population at large, the funding and social support that you need to do your jobs will be in equally short supply.

So I would submit that you have both a responsibility and an opportunity to improve the your own futures. You are the most recent beneficiaries of an educational system that has prepared you for very promising careers. Now is the time to return the favor.

There are many different ways to improve the state of scientific and technical literacy in this country. There is a program at Yale where science majors go into the community and work with poor and disadvantaged children to spark their interest in science. Other people become big brothers or sisters or teach classes after work.

Some people come to Washington or take state or local jobs in government, and I can tell you from my own experience that government service is a rewarding and valuable thing to do. Other people express their commitment by political action, by writing letters and becoming involved in the issues that concern them.

The important point is to try to give back to others some of what you have received. It can be your own form of investing in the future, and it is an investment from which you and all of the rest of us will benefit.

Your years here at Rensselaer have prepared you well for the task. You are among the brightest and best educated young people in the nation. I know that you will have an exciting and rewarding time.

So on behalf of those of us whom you may feel have received our Rensselaer degrees today with considerably less work than was required of you, let me only say how honored and privileged we are to be able to join this very select group -- the Rensselaer Class of 1990.

BUILDING ON OUR STRENGTHS: THE INFORMATION TECHNOLOGY INDUSTRY

D. ALLAN BROMLEY
Assistant to the President for Science and Technology
Executive Office of the President

Computer and Communications Industry Association
Washington, D.C.
May 22, 1990

Last week I was on Capitol Hill testifying before Senator Gore's Subcommittee on Science, Technology, and Space about the state of the semiconductor industry. He pointed out, quite correctly I believe, that American industry has taken major steps to bolster the strength of that industry. He went on to contend that the federal government has done very little to help the industry, after which he and I had what I might describe as a spirited discussion.

He didn't change my mind. I still believe that the federal government is in the process of putting together a comprehensive, long-range, responsible approach to the problems of the semiconductor industry. Furthermore, it is an approach that will benefit all sectors of the information technology industry, including computers and communications. Whilte they may not satisfy all critics, I believe they will ultimately result in a stronger and more stable industry, one that is well equipped to meet the challenges of the 21st century.

BUILDING ON OUR STRENGTHS

The information technology industry has a number of components, each with somewhat different characteristics and different needs. Yet all three are not only interrelated but interdependent. And all three are united by a common feature: a rate of change that is virtually unparalleled in science and technology.

It is sometimes hard to believe that Howard Aiken, in a basement at Harvard, laid the foundation for the computer revolution just 50 years ago. Today, only about 15 years separates the first appearance of a top-of-the-line supercomputer from the appearance of that same computing power in the higher end of the personal computer market. In the area of communications, a recent article in <u>Science</u> noted that the use of NSF's national network has been going up by 20 percent <u>per month</u>.

Of course, not all of the changes that have occurred in the industry in recent years have been for the better. In particular, the semiconductor industry has experienced a substantial loss of market share as foreign producers, often with the active participation of their governments, have entered and in many cases come to control world markets. This situation has been analyzed quite well in a number of reports -- most recently in the November 1989 report of the National Advisory Committee on Semiconductors. That report documents a number of deficiencies in the structure and practices of the industry that have harmed its competitiveness. It also points out that similar, though not necessarily identical, deficiencies could also threaten the computer and telecommunications industries.

As I shall describe in a moment, the federal government has an important role to play in correcting these deficiencies. But the federal role must be built on more than just correcting deficiencies. A successful strategy must also exploit the strengths and advantages unique to the United States.

Undoubtedly our greatest strength is the infrastructure for research and development that exists in this country. Since World War II, the generous support provided by the federal government, and by the American taxpayer, has given the United States the strongest scientific and technological enterprise that the world has ever seen. It is a national and global resource; it is essential for our standing in the world.

In addition, the United States has a university system superior to any, an open and hospitable society that attracts the best scientific minds and inventive talents of the world, a business climate that encourages innovative enterprises, and a financial system that allows new enterprises to grow quickly into major businesses. Perhaps most important, we have a culture that continues to prize and reward innovation, the keystone of modern economies.

The United States needs to maintain the superiority of our science and technology base if we are to remain a world economic leader. Both the public and private sectors need to increase their support for basic and applied research in universities and industry. This research has traditionally been the source of our strength, and it cannot be allowed to languish as other concerns are addressed.

But another important thing we must do is work at retaining the lead that our research gives us. As many analysts have pointed out, we need to strengthen the entire innovation process, from basic research to product development, manufacturing, and marketing.

The federal government is taking a number of actions to strengthen the steps in the innovation process:

o We are drawing on the expertise of the hundreds of federal laboratories around the country to transfer technology from the public to the private sector.

o We are catalyzing the formation of consortia, such as SEMATECH, among universities, industry, and government, so that each of our industries, and particularly the small and medium-sized ones, do not have to reinvent the technological wheel.

o Recently the Administration proposed relaxing antitrust restrictions on joint production ventures, building on the success of previous legislation that allow joint precompetitive research and development ventures.

We clearly have much more to do in each one of these areas, but we have also at least begun to address the problems.

The federal government also has a role in supporting the development of generic, enabling technologies. These are technologies that are important in a wide variety of commercial and defense applications, but no single company can capture enough of the benefits to justify investing an adequate amount of R&D in them. The rationale for investing in these enabling technologies is essentially the same as that for investing in basic research: individual companies cannot bear the cost and risk of such investments alone given the diffuse nature of the benefits.

In a speech to the American Electronics Association on March 7, President Bush pointed specifically to the importance of these enabling technologies. He said, "This Administration is committed to working with you in the critical precompetitive development stage where the basic discoveries are converted into generic technologies that support both our economic competitiveness and our national security. Here again we can help to level the international playing field on which you compete."

This is a policy that I wholeheartedly support, and I shall do my best to assist in its execution. One of the four Associate Directors in my office, William Phillips, is specifically in charge of industrial technology, and he and I will be working closely with the rest of the Administration, with the Commerce Department, and with the Defense Department to promote the federal government's development of technology.

MANUFACTURING MATTERS

I believe that this focus on technology development, and particularly on the development of manufacturing and production techniques, is critical because it helps to dispell a very serious misconception: that America has moved beyond production and manufacturing into an age of services. This is part of what I characterize as a myth that has developed in this country: that we as a nation have moved, in a rather leisurely fashion, from an agricultural economy to a manufacturing economy to a service economy. Nothing could be farther from the truth. It would be impossible for a country as large and diverse as America to have a services economy without a manufacturing sector, just as it would be impossible to have either without an agricultural sector. Unfortunately, this myth has begun to permeate our culture, with very harmful effects.

One is that in science and technology we continue to focus on the revolutionary types of discoveries, the ones for which people are awarded Nobel prizes, rather than on the evolutionary developments. Yet these evolutionary advances are the ones that allow companies to bring products to the market a little faster, a little cheaper, and a little more reliably. It is extremely distressing to note that at MIT, one of our most distinguished engineering schools, less than 4 percent of its engineering graduates demonstrate even the slightest interest in production or manufacturing.

Much of this problem is a cultural one, and like many of the problems I've been discussing it will be solved only through simultaneous efforts on a number of fronts. We have to reemphasize the importance of manufacturing on many levels, from the boardroom to the classroom. The federal government has instituted a number of policies that affect manufacturing. These policies also have an important indirect effect: they focus national attention on this important component of our competitiveness.

THE MACROECONOMIC CLIMATE FOR RESEARCH AND DEVELOPMENT

So far I've been talking about actions that focus specifically on research, development, and innovation. But the federal government has an even more fundamental responsibility in the area of industrial competitiveness. It has to help create the climate in which industrial innovation can flourish. Without such a climate, other efforts will have only marginal effects.

The single most important factor in the business climate is the availability, cost, and patience of capital. Many believe that the decline in our electronics industry can be related directly to a persistent underinvestment by companies in the industry over the past decade. Furthermore, the most important factor behind Japan's success as a producer is its persistently high rate of investment.

It is difficult to calculate with great precision the different costs of capital in different countries, but it is indisputable that at least several factors contribute to making capital more expensive here than it is on some other countries, particularly Japan. The federal budget deficit, tax provisions, low savings rates, and uncertainty about the future can all drive up the cost of capital.

The Bush Administration has taken several important steps in this regard. We are working to reduce the budget deficit, most immediately through the budget summit initiated by the President. We have also proposed, mostly recently in the 1991 budget document, several actions that would increase domestic savings and thereby promote investment.

A proposal that focuses specifically on research and development is the research and experimentation tax credit. The President has proposed changes to the present tax credit to encourage U.S. industry to invest in long-range research. These changes include making the R&D tax credit permanent, extending the credit to cover expenditures by startup firms, and establishing a two-tier structure for the tax credit that will encourage rapid growth in R&D expenditures as well as sustained commitments.

Trade policies will also be a major part of the competitiveness equation. We all agree, for instance, that the U.S. government has a duty to ensure fair trade treatment for U.S. industry in the global marketplace. Dumping and other unfair trading practices must not and will not be tolerated. U.S. companies must have access to world markets free from tariff and nontariff barriers. And our intellectual property rights must be protected.

The Administration is taking an active role in helping to ensure a level playing field in the global marketplace by reducing barriers to fair and free trade. For example, the U.S. representative to the ongoing Uruguay round of GATT talks is pursuing such issues as governmental subsidies for targeted technologies. Intellectual property issues are being addressed by the Administration not only in GATT but also in bilateral negotiations.

HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS

Having described those government-wide efforts, let me turn more specifically to some of the areas on which the Office of Science and Technology Policy has focused. Since I was sworn in last August, OSTP has dealt with a large number of issues. But if I had to pick the topics that have taken up a majority of our time, I would have to name four: the impact of science and technology on economic growth, global change, science and mathematics education, and high-performance computing and communications.

The inclusion of high performance computing and communications is an indication of its prominent role in modern science and technology. Not only is high performance computing and communications important in its own right, but it is a major factor in the other three areas on which OSTP has focused. High-performance computing and communications will be required to handle the huge projected growth in numeric and graphic data generated by our study of the earth system. It is a key enabling technology for industrial design and manufacturing, being used in the aircraft, automotive, energy, chemicals, and pharmaceuticals industries, to name just a few. And in education the possibilities are virtually limitless. Imagine the progress that could be made if you brought a single optic fiber into every classroom and allowed each student to be instructed at his or her own speed -- not to mention the market it would provide for the domestic computing and communications industry.

Last fall, OSTP sent to the Congress a report entitled "The Federal High Performance Computing Program," which was put together by the Computer Research and Applications Committee of the Federal Coordinating Council for Science, Engineering, and Technology. This report was designed to take at least the first steps toward developing a truly national capability at the next level of performance in the computer world.

The report is organized around four main themes.

1. The first is to develop the hardware that will increase computer and communications performance a thousandfold. This part of the plan builds on efforts that the government already supports that have helped to establish U.S. leadership in high performance computing. It seeks to promote the transfer of these results to U.S. industry through close collaboration between researchers in universities and national laboratories and industrial scientists and engineers.

2 The second is to develop the advanced software and algorithms that in many applications have become the determining factor for exploiting high performance computing and communications. Many are now recognizing that supercomputers remain most valuable to those who invented them or are developing them for their own specific purposes in national laboratories and specialized industrial labs. If we are going to realize the potential of this new capacity, we must develop more general, user friendly software than we now have.

3. The third theme is to develop a National Research and Education Network that will provide a distributed computing capability that links the government, industry, and higher education research and education communities. Today, all major

organizations and government agencies use computer networking to some extent, and a number of national and regional computer networks have been established to meet particular needs. However, these networks are far from uniform in type and quality of service needed, and they do not yet reach the entire research community. Our goal is to create a national network that operates at rates of gigabits per second nationwide. This challenge can be reached in the 1990s. Furthermore, this network could be a prototype of a new national information infrastructure that could be available to every home, office, and factor in the nation. Wherever information is used, from manufacturing to high-definition video, and especially in education, the country will benefit enormously from the deployment of this technology.

4. The fourth is to produce the trained personnel who will be needed to expand the base of research and development in computational science and technology. In its most recent analyses, the National Science Foundation has concluded that the greatest shortages of trained manpower in the United States in the 1990s will be in the areas of computer science and engineering, amounting to hundreds of thousands of people.

FCCSET AND PCAST

Through the Federal Coordinating Council, the Administration is now building on last year's report to create an integrated, truly comprehensive program in high performance computing and communications. Last year's report was released too late in the budget cycle to be reflected in the budget submission sent to Congress last January. But high performance computing and communications should receive much more emphasis in the fiscal year 1992 budget.

So far this year, two meetings have been convened of agency heads and their deputy directors from federal agencies that support high performance computing and communications. As a result of this effort, several agencies are in the process of reprogramming funds within the current fiscal year to deal with this critical issue. This effort should grow substantially in the next few years.

The Federal Coordinating Council has also just been reorganized and reinvigorated, with the result that we now have a much higher level of representation among the members of the council. This, in turn, will result in substantially more visibility in the programs that are instituted by subcommittees of the Council, including the High Performance Computing Program.

I should also mention that OSTP's liaison representative to the Council in this area brings a special expertise in information technologies. Our office's Associate Director for Physical Sciences and Engineering, Eugene Wong, was a professor of computer science at Berkeley before we lured him away to Washington, and he will be devoting a substantial amount of time to the issue of high performance computing and communications.

Finally, you might know that the President has convened a Council of Advisors on Science and Technology, consisting of 12 distinguished representatives of academia and industry, to provide him with information and advice about issues of science and technology that require and deserve Presidential attention. PCAST, as it is known, plans to convene panels of private sector experts on particular subjects of importance. The first panel so convened -- and I have just approved their charter within the past few weeks -- is on high performance computing and communications. That panel is now beginning their work, and we should hear back from them within a few months.

This is the kind of organization that I would like to bring to a number of subjects in science and technology. In that respect, the efforts of PCAST and the Federal Coordinating Council in high performance computing will act as models for other efforts.

So, in conclusion, I believe that you will be hearing a great deal from our office in the future on the subjects of computing and communications. At the same time, we will be drawing on your expertise as we consider federal actions that influence your industries. For many years, people have been talking about the need for increased cooperation between the public and private sector on subjects of national importance. Here is one area where we can move beyond generalities to the specific arrangements that can make a difference.

Rick Yannuzzi

MEMORADUM

January 3, 1990

FROM: Steve Olson

TO: OSTP Staff

SUBJECT: Recent Speeches

Attached are several recent speeches that give a fairly representative idea of what Dr. Bromley has been saying in public forums over the past few months. I've included one special purpose speech--an address on scientific progress and human rights that Dr. Bromley gave at the National Academy of Sciences. I've also included one speech by Tom Ratchford that sums up the office's pre-budget-release position on economic issues.

SCIENCE, TECHNOLOGY, AND POLICY IN THE BUSH ADMINISTRATION

D. ALLAN BROMLEY

ASSISTANT TO THE PRESIDENT FOR SCIENCE AND TECHNOLOGY

EXECUTIVE OFFICE OF THE PRESIDENT

New York Academy of Sciences

New York City

December 4, 1989

I am deeply indebted to the Academy, and to you, President Thomas, for the honor of the 1989 Presidential Award supported by A. Cressy Morrison. It is a proud moment to have one's name added to the list of distinguished scientists who have been given this award in the past. Just this fall I had the privilege of calling last year's winner, Joshua Lederberg, and telling him that he was to receive the National Medal of Science. And during my confirmation hearings last summer, I was told many times that I ought to emulate the approach and independence of the 1987 winner, C. Everett Koop. So far my most obvious success in emulating Dr. Koop has been in hiring away his executive assistant; she is a superb executive assistant, and to the extent that an excellent executive assistant stands behind every successful bureaucrat, I've made a good start.

I had come to New York intending to tell you about the activities of my office, and about the things we have planned for the next several years. But first I want to pay a brief tribute to our Academy, and to the vital role it has played in science throughout its history. For 172 years the New York Academy of Sciences has embodied all that is best about American science. Our academy was founded on the goals of the Enlightenment, on aspirations of democracy and social responsibility, and in all the times since then--unenlightened as well as enlightened--that vision has never faded.

The Academy has always believed that science belongs to everyone, nonscientists as well as scientists. Since the 19th century the Academy has been sponsoring lectures on scientific developments for interested laymen, and organizing receptions and exhibitions on recent advances in science. The continued support of The Sciences, a publication that certainly makes the rounds in my office, bespeaks the Academy's commitment to scientific communication. At a time when science and technology are becoming an ever increasing part of our daily lives, and when the pace of scientific change continues to accelerate, this commitment to public education has become one of the most important issues facing the scientific community.

I'll come back to this point in a moment, but first I want to tell you something of my plans for the Office of Science and Technology Policy. OSTP was established by Act of Congress in 1976 to serve two major functions. The first is to provide the President with accurate, objective information on science and technology as it affects public policy--in short, science and technology for policy. Of particular importance here is making sure that policy makers not only have the science and technology input but also some realistic feeling for how liable and trustworthy is that input.

This function of science and technology for policy requires that I have access to the President, to members of the Cabinet, and to the policy-making process within the White House. I am very fortunate in this regard, because President Bush has upgraded my position to be equivalent to that of the National Security Adviser. That has made me a member of the Domestic Policy Council, the Economic Policy Council, and the other groups, at the highest level in the White House, that help establish and implement administration policy.

Even more important, the President himself believes that science and technology are essential and ever more important components of our society and our future; he is prepared to listen and to take action where appropriate. This Presidential involvement gives me a substantial advantage over my predecessors in this office.

OSTP's second major task is to work to maintain the health and productivity of science and technology in this country--in short, to establish policy for science and technology. One important aspect of this task is our coordination of R&D within the federal government. This can seem a daunting responsibility with science as pervasive in the federal government and in society as it is. But let me describe a recent project that I see as a model for our coordinating efforts. Last summer the Committee for Earth Sciences, which consists of representatives from all of the federal agencies conducting research on the global environment, released a working group report on the federal government's research plan for global change during fiscal year 1990. The report sets up a coordinated national strategy and implementation plan for all federal research on global change. I shall describe some of our activities on global change in more detail in a few moments, but this is the kind of coordinating activity that I would like to extend to a number of different areas of science and technology, such as materials science, energy policy, education and training, and biotechnology, to name only a few.

One of the problems with the FCCSET mechanism, however, is that it makes no provision for input from the private sector to decision making at the highest levels of government. I shall return to this point in a moment.

Of course, it would be impossible for me to pursue these activities on my own, and so I have placed a very high priority on recruiting very senior, very experienced scientists and engineers to join me in OSTP. The legislation that established OSTP allows the office to have up to four Associate Directors who are appointed by the President and confirmed by the Senate. In terms of Senate-confirmed officials, this makes us the second largest agency in the federal government; unhappily, the legislation falls short of providing us with the second largest budget in the federal government!

For the first time in OSTP's history, I intend to have all four of the Associate Directors called for in our founding legislation. Two of these Associate Directors were sworn in last week. My Associate Director for the Life Sciences is Dr. James

Wyngaarden, formerly Director of the National Institutes of Health. Dr. Wyngaarden will be working on the broad range of life sciences issues, including biotechnology, the human genome project, drug abuse, AIDS, and the overall health of our national biomedical programs.

My Associate Director for Policy and International Science is Dr. Thomas Ratchford, formerly Associate Executive Director of the American Association for the Advancement of Science. I had the great pleasure of working with Dr. Ratchford when I was president of the American Association for the Advancement of Science, and I consider myself very fortunate to have been able to convince him to join us in the White House.

In the White House, as in all other organizations, parking privileges and office space are the true indicators of influence. Although it gave me, even as a 30-year veteran of Ivy League faculty affairs, new insight into the meaning of mortal combat, I am happy to be able to report to you that I have succeeded in carving out offices adjacent to mine for my four Associate Directors--and they all have parking permits!

The President has not yet forwarded the names of the other two Associate Directors-Designate to the Senate, although I expect that to happen in time so that they will be confirmed very soon after the Senate reconvenes. I can tell you, however, that the new Associate Director-Designate for the Physical Sciences and Engineering is a very senior academic engineer, and the Associate Director-Designate for Industrial Technology--which is an entirely new post at OSTP--will be a very senior R&D executive from the private sector. I think you will be very impressed by their qualifications when their names are announced by the President.

My intention is that the four associate directors and I will work together collegially to address, cooperatively, the issues involving science and technology that have risen to the Presidential level. We will also keep a watchful eye on emerging issues and, when necessary, develop recommendations for appropriate actions that will shape those issues.

I have mentioned the importance of having input from the private sector to our activities. To that end, the President will, very soon, announce the membership of the President's Council of Advisers on Science and Technology or PCAST, which the President has asked me to chair. This will be a group of 12 prestigious individuals from academia and industry who will report directly to the President and, at his request, examine a broad range of science and technology issues. In addition, PCAST will have the authority to form ad hoc panels of private sector executives, researchers, and academics to parallel the committees that we establish within OSTP under the Federal Coordinating Council for Science, Engineering, and Technology or FCCSET. By bringing the PCAST panels and corresponding FCCSET committees together frequently, a mechanism will be available for the private sector to provide input to the government at the highest levels.

President Bush has told me that he plans to host the first PCAST meeting, on an informal basis, outside of Washington in late December or early January and that thereafter he plans to participate personally in Council meetings to the extent that his schedule allows. This will give PCAST much more direct access to the President than has been the case in recent years.

We will obviously be working on a wide variety of issues in OSTP over the next few years. At the moment, a very large fraction of our available time and effort is being devoted to working with senior staff of the Office of Management and Budget (OMB) on the preparation of the President's fiscal year 1991 budget, which will be delivered to the Congress in January. Each year the preparation of the budget will occupy much of our attention as we work to integrate and coordinate science and technology issues government-wide. Richard Darman, Director of OMB, and I have agreed that our staffs will collaborate closely through the entire year of the budget preparation, not just in its concluding phases, as has been the case in the past.

However, rather than give you a laundry list of activities, let me pick two of particular importance--global change and education.

Global Change

Many people have the impression that the Bush Administration is doing less than other countries about global warming and other major environmental problems. That impression is entirely mistaken. If we measure progress in terms of concrete actions, we find that the United States is doing more than any other country to understand and address these problems--and by more than a factor of ten in terms of commitment of both financial and human resources.

As everyone here tonight knows, global change includes global warming, ocean pollution, clean air, pure water, biodiversity, and an enormous range of other topics. But let me focus on global warming. The greenhouse effect is nothing new; it is what has made our planet livable. But the burden of greenhouse gases--carbon dioxide, methane, chlorofluorocarbons (CFC's)--that we have dumped into our atmosphere in the process of industrialization is the largest impact--by a substantial margin--that man has had on this planet.

Our understanding of the details of the greenhouse process, however, is far from complete. There are relatively large uncertainties associated with our present global climate models and their predictions. But few will argue against the contention that if we continue to load our atmosphere with greenhouse gases at the present rate, we will eventually experience significant warming.

We are only beginning to understand what the impacts of such warming might be on agricultural productivity, sea level changes, biological productivity in the oceans, shifting vegetation patterns, storm patterns and severity, droughts, and the like--and we are even further from any quantitative understanding of what the corresponding economic impacts might be. Much of this understanding requires global climate models of much higher spatial resolution and accuracy.

As chairman of the Domestic Policy Council Working Group on global change, which is charged with the development of the official U.S. policy in this area, I have initiated government-wide activities aimed at getting a much better understanding of these matters within the next year. The Working Group is also scheduling meetings with distinguished groups of scientists, economists, and environmentalists working in this area, selected for us by the National Academies of Science and Engineering.

But it is important for me to emphasize that we are not waiting for the results of these activities before taking action. There are a great many things that we can and should do immediately, in effect as an insurance policy against the possible effects of global warming.

First of all, we are committed to phasing out the production of all ozone-destroying chlorofluorocarbons, which account for about 25 percent of our total greenhouse gas emissions, by the year 2000--earlier than is called for by the Montreal protocol.

The United States is also taking a number of aggressive steps to improve energy conservation, which is the most immediate means of reducing the emissions of greenhouse gases, since 57 percent of our greenhouse emissions come from the combustion of fossil fuels. The Clean Air Act is being reauthorized, auto emission standards are being tightened, and new appliance efficiency standards have recently been released by the Department of Energy. The Department of Energy is also conducting a thorough review and revision of our National Energy Policy. The new strategy will emphasize both energy conservation and the development of alternate energy sources that do not emit greenhouse gases, including specifically a new generation of inherently safe nuclear reactors--the only technologically available alternative for the production of large blocks of electrical energy--and more widespread use of solar energy.

We are also working, through diplomatic and other channels, with countries like Brazil in the hope of developing programs to save tropical forests that are, apart from the oceans, the largest sink for carbon dioxide on the planet. These forests also contain more than 80 percent of the remaining uncharacterized gene pool on the planet--an absolutely irreplaceable human treasure. Yet they are in danger of being totally destroyed in 15 to 20 years.

All these activities work to reduce future greenhouse warming, and most have other compelling rationales as well.

What this Administration insists upon is that all its activities in this area be solely based on the best scientific and economic understanding that we can get. To that end, in late spring, at the President's request and as announced in Malta, I will host, in Washington, a meeting of the senior scientist, the senior economist, and the senior environmentalist in the governments of a large number of the world's nations, with the goal of developing agreement on how to best bring the available expertise, data, and understanding--worldwide--to bear on the global warming problem, its impacts, and its costs.

In parallel, the United States is an active participant in the United Nations-sponsored Intergovernmental Panel on Climate Change (IPCC). The three IPCC working groups will meet in plenary sessions in Washington in February. The IPCC process will conclude its first phase prior to the Second World Climate Conference scheduled for Geneva in November 1990. Finally, and most important, this ongoing process under the auspices of the United Nations, to which the United States is committed, will lead to an international Framework Convention on global warming within the next 18 months.

Taken together, all of the activities I have noted will provide us with the information needed to consider quantitative proposals for stabilizing and/or reducing emissions of greenhouses gases, something we were unable to do at the recent Noordwijk ministerial conference in the Netherlands. In this way, they will lead to a Framework Convention that is economically realistic, politically feasible, and based on the best available science at the time.

There is one other important point I would like to make on this issue. The industrialized nations bear a leadership responsibility in the area of global change, since a very large fraction of the current manmade greenhouse burden reflects our industrialization and our burning of fossil fuels. The United States and other industrialized nations therefore have a very real responsibility for seeing that the developing countries have the technology they need to continue their own industrial development without further gross damage to the environment. By taking a proactive stance in this matter and acting before we are pressured into doing so, we in the United States and the other industrialized nations can reap handsome dividends--both environmental and political. The Bush Administration is aggressively exploring how best this should be accomplished.

Education and Training

The other major topic that I thought I would discuss with you tonight is education. I speak here not just of mathematics and science education--although they are critically important in a technologically advanced world--but of education in general. It is impossible to separate science and mathematics education from the larger problem of restructuring and upgrading our schools.

I have noted elsewhere that in this country we are perpetrating a fraud on many of our precollege children. For the first time in the history of this nation, the education our children are receiving is substantially inferior to the education that we received. That is a national scandal and disgrace.

At the college level, we, as the only developed nation that has no centralized control over what constitutes a college education, have peaks of excellence and troughs of mediocrity. But on the average we are competitive with the rest of the world. At the graduate level, we continue to set standards for world activity.

The answer as to why we are so good at the graduate level and so bad at the precollege level is surprisingly simple. We are prepared to sacrifice an unacceptable fraction of our young people along the way. Only about 0.2 percent of high school sophomores complete a Ph.D. in any area of the natural sciences or engineering. That is the lowest of any developed nation.

Last September I had the privilege of going with the President to the Education Summit in Charlottesville, and despite the skepticism that surrounded the meeting I came away tremendously heartened. There was a freshness of outlook and a unanimity of approach that offered the promise of real progress. The governors of the nation are to be commended for their innovative steps toward school reform and for their commitment to making a difference.

We in the federal government will take on the challenge of spreading the successful innovations now in place in isolated states across the nation. It was agreed at the Summit that the federal government also must share in preparing our children--both physically and mentally--for education when they reach school age; this will involve increased emphasis on, and support for, programs such as Head Start. And the White House is now working on the development of national goals in education--not national curricula, since these imply a degree of coercion--as well as mechanisms whereby performance can be measured against these national goals. In this way, not only each student but also the teachers, the schools, the states, and the federal government can receive an annual report card documenting progress in this all-important question of education.

With respect to science and mathematics education in particular, the governors and the educational community in general could learn much from the activities of this Academy. Several of the programs that you administer could serve as models for the kinds of activities that should be in place across the country, and we at OSTP will certainly be looking at them as we consider our own initiatives. The Scientists in Schools program, which sends scientists to elementary and secondary school classrooms to give lectures and demonstrations, is an excellent way to stimulate a student interest in science and to overcome at least some of their misconceptions about scientists. If we do not reach students at a very young age, before their junior year in high school, we have lost most of them forever, because research has shown that most scientists and engineers decide on their future careers at this early stage.

The Science Research and Training Program, which gives students a chance to learn about science by working in a university or company professional laboratory, is another excellent example of how young people can be introduced to science and perhaps attracted to it as a career. Finally, the Junior Academy program, which now has over 1,000 members, has proven immensely successful in producing young and enthusiastic scientists. These are the kinds of programs that will produce not only the Nobel Prize and Presidential Award winners of tomorrow but also the scientists and engineers responsible for the evolutionary discoveries that will retain U.S. competitiveness in an increasingly demanding and sometimes hostile international marketplace.

Let me then conclude by expressing to my old friend Lewis Thomas--and to all of you--my deep appreciation of the honor you have done me in awarding me your Presidential Medal. It is an award that I shall cherish. And let me also thank all of you for the leadership that this Academy has provided in the past in fostering excellence in science, education in science, and public interest in science. I know that we can look to you for continued leadership; it is truly an investment in our common future.

SCIENCE, TECHNOLOGY, AND GRADUATE EDUCATION

D. ALLAN BROMLEY
ASSISTANT TO THE PRESIDENT FOR SCIENCE AND TECHNOLOGY
EXECUTIVE OFFICE OF THE PRESIDENT

An Address to the National Association of
State Universities and Land Grant Colleges
Washington, D.C.
November 20, 1989

It gives me great pleasure to talk with this group, because I have long felt that the Morrill Act of 1862 marked one of the most significant turning points in American history. By recognizing the importance of higher education, the Land Grant Act committed the federal government to a program of support for higher education that, over the years, has expanded and diversified to produce truly spectacular results. By having at least one such educational institution in each state, the act also emphasized the importance of making higher education available to a broad segment of the population. I'm delighted to be addressing a group that embodies the ideals and successes of that remarkable vision of higher education.

Today, the United States has a unique dependence on its colleges and universities, both for new knowledge and for young minds trained to use this knowledge in innovative and creative ways. We alone in the developed world believe--as a matter of fundamental policy--that higher education and research are synergistic and inextricably interwoven. As a result, support of university-based research has both an immediate payoff--well-trained young scientists and engineers--and a longer-term benefit--the fruits of the new fundamental and applied knowledge that result from that research. It is this system that has enabled the United States to build the strongest science and technology enterprise that the world has ever known.

Yet if one examines the full range of education in the United States, one is struck by a picture of stark contrasts. At the graduate level, the United States continues to set world standards. The number of foreign students enrolled in the graduate schools you oversee is dramatic testimony to the tremendous successes you have achieved in offering an education unequaled anywhere else in the world. We should not forget that this education is one of the United States' most valuable exports.

At the undergraduate level, we, as the only developed nation that has no centralized control over what constitutes a college education, have peaks of excellence and troughs of mediocrity. But on average we are competitive with the rest of the world.

At the precollege level, I can only describe the situation by saying that in many cases we are perpetrating a fraud on many of our children. For the first time in the history of this nation, the education our children are receiving is substantially inferior to the education that we received. That is a national scandal and disgrace.

The reason why we are so good at the graduate level and so bad at the precollege level is surprisingly simple. We are prepared to sacrifice an unacceptable fraction of our young people along the way--particularly, in science and engineering, our women and minorities. Only about 0.2 percent of high school sophomores complete a Ph.D. in any area of the natural sciences or engineering. That is the lowest percentage of any developed nation.

I would like to discuss both ends of the educational spectrum this morning, starting with graduate education and concluding with precollege education. Although I will spend the bulk of my time on higher eduction, I must emphasize the importance to us all of precollege education. It is something on which my office is going to be spending much time over the next few years. And, I would submit, it is something on which you will need to spend much more time if the tradition of excellence that you have established is going to be maintained.

Graduate Education and the Federal Government

Turning first to graduate education, I think that Congressman Justin Morrill of Vermont would be amazed at what his Land Grant Act hath wrought. Today, as you well know, a substantial fraction of the operating expenditures for universities--particularly private ones--comes from governmental grants and contracts. The growth in federal involvement has been especially dramatic since World War II. But that growth has hardly taken the form of a smooth, steady increase. Rather, it has been marked by severe contractions and expansions, which have caused colleges and universities great problems over the years.

The flight of Sputnik in 1957 galvanized our society, and from 1958 to 1968 support from the federal government for university activities rose at roughly 20 percent per year. When, in 1968, the federal government noted that the goals that had been established for manpower production for 1970 had already been met, not surprisingly the crash program of support was turned off. At this point, American universities, which should have known better, found that they were diode-coupled. During the period of rapidly increasing funding, they had constructed many new facilities, which now required expensive maintenance and modernization. Much worse, they had greatly expanded their tenured faculties beyond the needs of any equilibrium student body. In many cases, taking advantage of readily available funds, they had also lowered standards for tenure. Indeed, by loading its tenured ranks, higher education in the United States in the 1960s essentially froze out a whole generation of young people in the 1970s from access to academic careers.

During the first half of the 1970s, the level of real R&D performance in colleges and universities was essentially flat. After 1975, academic R&D once again began to increase, but the damage had been done. Universities and colleges found themselves with aging facilities, obsolete equipment, growing shortages of faculty and students, and not enough funds to recover from the years of neglect.

This was the situation that we faced in 1984, when I was Vice Chairman of the White House Science Council's Panel on the Health of U.S. Colleges and Universities. As you well know, our main conclusions was, and I quote, that "our universities simply cannot respond to society's expectations for them or discharge their national responsibilities in research and education without substantially increased support."

I am happy to report that support for the nation's colleges and universities has increased since that time, that some very real progress has been made. Since 1985, the level of R&D done in colleges and universities has gone up by an average of 6 percent annually in real terms. But in many important areas, the record has been less than satisfactory. Whereas the federal government provided two thirds of the R&D funds for colleges and universities at the beginning of the decade, that figure is now down to 59 percent. The needs of academic laboratories for new facilities and instrumentation also remain largely unfulfilled.

In general, of the $132 billion expended nationally for research and development this year, only about 11 percent will find its way to the nation's colleges and universities. By any standard, I find this percentage inconsistent and incommensurate with the demands being made upon our institutions of higher education.

Regarding the research infrastructure, several independent studies have concluded that the universities can be brought back to a state from which they could be self-sufficient at a cost of roughly $10 billion over the next decade. There is also general agreement that half of this money ought to come from nonfederal sources, with the rest provided by federal matching funds. It is important to emphasize, however, that such a program should be limited in time and not a program that universities can expect to rely on in perpetuity. Rather, mechanisms must be put into place that allow universities to catch up and then be self-sustaining on a continuing basis.

Regarding the overall level of funding support, you will recall that one of the major recommendations emerging from the Reagan Administration was that the National Science Foundation's budget should be doubled within five years. That recommendation has been endorsed by President Bush and by the Congress. But because the NSF budget is dictated by matching House and Senate subcommittees that also consider Housing and Urban Development, Veterans' Affairs, NASA, EPA, my own office, and a number of other agencies under the same appropriations bill, research funds inevitably come into conflict with appropriations for the homeless, veterans, and other programs that have much larger and more vocal constituencies. As a result, the NSF budget has actually been growing at about 4 to 6 percent a year rather than the 17 percent that would be necessary for it to double in five years.

This trend is particularly troubling because of the demographics of scientists and engineers at present. At this moment, about 87 percent of all the scientists and engineers who have ever lived on the planet are still alive and working, whereas only about 5 percent of the human beings every to live on the planet are still alive. As a result, the pool of applicants for NSF funding is growing significantly faster than are the foundation's resources. At this point, the only way that the NSF can fund some of the bright, young investigators who are going to produce tomorrow's dramatic advances is by cutting out some of the senior investigators who have done--and are continuing to do --distinguished and productive work.

Restructuring Support for Higher Education

Addressing the problem of federal support for higher education is not going to be easy, particularly at a time of pressures on the budget from large federal deficits. But dollars and cents are not the only answer. We need to examine the entire relationship between the universities and the federal government and between the universities and the private sector. The time has come to return to an earlier view of the support of university activities as reflecting an investment in the national future rather than the procurement of necessary goods and services.

One clearcut need is for a reassessment of the interface between the defense department and the academic community. In the postwar decades, the defense department and this nation's universities had a close and productive relationship. To give a very early example, from 1839 to 1879 the Navy had what was essentially a one-man Office of Naval Research in the person of John Ericsson, a Swedish engineer about whom much more should be known. He, for example, was the individual who first decided to put iron armor plating on a battleship. Why he decided to call the ship the <u>U.S.S. Princeton</u> I simply do not know! In about 1840, Ericsson decided that his new armored battleship needed 12-inch rifles, and not having any he contacted seven of the nation's best engineering schools with the request that they design such a rifle to be built at the Navy's expense. Following construction, the different designs would be subjected to a series of competitive tests and the winning design would be accepted by the Navy and the winning university would receive very handsome rewards both in payment and in opportunities to become involved in the continuing production of their design.

On a bright morning in 1845, the Princeton steamed out into Chesapeake Bay, and the first 12-inch rifle to be tested, fortunately, was that designed by the Navy itself. When it exploded, as it did, it killed the Secretary of the Navy, the Secretary of State, the Governor of Maryland, three Congressmen, several Navy captains, and, as the newspaper reports of the day expressed it, "sundry other dignitaries." This is the sort of thing that gives technology a bad name.

During the 1950s and early 1960s, the Department of Defense was, by a large measure, the dominant supporter of fundamental research in the nation's universities. Unfortunately, during the latter part of the 1960s and early 1970s--during and after the Vietnam conflict--many of the bridges that had been carefully built between the Defense Department and the academic community were destroyed. I am convinced that these are exceedingly important channels and that one of the challenges now facing us is that of rebuilding them and reestablishing the easy flow of ideas and people between the military and our academic establishments. I believe that both have much to gain.

At the beginning of the 1980s, research and development in the United States was split about 50-50 between defense and nondefense areas. Now the split is two-thirds going to defense R&D and one third going to nondefense R&D. In fact, of the growth of research and development in the 1980s, 90 percent has occurred in the areas of defense.

Yet it is important to draw the distinction between these two categories of funding. Of the defense department's spending on R&D, about 92 percent goes toward the development and demonstration of specific weapons systems. Only about 8 percent goes toward what would be considered R&D according to the usual definition of the terms.

I believe that because of the present lessening of tensions between the Warsaw Pact countries and the United States, it is a particularly appropriate time for the Department of Defense to increase its support of basic research. Times of lessened tension are when we have to protect ourselves as a nation against scientific and technological surprises and when the Defense Department needs close contact with some of the best minds that the country has to offer. Changes to bring this about would be to the advantage of both the military and the academic sector.

Scientific and Engineering Personnel

The military faces a problem that is of great concern throughout science and technology: a growing and quite alarming shortage of well-trained personnel. Over the next 17 years, the NSF estimates that there will be a cumulative shortfall of more than 100,000 Ph.D. scientists and engineers. At the college level, the situation is equally dire: next year the number of college graduates in science and engineering will fall short of the need by 50,000, which is about a 30 percent shortfall.

These projections are substantially more accurate than most. The time constants of American education are such that it takes roughly ten years from the time a student graduates from high school until he or she finishes graduate training in a chosen field. We already know the number of people in this educational pipeline, and there is not a thing that we can do to affect directly the shortages that are now projected for the 1990s. It is simply too late, and we must start work now if we are to have any impact on the late 1990s and into the 21st century.

As you well know, particularly in engineering, but in a number of other fields such as mathematics, the fraction of the advanced degrees being awarded each year in the U.S. to foreign students is growing. This does not mean, however, that there are too many foreign students. Rather, it means that there are too few U.S. students choosing to enter these fields. This reflects the fact that our elementary and high school educations are such that students receive inadequate exposure to both mathematics and science to attract them into these fields in colleges, or to prepare the fraction that does so choose for their subsequent careers.

Precollege Education

The pipeline effect is critical in science and technology. The American students who will be in your graduate schools in the 1990s and beyond are now in the high schools and elementary schools of this country. What kinds of education are they getting? Will they be able to carry on the traditions of excellence that your graduate schools have established?

I need not dwell on how bad our national report card in science and mathematics education really is, but let me remind you of a few statistics. In the 1988 International Assessment of Educational Progress, the United States ranked 9th of 12 industrialized countries in science and 12th--last--in mathematics. More than half of the nation's 17-year-olds appear to be inadequately trained to perform jobs that require technical skills or specialized on-the-job training. Only 7 percent have the prerequisite knowledge and skills to perform well in college-level science courses.

These are alarming numbers. In an increasingly competitive international marketplace, our ability to provide jobs and to improve our standard of living depends greatly on how well we innovate technically. If we do not wish to risk becoming, as some have put it, "the only industrialized third-world country," we must pay close attention to our science and technology base, and therefore to science education.

The problem extends beyond scientific and technical personnel. In a democratic society whose technological content is increasing at an accelerating rate, all of our students should acquire a sufficient degree of literacy in mathematics and science to enable them to function effectively. If people cannot understand the broad issues under discussion, even if they do not contribute personally to their resolution, they will become alienated and disengaged from the important issues of the day. No nation can remain healthy for long under such conditions.

Addressing the Failures of Precollege Education

In the last few years, we have begun to recognize the dimensions of the problem and to take some significant steps toward solutions--especially at the state level. Several weeks ago I had the privilege of going with the President to the Education Summit in Charlottesville, and despite the skepticism that surrounded the meeting I came away tremendously heartened. There was a freshness of outlook and a unanimity of approach that offered the promise of real progress. The governors of the nation are to be commended for their innovative steps toward school reform and for their commitment to making a difference.

With regard to my office, we have been charged with developing national goals in education--not a national curriculum, which would be unproductive in this country--but national levels of performance. In this way, it will be possible to measure performance each year so that teachers, students, school districts, states, and the federal government can receive a report card on how they have fared in matters of education. We will be calling on you, on your colleagues, on the professional societies, and on a great many other inputs in carrying out this important work.

You might ask what your role can be in improving precollege education in this country. I see a very significant role for administrators and faculty from higher education. You serve the state and have close connections with your governors and the state educational system. You have a great deal of influence, and I would urge you to apply it in this area.

There are also steps that each of us can take as individuals. You can talk to superintendents, visit classrooms, convene meetings with public school teachers. These activities need not take a great deal of time. I have done them myself in New Haven. And they can make a very real difference in the education that our young people are receiving.

Your own association has undertaken some particularly noteworthy programs in this regard. Under your association's Urban University-Urban School Collaborative Program, 16 of your members in urban areas have initiated innovative programs between university presidents and school superintendents to bring the expertise of the university to bear on local problems of precollege education. In Kansas City, for example, the University of Missouri and local districts established a Mathematics and Science Institute that bring urban and suburban high school students to the campus for intensive work in mathematics and science. In Providence, the University of Rhode Island helped to set up a magnet elementary school concentrating on science and mathematics. These are the kinds of initiatives that can make a difference.

I might also point to the effort by Fermi National Laboratory, in collaboration with Argonne National Laboratory and the University of Chicago, to adopt a number of Chicago inner city schools in a pioneering program that will bring a major concentration of the nation's scientific and engineering talent to bear on some of the schools' problems. Such programs can be particularly vital in concentrating on minorities, who will have to assume a much larger role in science and technology if the achievements of the past are to be extended.

Finally, I think it is important for us to recall that the problems of precollege education extend far beyond science and engineering. We cannot reform science and mathematics education separately from the larger problems of restructuring and upgrading our schools. Probably everyone has a favorite story of a student who brings the failings of our education system into sharp relief. My own favorite is a graduate student I had at Yale, who had been an undergraduate at Harvard and is now an internationally known physicist. However, the first sentence of his Ph.D. thesis, when I received it in draft, read: "This field of research is so virginal that no human eyeball has ever set foot in it."

I realized then that the problems were not confined to science, and that we had no option but to make common cause. I hope that I can count on you to join me in this effort.

HUMAN RIGHTS AND THE SCIENTIFIC COMMUNITY

D. ALLAN BROMLEY

ASSISTANT TO THE PRESIDENT FOR SCIENCE AND TECHNOLOGY

EXECUTIVE OFFICE OF THE PRESIDENT

National Academy of Sciences

Washington, D.C.

October 27, 1989

Because of scheduling difficulties, President Bush was not able to attend this distinguished gathering. But he sent with me the following message:

[MESSAGE PREPARED SEPARATELY.]

It is a proud moment for me to stand before you tonight and deliver that message from the President. When I was formally sworn in two weeks ago as Assistant to the President for Science and Technology, I took an oath to "support and defend the constitution of the United States," to bear "true faith and allegiance to the same." In that colorful, 18th century wording I find one of the true rewards of government service: to be part of a tradition that extends through history to the founding of this country. To serve in the federal government is to share in a higher vision, a vision that inspired the founders of this nation more than two centuries ago.

I am also here in another capacity: as a representative of the international community of scientists, a community with a vision no less grand than that of the founding fathers. When a scientist looks back two centuries, to the events that this symposium commemorates, other milestones are equally apparent. In England two centuries ago, James Hutton has just published his <u>Theory of the Earth</u>, which introduced for the first time the idea of the earth's great antiquity. In that essay's memorable last line--that nature has "no vestige of a beginning, no prospect of an end"--we can see the opening movement in an intellectual chorus that would lead inexorably to the ideas of Charles Darwin. In France two centuries ago, Lavoisier published his <u>Traite elementaire de chimie</u>, which laid the foundations for modern chemistry, and Laplace was working on his <u>Systeme du monde</u>, which would represent for many years the final synthesis of the Newtonian worldview.

In other words, it was a time of great ferment in science, just as it was a time of great ferment in the political and social affairs of man. Science was moving toward a more accurate and faithful understanding of the antiquity of the earth, its place in the cosmos, and man's place in nature. At the same time, in the political sphere, society was moving toward a more faithful understanding of the natural and civil rights of man, which found its resounding affirmation in the documents we are here to celebrate.

It was no coincidence that scientific progress and human rights were so firmly linked. Science has many characteristics that ally it with a respect for human freedom and dignity. It seeks the truth through a process of examination and dissent. It seeks to verify observations through free communication and dissemination of results. It seeks a common language to convey its findings, a language that extends beyond national and ethnic boundaries. As Louis Pasteur wrote, "Science knows no country because knowledge belongs to humanity, and is the torch which illuminates the world."

The links between science and human rights are especially apparent in Thomas Jefferson's Declaration of Independence. In that document, Jefferson called human rights "self-evident," in the form of a proposition in science. These rights were inherent and unalienable, justified not by God or the government but by the nature of man.

Today, of course, science and technology have become dramatically more powerful influences on our society than they were two centuries ago. Scientific and technological change has become the hallmark of our age. Not only have these changes irretrievably altered the character of our society, but they have transformed how we as a nation view ourselves and our future.

Yet in the midst of this change, the connection between science and human rights remains strong. When free communication is impeded, science is weakened. When the truth is subverted, science is debased. When dissent is outlawed, science cannot progress.

Your presence here testifies to the continued symbiosis between science and human rights, as do the many efforts that have been made by scientific, engineering, and medical organizations on behalf of human rights. In particular, the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, through the Academy's Committee on Human Rights, has been very active in defending the rights of scientists, engineers, and medical personnel who have come into conflict with their governments. The committee works by appealing to the governments concerned, providing moral support to individuals and their families, sending delegations to particular countries, and on occasion making public statements. It also relies on the support of other national academies, including very notably the French Academy of Sciences through its committee on human rights under chairman Francois Jacob.

Much of the committee's work is private, operating through private channels using private funds, so its accomplishments are not well known. Yet its successes have been dramatic. Since the committee's formation in 1976, it has taken on the cases of more than 330 scientists, engineers, and medical personnel who have been prisoners of conscience, and more than 245 of these cases have been successfully resolved. For example, last March, 12 scientists were released from prison in Somalia, after spending more than seven years in solitary confinement. This release occurred soon after a commission from the academy and the Institute of Medicine traveled to Somalia and met with government officials to press for their freedom.

Also not well known is the fact that, of the memberships of the National Academies of Science and Engineering and Institute of Medicine, over 1,200 individuals have volunteered to become active supporters of the committee's work, writing letters, meeting with government officials and with detained scientists, and otherwise working to further the committee's goals. In addition, the Institute of Medicine has its own Committee on Health and Human Rights, which has done much in this area. The courage and conviction of these individuals working selflessly in behalf of human rights are actions of which all scientists can be proud.

Another group that has taken a prominent role in the struggle for human rights is the American Association for the Advancement of Science. Under its Science and Human Rights Program, the AAAS has worked steadily for the freedom of many scientists and technologists detained or silenced because of their convictions. When I was president of the AAAS in the early 1980s, the program added a specific focus on health care professionals: both those who had been involved in the administration or concealment of torture and those who spoke out against it or treated its victims.

Most recently, the AAAS has been involved in an innovative effort to apply the tools of science and technology to the protection of human rights. At the invitation of the Alphonsine government, it sent a delegation of forensic scientists to Argentina to exhume and identify the skeletal remains of people who had been killed in the so-called "Dirty War." The team also trained a group of Argentine graduate students who have since carried on this work. These activities not only can bring to justice those responsible for these terrible crimes; they can also have a powerful deterrent effect on individuals who might consider similar crimes.

The AAAS has also been involved in a program to use genetic markers to identify the children of the disappeared so that they can be returned to their rightful families. So far, about 60 children have been identified using these sophisticated biological techniques.

I would also like to mention the activities of the International Council of Scientific Unions, which has long been involved in protecting the rights of scientists to free speech and movement. When a violation of these rights is reported to ICSU's headquarters in Stockholm, its human rights division under the leadership of Olaf Tanberg works through the many contacts it has available in most countries to bring about the resumption of those rights. This is another example of how the commitment of scientists to human rights finds concrete expression.

I have mentioned just the largest groups, and only some of their activities. But many other groups and individuals have been involved. Whenever a single scientist writes a letter, or travels to another country and brings up the case of a repressed colleague, progress is being made.

Of necessity, scientists, engineers, and medical professionals have tended to focus their efforts on their colleagues, because that is where they can have the greatest effect. But that leaves open the broader question: What part can science play in extending human rights to all people? We should not forget that more than basic civil and political rights are needed by people who do not have enough to eat, or who lack proper medical care, or who are subject to the devastation of natural disasters. Nor do universal pronouncements of human rights guarantee their existence. Thomas Jefferson had slaves, and many of us sitting in this room would not have experienced the rights we enjoy today if we had lived during the French Revolution.

I do not think that the commitment of scientists to human rights can be questioned, as demonstrated by the examples I have cited. But science has a much more pervasive, though perhaps more subtle, influence on human rights. On the ceiling of the great hall outside this auditorium, there is a passage from Aeschylus's Prometheus Bound, and I would encourage all of you to look at it during dinner, because it describes an attribute of science that has not changed in over two millennia. In that passage, Prometheus says, "I taught [humanity] to discern the risings of the stars and their settings. . . . And numbers, too, chiefest of the sciences, I invented for them. . . . If ever a man fell ill, there was no defence, but for lack of medicine they wasted away, until I showed them how to mix soothing remedies wherewith they now ward off all their disorders."

That is the true promise of science: to act as a force for human progress, to reveal all that is best and most noble in mankind. That promise is as strong today as it was during the time of the Greeks, or during the time of the French and American Revolutions. It is the promise of universal human rights, of a world in which the dignity and liberty of all people can be realized. Thomas Jefferson put it best: "The main object of all science," he said, "is the freedom and happiness of man."

THE WHITE HOUSE

WASHINGTON

October 25, 1989

I am pleased to offer my warmest greetings to all those gathered in our Nation's Capital for the Symposium, "Les Droits de l'Homme and Scientific Progress," sponsored by the National Academy of Sciences and the Smithsonian Institution, in cooperation with the University of Virginia.

This series of discussions is a wonderful way to observe the 200th anniversary of two documents that have shaped the course of modern democratic government: our Bill of Rights and the French Declaration of the Rights of Man and the Citizen. In July, I met with French President Mitterand and the heads of government of five other industrialized nations at the Economic Summit in Paris. In a joint statement on human rights, we noted the bicentennial anniversary of the French Declaration and reaffirmed our commitment to respecting and protecting, without fear or favor, the rights and liberties of individuals. We also noted that developments in the human sciences, such as advances in genetics and organ transplantation, must be applied in accordance with those rights if the dignity of all human beings is to be preserved.

Because their work has such a great impact on virtually every aspect of human life, it is fitting that scientists reflect upon the rights of individuals and how they can help protect them. I am pleased to note that, over the years, many scientists around the world have been champions of human rights. With great conviction, and often at great risk to themselves, they have advocated the free exchange of ideas and information, the right to self-determination, and freedom of speech and of association. They have been a credible and influential voice for human rights in nations ruled by totalitarian regimes, and they have helped to bring about the release of political prisoners around the world. Scientists have also helped prominent colleagues to emigrate from countries where they have suffered political repression and religious persecution.

However, much work remains to be done. As we celebrate the human rights enshrined in our Bill of Rights and the French Declaration of the Rights of Man and the Citizen, we should renew our determination to cherish and defend them. Your efforts to promote consideration of the relationship between human rights and scientific progress represent an important step toward that end.

Barbara joins me in sending best wishes for a most enjoyable and productive symposium. God bless you.

George Bush

SCIENCE AND TECHNOLOGY POLICY AND THE NATION'S ECONOMY

J. THOMAS RATCHFORD
ASSOCIATE DIRECTOR FOR POLICY AND INTERNATIONAL AFFAIRS
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
EXECUTIVE OFFICE OF THE PRESIDENT

An Address to Participants in the
Academy-Industry Program
National Academy of Sciences
Washington, D.C.
December 11, 1989

I should begin this evening by conveying to you Dr. Bromley's greetings and sincerest apologies for not being able to attend this session. At this moment, he is cloistered with the President and several members of the Cabinet reviewing requests for additional funding in the President's FY 1991 budget. I'll be talking about that process in detail in a few minutes, but for now I'm sure that Dr. Bromley would agree with the old saying that the road to good intentions is paved with hell.

This is a particularly appropriate time for a representative of the Office of Science and Technology Policy to be talking with you, because our office is currently caught up in the preparation of the President's budget, and much of our time between now and January 22, when the budget is scheduled to go the Hill, will be taken up with that task. But I do not mean to imply that the budget will occupy us just a few months out of the year. Coordination and oversight of the federal R&D budget is going to be an ongoing concern of the Office of Science and Technology Policy, and we expect to have a significant impact on the budget in coming years.

In fact, as Dr. Bromley stated in a talk at the Brookings Institution last week, economic concerns, as represented by the preparation of the budget, are going to be perhaps the most important issue that we will be facing both within OSTP and within the administration as a whole. To quote Dr. Bromley, "The simple fact of the matter is that if the United States does not remain healthy economically, we will be unable to achieve all of the things we would like to achieve in other areas of national concern--in defense, in health care, in education, in the protection of the environment. Economic productivity is the foundation on which we build our national policy, and we ignore that foundation at our peril."

You more than anyone are aware of the many connections between science and technology, on the one hand, and economic health, on the other. These connections are intuitively obvious, and any reading of economic history since the turn of the century makes them apparent. But I think it is also interesting that these connections have been quantified. A recent economic study by Edwin Mansfield of the University of Pennsylvania of 76 major American corporations in 7 industrial sectors has shown that the average social rate of return on the investment in academic research is about 28 percent. This is one of many reasons why this country cannot afford to shortchange basic science and technology.

In 1989, out of a national R&D budget of $132 billion from both public and private sources, the United States spent about $19 billion on basic research. This is probably the wisest investment that the citizen makes in both the short-term and long-term future of the nation, even if few have any direct control over it or, indeed, even think about it.

The private industry of this country is especially to be commended for its commitment to basic research. Private industry in this country conducts 72 percent of the nation's total R&D, with about two-thirds of the funds for that work coming from its own coffers. During the 1980s, company funding of industrial R&D has grown at an average annual rate of 3.8 percent in real terms. Even more impressive, since 1975, industry's support for basic research has grown by 5.8 percent a year. By any measure, this is a remarkable investment in our country's future, and it does much to belie the notion that private industry in this country is focused only on the next quarter's profits.

But the competition is fierce, and we can only expect it to get worse. We are all familiar with the statistics that civilian R&D funding in the United States amounts to only 1.7 percent of our GNP, whereas the corresponding figures in Japan and West Germany are 2.8 and 2.6 percent. Even more apparent are the headlines that document a continuing loss of market share to other countries.

Particularly troubling is the continuing erosion of market share in high-technology industries. Our office has focused much attention over the past month on the semiconductor industry. But in many ways, what has and is happening to the semiconductor industry is a paradigm for what could happen to many other U.S. industries, such as the computer and telecommunications industries, unless corrective actions are taken in the immediate future.

I'm going to come back in a few moments to the specific actions that the Office of Science and Technology Policy will be undertaking in the area of economic competitiveness. But first I thought I would go over some of the general policies of the Bush Administration to establish a context in which to place the actions of our office.

The Federal Role in Enhancing Competitiveness

The Bush Administration recognizes that the federal government cannot help but be an important factor in the competitiveness equation. In fact, the administration is committed to several policies designed explicitly to enhance the competitiveness of American industry. For example, the government has a duty to insure fair trade treatment for U.S. industry in the global marketplace. Dumping and other unfair trade practices must not and will not be tolerated. Our intellectual property rights must be protected. And U.S. companies must have access to world markets free from tariff and nontariff barriers.

Some would point to the loss of market share in key industries and advocate that the U.S. government should go farther--that it should move to bolster those industries through direct federal involvement. But the Bush Administration believes that private industry, not the federal government, knows what is best for private industry. The Bush Administration will not adopt a policy that has the effect of picking winners and losers in the marketplace. Such a process is often a political, non-analytical process that results in some industries receiving preferential treatment and others not. I'm speaking for Dr. Bromley when I say that our office sees that process as a risky, short-term fix for perceived immediate problems, not as a strategy for long-term competitiveness. In fact, in the long run, it could hurt competitiveness.

But the options available to the federal government do not necessarily fall into the stark categories of massive government subsidies of favored industries on the one hand and a total "hands-off" approach by the federal government on the other. At OSTP, we strongly believe that the real choices lie in another direction.

o To take the more obvious choices first, the government should clearly fund research, development, and demonstration in areas where it is the primary customer, such as defense applications. It is also appropriate for the federal government to fund areas where the private sector cannot take the risks associated with uncertain returns and long incubation periods, such as basic research.

o It is also the responsibility of the federal government to create the macroeconomic conditions that are conducive to investments in research and development by private industry. In his message to Congress that accompanied last year's budget, President Bush outlined a number of actions designed to establish such conditions, such as making the R&D tax credit permanent, cutting the capital gains rate, and reducing the deficit. The administration remains committed to those priorities.

o The government also has an important effect on competitiveness through its regulatory policy making. Government regulation can shape not only a company's domestic markets but its international markets, through the degree of harmonization between regulations here and abroad.

o In the long term, there is no more important determinant of our future economic prosperity than the strength of our educational system. Dr. Bromley is the first science adviser to have made science and mathematics education one of his top priorities. He intends to work in a number of ways, both within the administration and in public forums, to promote the need for restructuring and upgrading our schools.

o A specific area in which the federal government can play an important role is with respect to generic, enabling technologies. These are technologies that are useful for a large number of industries but are relatively peripheral for any one industry, so that the total private investment for that technology is less than optimum. These technologies have the potential to exert a high leverage on many industrial sectors, so governmental support in this area can have a substantial return.

o Finally, the government must try to eliminate both real and perceived disincentives to industrial collaboration. These collaborations, from R&D through joint precompetitive ventures, provide a means for companies to share risk and pool resources, and they are common in other countries. Ironically, they are also common between U.S. firms and foreign firms. But this country has been slow in adjusting to the new reality that we are now competing in a global marketplace, and new mechanisms need to be found that allow companies and the federal government to work together to better meet this competition.

One example of industrial collaboration that combines both horizontal and vertical collaboration is SEMATECH, the consortium of semiconductor companies that focuses on precompetitive research and development. Dr. Bromley has stated in testimony to Congress that we need more such efforts in other high-technology industries of interest to the economic and military security of this nation.

The federal role in such consortia has to be determined on a case-by-case basis. Increased federal spending, per se, is not necessarily the answer for increased U.S. competitiveness. But a governmental role may be accompanied by federal dollars, as in the case of SEMATECH. That decision can only be made after carefully weighing both national security and competitiveness considerations.

The Budget Process

As is clear in my being here rather than Dr. Bromley, the Administration is in the middle of a very complex budget review. Tough budgetary times lie ahead for all federal programs, not just those involving research and development.

In the current fiscal year, the Gramm-Rudman law calls for a deficit level of $110 billion. In the President's budget for FY 1991, the budget deficit must be cut to $64 billion. There will obviously be severe pressure on those parts of the budget that are not already tied up in entitlements, including research and development.

This year, Dick Darman of the Office of Management and Budget has introduced a new process in apportioning funds among competing programs. Various agencies that can make a case for increased spending will have to compete for a limited amount of funds. Current requests for add-ons and new initiatives amount to something like eight times the discretionary funding that is available. So there will have to be an eight-to-one compression of these programs--a truly Procrustean task--carried out ultimately by the President, before the budget can be released in January.

The federal government obviously has a number of national objectives in science and technology, and it must balance its R&D funding across a number of areas to meet these objectives. What is needed is a carefully constructed, balanced portfolio of programs and projects. One aspect of this relates to the balance between individual, principal-investigator-initiated projects and the megaprojects in science such as the superconducting supercollider, the space station, the human genome project and so on. As Dr. Bromley has stated, the high quality of American science and technology depends on continued, adequate funding of the individual principal investigator. The megaprojects must, in all cases, be weighed against this need.

With respect to the funding decision being made for the broad portfolio of science and technology needs, all I can say at this point--and all that Dr. Bromley would be able to say--is stay tuned. Some very difficult decisions are in the process of being made, even as we meet. I'm sure that the results are going to be very interesting.

The Role of OSTP

One very favorable indicator regarding the science and technology parts of the budget is Dr. Bromley's strong involvement in the process. As you know, his position has been elevated within the Administration to that of Assistant to the President--which is not a Cabinet level position, as has sometimes been reported--but carries a much more important cachet than the position of OSTP Director formerly did. For instance, Dr. Bromley has been made a full member of the Domestic Policy Council, the Economic Policy Council, and the Space Council--and he is involved with the National Security Council and the Competitiveness Council--all of which are responsible for establishing and implementing administration policy.

In general, the Office of Science and Technology Policy is working closely with the Office of Management and Budget to develop those parts of the President's budget that deal with research and development. In fact, we have an agreement with OMB to work at all staff levels and throughout the development of the budget, not just in its final stages, as has often been the case in the past.

OSTP will be undertaking a number of other activities that deal specifically with economic and industrial concerns. Most important, one of my fellow associate directors will focus on industrial technology. This is an entirely new post at OSTP, and Dr. Bromley has spoken often of its importance. This individual will work in close collaboration with the occupant of the newly-created post of Under Secretary of Commerce for Technology to coordinate federal activities in support of engineering and technology R&D and to catalyze the growth of pioneering state and regional technology initiatives.

The President has not yet forwarded the name of this Associate Director-Designate to the Senate, but I can tell you that he is a very senior R&D executive from the private sector. I think you will be very impressed by his qualifications when the name is announced.

There will be four associate directors within OSTP--Dr. James Wyngaarden in the life sciences, the associate director for industrial technology, an associate director for physical sciences and engineering, and myself. Dr. Bromley's intention is that he and the four of us will work in a collegial manner, with no firm boundaries drawn between our various responsibilities. In this way, we will be working together on one of the office's two main responsibilities--what Dr. Bromley calls science and technology for policy--namely, providing to the President and the Administration with the best information, analysis, and advice that the scientific and engineering communities can produce.

Our other main responsibility is what Dr. Bromley refers to as policy for science and technology. The legislation that established OSTP in 1976 calls on the office to evaluate the federal effort in science and technology, recommend ways in which that effort might be improved, and coordinate the R&D programs of the federal government. One of the primary mechanisms by which this coordination is achieved is the Federal Coordinating Council for Science, Engineering, and Technology or FCCSET. FCCSET is the entity within the executive branch, established by OSTP's organic act, that is responsible for coordinating R&D across the federal government. The members of FCCSET are appointed by the heads of each agency that funds substantial R&D. Typically these members are the top science administrators at each agency, so at NSF the FCCSET member is the director and at the Department of Energy it's the head of energy research.

FCCSET, in turn, sets up special committees consisting of agency officials who work to coordinate specific areas of science and technology. For example, one FCCSET committee that we see as a model for future efforts is the Committee on Earth Sciences. Last summer a working group of the committee released a report entitled <u>Our Changing Planet: The FY 1990 Research Plan</u>, which described the efforts of the eight federal agencies involved with research on global change and meshed these efforts into a coordinated research plan and budget. That is the kind of coordination we would like to see throughout the federal government's R&D activities.

One problem with the FCCSET structure, however, is that it has no formal mechanism for input from the private sector. Toward that end, Dr. Bromley is putting together a new body called the President's Council of Advisers on Science and Technology or PCAST. PCAST will consist of 12 distinguished scientists and technologists from the private sector and academia. It will examine a wide range of issues in science and technology and report directly to the President. In addition, PCAST will have the authority to form ad hoc panels of executives, researchers, and academics to parallel the committees that we put together within OSTP under FCCSET. By bringing the PCAST panels and FCCSET committees together frequently, a mechanism will exist to provide input to the highest levels of government from the private sector.

Future Challenges

Once these three layers of personnel are in place--OSTP's internal staff, a revitalized and enlarged FCCSET structure, and PCAST--the office will be able to move forward at full speed on some of the major challenges facing the nation in science and technology policy. For instance, in the area of regulation, bringing together FCCSET committees with groups from the private sector under PCAST will provide a means for competitiveness concerns to enter into regulatory decision making. For example, one area where such public-private coordination would be especially valuable is biotechnology, where regulatory actions undertaken in the next few years will have a substantial impact on the ability of U.S. companies to compete worldwide.

This three-tiered structure will also be able to focus federal efforts on the problem of mathematics and science education. It is anticipated that a new FCCSET committee -- most likely called the Committee on Human Resources -- will be set up to coordinate on a continuing basis the activities of all federal agencies with significant responsibilities in science and mathematics education. The President also plans to ask PCAST, as one of its first tasks, to form a group to look at the federal role in mathematics and science education.

But even with the assistance of FCCSET and PCAST, the Office of Science and Technology Policy cannot do what it has set out to do without a great deal of additional help. In that regard, I would like to leave you tonight with a challenge. I mentioned earlier the importance of generic, enabling technologies to many industries and the important leveraging effect that can be achieved through federal support of these technologies. This issue was eloquently framed in the statement on Technology and Competitiveness, issued earlier this year by the Council of the National Academy of Engineering. The question we face now is: how do we do this right? What are those technologies that could make a difference to your companies but are too long-term or speculative to satisfy the pragmatists in your financial management departments? Dr. Bromley has proven himself very open to suggestions from the private sector regarding the activities and concerns of our office. I encourage you to let him know your thoughts on this. I can assure you they will meet a receptive audience.

We have laid out a very ambitious program for the Office of Science and Technology Policy, and there are some who say we will be hard-pressed to do everything currently on the drawing board. But it is a very exciting time at OSTP, with Dr. Bromley's arrival, a revitalization of the staff, and the excellent White House environment. All of us view the next few years as a time of great opportunity; I hope that when an accounting is made of our stewardship, it will show that these opportunities were grasped.

/ :

Dr. Norman Borlaug
International Maize and Wheat
Improvement Center (CIMMYT)
Apartado, Postal 6-641
Delegacion Cuauhtemoc
06600 Mexico D.F.

Norman

Dr. Solomon J. Buchsbaum
Executive Vice President
Customer Systems
AT&T Bell Laboratories
Crawfords Corner Road
Holmdel, New Jersey 07733

Sol

Professor Charles Drake
Department of Earth Sciences
Dartmouth College
228 Fairchild
Hanover, New Hampshire 03755

Charles
603-646-3338 (Pam Transp.)

Dr. Ralph E. Gomory
President
The Sloan Foundation
530 Fifth Avenue
New York, New York 10111

Ralph
Carin Rogers 212 649-~~4643~~ 1643

Bernadine Healy, M.D.
Chairman, The Research Institute
The Cleveland Clinic Foundation
9500 Euclid Avenue
Cleveland, Ohio 44106

Bernadine

Dr. Peter Likins
President
Lehigh University
Alumni Building No. 27
Bethlehem, Pennsylvania 18015

Pete

Dr. Thomas E. Lovejoy
Assistant Secretary for External Affairs
The Smithsonian Institution
1000 Jefferson Drive, S.W.
Washington, D.C. 20560

Tom

Dr. Walter E. Massey
Vice President for Research
and for Argonne National Laboratory
The University of Chicago
5801 Ellis Avenue
Chicago, Illinois 60637

Walter

Dr. John P. McTague
Vice President, Research
Ford Motor Company
Scientific Research Laboratories Building
20000 Rotunda Drive
Dearborn, Michigan 48121

John

Professor Daniel Nathans
Department of Molecular Biology and Genetics
Johns Hopkins School of Medicine
725 North Wolfe Street
Baltimore, Maryland 21205

Prof. Nathans

The Honorable David Packard
Chairman of the Board
Hewlett-Packard Company
1501 Page Mill Road
Palo Alto, California 94304

Dave.

Dr. Harold Shapiro
President
Princeton University
One Nassau Hall
Princeton, New Jersey 08544-0015

Harold.

(A)

OSTP-WP-1990-1

INDUSTRIAL TECHNOLOGY AND THE FEDERAL GOVERNMENT

WILLIAM PHILLIPS
Associate Director for Industrial Technology
Office of Science and Technology Policy
Executive Office of the President

An Address to the Spring Meeting of the
Laboratory Products Association
March 20, 1990
Washington, D.C.

I should begin by extending Allan's sincerest apologies for not being able to meet with you today; he very much wanted to do so. The second meeting of the President's Council of Advisors on Science and Technology is this Thursday, and he is deeply involved in the preparations for that meeting. For the first time in almost two decades, a scientific advisory committee has been formed to channel science and technology advice to the President. PCAST, as it is known, consists of 12 distinguished industrial and academic leaders in science and engineering. At a time when science and technology are at the core of our industrial competitiveness, I think you will agree that this is an important endeavor.

I would like to focus on competitiveness for much of my time this afternoon, but in a broad fashion. I will be looking at an important short-term influence on competitiveness--federal funding for R&D--and on a much longer-term influence--the state of precollege education. And before I get to either of those topics, I thought I would briefly describe our office and some of the activities that we will be pursuing that have an effect on industrial competitiveness.

PCAST is one of three components of the science and technology advisory apparatus within the Executive Office of the President. Another component is the Office of Science and Technology Policy itself, of which I am one of four Associate Directors. OSTP was created in 1976 by the Congress to serve two main functions: (1) to provide the President and the rest of the Administration with the best possible information, analysis, and advice regarding the influence of science and technology on national and international policy and (2) to review and coordinate research and development within the federal government, taking into account the simultaneous efforts of industry and academia. Allan tends to describe these two functions as, first, science and technology for policy and, second, policy for science and technology.

Much of the coordinating function of our office takes place through the third component of the science advisory apparatus: the Federal Coordinating Council for Science, Engineering, and Technology. FCCSET was created by the same 1976 legislation that created OSTP. It is charged with reviewing and coordinating science, engineering, and technology activities that affect more than one federal agency.

In the past, several FCCSET committees--such as the Committee on Earth Sciences and the Computer Research and Applications Committee--have demonstrated the great advantages to be derived from effective coordination of cross-cutting issues in science and technology. For example, over the past several years, the Committee on Earth Sciences has organized all of the formerly disparate research on global change into the U.S. Global Change Research Program, which is now a coherent, government-wide approach to the scientific understanding of global change.

Allen is now in the process of revitalizing and reorganizing the FCCSET structure. An array of umbrella committees are being established in such areas as health and the life sciences, the physical, mathematical, and engineering sciences, and education and human resources. Various subcommittees will be formed under these committees in such areas as high-performance computing, the social and behavioral sciences, and materials science and engineering. Through this revitalized mechanism, we hope to focus attention on areas of R&D that are particularly crucial in our international competitive stance.

Allan is the chairman of both PCAST and FCCSET, besides being the head of OSTP, so he is able to coordinate the activities of all three. For example, he is considering the prospects of setting up committees under PCAST that would parallel some of the committees under FCCSET. This would allow input to the FCCSET committees from the private sector to a much greater degree than has been possible before.

SCIENCE AND TECHNOLOGY IN THE FEDERAL BUDGET

I've described this long institutional apparatus to make a relatively simple point: science and technology are much closer to the center of White House thinking than they have been in the past.

One of the best reflections of that changed status for science and technology can be seen in the 1991 budget. As I.F. Stone has noted, in Washington "the budget is the message." I doubt that many of you have seen much of the budget--though this year it is actually a quite lively and enjoyable document--but the two chapters on research and development are preceded only by a chapter on increasing savings. To the extent that you can read priorities from a table of contents, science and technology have done quite well.

The budget calls for a record $71.2 billion for research and development, a healthy 7 percent increase in what is otherwise a tight budget year. But our office is even more encouraged by some of the trends within that total. Civilian R&D would go up 12 percent, from the $23.8 billion that was enacted in FY 1990 to $26.7 billion in FY 1991. Basic research would rise $1 billion, from $11.4 billion to $12.4 billion, an increase of 8 percent. At a time of declining real defense expenditures, basic research by the Defense Department would go up by about 6 percent.

There are several aspects of the President's budget that are of particular interest to the Laboratory Products Association. The budget calls for the funding of the National Science Foundation to increase by 14 percent, to $2.4 billion, so that NSF's budget would resume its track to doubling by the year 1993. Funding for the National Institutes of Health would rise to $7.9 billion, which marks a doubling of NIH's budget in current dollars since 1983.

However, you as well as know, the funding situation at these two agencies is far from optimum. During fiscal year 1989, for the first time ever, the fraction of excellent, peer-reviewed, new proposals that were actually funded by these two agencies fell below 30 percent. The discouragement caused by a lack of funding is particularly unfortunate at a time when the nation has a very serious need to recruit more young people into scientific careers.

There are several reasons for this distressing state of affairs, including a rate of inflation for scientific research that is higher than the consumer price index, a greater number of multiyear grants, and the simple fact that scientific research has been so successful at generating new opportunities. We are very aware of the problem in our office and will be looking for ways to ease the pressure on individual investigators. Allan has often said that individual investigator and small group research is the heart and backbone of science in this country and that support for this kind of science must come first.

Another section of the budget that you would find particularly interesting is that on developing advanced technologies to meet government and civilian needs. For instance, robotics research is slated for a 28 percent increase to $192 million. High-performance computing is proposed to increase 5 percent to $469 million. Research on semiconductors remains about the same at $537 million, as does research on superconductivity at $215 million and research on advanced imaging technologies at $118 million.

At the Department of Commerce's National Institute of Standards and Technology, the budget proposes $10 million for the new Advanced Technology Program to support a number of consortia doing generic, precompetitive research into promising technologies. The budget also proposes $5 million for grants to the Regional Manufacturing Technology Centers that will transfer advanced manufacturing technologies to medium- and small-sized businesses.

Despite these relatively targeted programs, most federal support for R&D remains mission oriented, as has been the case since World War II. Nevertheless, we in the United States have built the largest science and technology base in the world. How have we managed to do this without engaging in the targeted R&D funding common among our major competitors?

I believe that much of the reason lies in the complementarity of federal and industrial support of R&D. Research results have broad applications and tend to diffuse rather quickly. As a result, the private sector tends to underinvest in such research because it is difficult for a single firm to realize exclusive benefits from these investments. But the long-term benefits are so large that the federal government cannot afford <u>not</u> to invest in this research, especially in university research that also produces trained scientists and engineers for industry, academia, and the public sector.

Meanwhile, private industry in this country has historically proven itself the best in the world at converting the results of basic research into commercially successful products. I think your industry is a prime example of that uniquely American excellence in innovation.

INTERNATIONAL COMPETITIVENESS

The question then becomes, Can we continue to rely on this traditional approach to the innovation process? I certainly don't need to recite for the people in this room the by now familiar litany of declining competitiveness within our manufacturing sectors. Should the government take a more activist role in moving to stem these declines?

I think it is important, in answering this question, to recognize not only the weaknesses but the continuing strengths of the United States in the international marketplace:

o We continue to have the world's largest research and technology base by a large margin.

o We have a large number of research universities that set world standards for excellence.

o We have a system of federal laboratories that are among the world's best.

o We have a culture that accepts and encourages entrepreneurism.

o And we have a tradition of successful federal civilian R&D in agriculture, health, and aeronautics.

However, these many strengths of the U.S. system must be weighed against the weaknesses--some perceptual, some real--of the United States in international competition.

o The cost of capital in the United States is higher than for our major competitors, and there is an emphasis on short-term returns on investments.

o There is a reduced willingness to take technological risks, especially in large corporations and in the financial community.

o The quality of the technical workforce is declining in terms of education, training, and the flexibility to adapt to technological change.

o There is an inefficient coupling between industrial R&D and production.

o Other countries are outperforming the United States in transforming discoveries quickly into high-quality products and into processes for designing, manufacturing, marketing, and distributing these products.

o There is a lingering fear of antitrust measures that inhibits company-to-company cooperation.

o Too often, there is an attitude of mutual distrust that inhibits cooperation between industry and the government.

o The coupling between federal laboratories and industry is weak, particularly with small- and mid-sized companies that could benefit most from federal assistance.

o There is a tendency for federal technology transfer programs to be decoupled from state programs.

ENHANCING INTERNATIONAL COMPETITIVENESS

If these problems are to be solved, actions must be taken on many fronts involving all components of our society. For the federal government, the challenge is to develop and exercise intelligent and visionary leadership emphasizing the long-term economic vitality of the nation.

Some people have advocated that the U.S. government should move to bolster industries that have lost global market share through favorable tax treatment or direct subsidies. But the Bush Administration believes that private industry, not the federal government, knows what is best for private industry. The Administration will not adopt a policy that has the effect of picking winners and losers in the marketplace.

But the options available to the federal government do not necessarily fall into the stark categories of massive government subsidies of favored industries on the one hand and a total "hands-off" approach by the federal government on the other. At OSTP, we strongly believe that the real choices lie in another direction, and we have been working within the Administration to promote some of these options.

First of all, it is obviously the responsibility of the federal government to create the macroeconomic conditions that are conducive to investments in research and development by private industry. President Bush has outlined a number of actions designed to establish such conditions, such as making the R&E tax credit permanent, cutting the capital gains rate, and reducing the deficit.

Secondly, the government has an important effect on competitiveness through its regulatory policy making. Government regulation can shape not only a company's domestic markets but its international markets, through the degree of harmonization between regulations here and abroad. For example, harmonized international protection of intellectual property will allow more benefits to be recovered from R&D investments made in the United States. Harmonization is also important between different states within the United States to decrease the risk for private investment.

Third, the government must try to eliminate both real and perceived disincentives to industrial collaboration. These collaborations, from R&D through joint precompetitive ventures, provide a means for companies to share risk and pool resources, and they are common in other countries. Ironically, they are also common between U.S. firms and foreign firms. But this country has been slow in adjusting to the new reality that we are now competing in a global marketplace, and new mechanisms need to be found that allow companies and the federal government to work together to better meet this competition.

Fourth, the government must make R&D activities at federal nondefense laboratories more relevant and accessible to the private sector. The objectives for such work should be set by the potential users. The results of federally financed R&D should also be diffused more broadly by actively licensing inventions and removing barriers to commercial development and marketing of federal computer software.

Finally, the government has a very important role to play in supporting the development of generic, enabling technologies. These are technologies that are important in a wide variety of commercial applications; however, no single company can capture enough of the benefits to justify investing an adequate amount of R&D in them. The rationale for investing in these enabling technologies is essentially the same as that for investing in basic research: individual companies cannot bear the cost and risk of such investments alone. Examples include certain materials technologies (such as superconductors), information technologies (an example is high performance computing), and biotechnologies (such as the development of scale-up technologies).

In a speech to the American Electronics Association last week, President Bush pointed to the importance of these technologies. He said, "This administration is committed to working with you in the critical precompetitive development stage where the basic discoveries are converted into generic technologies that support both our economic competitiveness and our national security. Here again we can help to level the international playing field on which you compete."

Later in the speech, the President said that he was going to charge the Competitiveness Council, which is chaired by the Vice-President, with a new task: "to find ways that American industry can better translate new ideas and technologies into marketable products."

At OSTP, we believe that this is an important function for the Administration. We will be working with the President, with the Competitiveness Council, and with the other parts of the Administration to further this work on leveraging technologies.

The FY 1990 Defense Authorization Act requires OSTP to set up a panel to identify critical technologies of importance to the long-term national security and economic prosperity of the United States. We are now in the process of setting up that panel and beginning the examination of candidate technologies. The panel's first report will be submitted to the President on October 1 of this year and transmitted to Congress 30 days later. This will be an important process within OSTP, and we are planning to devote a considerable amount of time to it this spring and summer.

EDUCATION

So far I've been discussing actions that could improve our competitive stance in the short- to medium-term. But in the long term, one factor emerges as of paramount importance--the education and training of American workers.

In an age of information, human capital is just as important as physical capital, and in many sectors it is more important. Yet if current trends continue, we will soon be running this country on the human equivalent of baling wire and scotch tape.

In 1983, the National Commission on Excellence in Education, in its report A Nation at Risk, warned of a "rising tide of mediocrity" that threatened to engulf our elementary and secondary schools. Yet in the seven years since then, despite a wave of school reform efforts, standardized tests show very little improvement in student achievement. Some have said that the three R's of education really ought to be the six R's: remedial reading, remedial writing, and remedial 'rithmatic.

Education is one of the most important concerns of the Bush Administration, and the science and mathematics component of that education will be a major concern of OSTP. Last September Allan accompanied the President to the Education Summit in Charlottesville, and even though a great deal of skepticism surrounded that meeting, he came away considerably heartened. Many of the states have instituted excellent and very innovative programs in education that could act as models for similar programs around the country.

The President and Governors agreed at Charlottesville that education will and should remain predominantly a state and local responsibility. But there remain many areas of responsibility and opportunity for the federal government. It has been said that "every problem that exists in education has already been solved somewhere." The federal government can monitor and identify the very innovative programs that originate at the state and local level and help to disseminate those programs to other locations.

During his State of the Union message three weeks ago, President Bush announced six national goals in education, including that U.S. students be the first in the world in science and mathematics achievement by the year 2000. These are very ambitious goals--and achieving them will require the best efforts of everyone associated with science and technology, including those of you in this room.

The Administration takes this set of national goals very seriously. The President and the Governors have agreed to work with Congress, with education groups, and with business to institutionalize a process to oversee the development of ways to measure progress against these goals and report regularly to the nation on whether they are being achieved.

We need to pursue a number of detailed steps to achieve the goals and objectives that the President and Governors have established. We need more magnet schools for science and mathematics that can inspire our most gifted young people. We must focus on the "forgotten middle"--the technicians who will be running the high-technology factories of the future. We need to encourage more women and minorities to study science and engineering and to pursue technical careers. And we must foster a level of scientific literacy in our society that permits people to understand, at least in outline, the vital role science and technology play in almost all aspects of contemporary life.

THE ROLE OF THE STATES

Education will be a responsibility shared by everyone at OSTP. But what I bring to OSTP, not only in education but in the broad range of issues covered by our office, is a somewhat different perspective. My background has been at the state level, and even though state governments and the federal government are quite different entities, there is much that each can learn from the other.

I believe, for example, that the federal government must consider the agendas of the states when it sets its own agenda. Unlike the federal government, the states can pick specific industries to support, based on their own histories, policies, and goals. The federal government must be aware of these activities and can act, through its own funding and programs, to maximize their potential for success.

The federal government can also learn from the states about the kinds of programs that work most effectively at the state and local level. This year's budget book has a chapter entitled "Advancing States as Laboratories," and even though the focus there is on services of various kinds such as transportation and education, the same general principles apply to industrial development. In turn, the federal government can act as a catalyst to spread programs that have proven successful in one location to other locations, where their success can be repeated.

These are the kinds of activities I will be trying to foster as OSTP's Associate Director for Industrial Technology. There is a great deal to be done in this area, and the obstacles to be surmounted are great. But Allan believes very strongly in the need for the federal government to address the problems of industrial technology, and together we hope to have considerable impact in the next few years.