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NATIONAL SCIENCE FOUNDATION FISCAL YEAR 2007 BUDGET REQUEST, PROGRAMS, AND SCIENCE PRIORITIES

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED NINTH CONGRESS

SECOND SESSION

MAY 2, 2006

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ONE HUNDRED NINTH CONGRESS

SECOND SESSION

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NATIONAL SCIENCE FOUNDATION FISCAL YEAR 2007 BUDGET REQUEST, PROGRAMS, AND SCIENCE PRIORITIES

TUESDAY, MAY 2, 2006

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE AND SPACE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:30 p.m. in room SD–562, Dirksen Senate Office Building, Hon. Kay Bailey Hutchison, Chairman of the Subcommittee, presiding.

OPENING STATEMENT OF HON. KAY BAILEY HUTCHISON, U.S. SENATOR FROM TEXAS

Senator HUTCHISON. I'm going to call our hearing to order and say that I'm very pleased to have you, Dr. Bement, and also Dr. Washington, the Director of the National Science Foundation and the Chairman of the National Science Board. We are very pleased that you could come and join us.

In addition, I wanted to mention that Dr. Neal Lane, a former Director of the National Science Foundation, was scheduled for our previous hearing, and, when we needed to change the date, he was not able to attend, but I certainly have asked him to submit a statement for the record, and we'll look forward to hearing from him.

I'm pleased that we have two such excellent panels, because this is a very important time in our country's history. We are engaged in an effort to really rejuvenate our emphasis on science and engineering in our country to increase the number of students and the world-class quality of students that we have had for all of our country's history, especially the last 100 years. But I know all of you are familiar with the report that came from the Committee appointed to look into our science and technology education and research, called "Rising Above the Gathering Storm," which has led to so much interest and focus on where we may not be going in the right direction, or, if we're going, maybe we're going a little too slow in the right direction. And I think that it is important for our Committee, as well as the Health, Education, and Labor Committee, to look into the National Science Foundation's part in all of this. Our part of the jurisdiction is research; theirs is the education part. And I am very hopeful that we can go forward with the President's Competitiveness Initiative and our PACE legislation—the PACE legislation being really based on the recommendations of

the Augustine "Rising Above the Gathering Storm" report proposals and recommendations.

So, I hope—Dr. Bement, you and I have talked about this a little bit, about the focus of the National Science Foundation and making sure that we are fulfilling the mission of hard sciences and engineering and technology innovation, which is what the National Science Foundation has done, and is doing very well, and, in light of this emerging challenge, whether we have enough of the complete focus of the National Science Foundation on these hard sciences. So, I will look forward to hearing your testimony on that, and also asking questions on that subject.

With that, let me turn it over to the full Committee Chairman, who is one of the largest proponents that we have in the Senate on this initiative for science and engineering focus. Senator Stevens has held several hearings, and I'm having this hearing. There have been other subcommittee hearings on our part of this initiative, because we want to be major players in moving America forward toward more—encouraging more children to go into science and engineering, and making sure that they have good teachers and that we have good research coming out of our country that is so important to our economy.

Senator Stevens?

STATEMENT OF HON. TED STEVENS,
U.S. SENATOR FROM ALASKA

The CHAIRMAN. Well, thank you, Madam Chairman.

I, too, welcome you, each of you from the Foundation and from the Board. As Senator Hutchison said, I have been quite moved by the Augustine report, and I think most of us have been. I don't take that report to be critical of either of you or the entities that you chair. I think it really is critical of the system, as a whole, and our failure to understand the changes that have come about, particularly with the increased challenges from India and China in the terms of science and technology, engineering, really the total impact of our—movement of so many of our industries to those areas has really changed the dynamics of our stimulus for our young people, the jobs available to them, and the future. I really have tried very hard to get the Congress, as a whole, to treat this problem similar to the way we treated the atomic energy problem and create a joint committee on this report, and to work with you and your organizations to fashion a way to rekindle the interest of our total U.S. community and taking the initiatives that must be started, must be fostered, really, to stimulate our young people and to provide incentives to them to once again make science and technology a priority, as far as our education system is concerned.

So, we're still going to continue working on that in this Committee, and the hearings that Senator Hutchison is holding will be quite helpful. We hope we can at least get the Senate together in one body to move forward with suggestions that will help reach some of the targets that were set by the Augustine report.

But I look forward to hearing your testimony. It does seem to me that we have to light a fire, and nothing short of a fire is going to really give us the intensity of consideration of these issues that

is required. So, I'm pleased to be with you today, and look forward to staying with you as long as I can.

Thank you.

Senator HUTCHISON. Thank you.

Dr. Bement?

STATEMENT OF DR. ARDEN L. BEMENT, JR., DIRECTOR, NATIONAL SCIENCE FOUNDATION

Dr. BEMENT. Got it, thank you.

Chairman Hutchison, Chairman Stevens, thank you for this opportunity to testify on the importance of basic research to technology, innovation, and competitiveness.

For over 50 years, NSF has been a strong steward of the Nation's scientific discovery and innovation process that has been crucial to increasing America's economic strength, global competitiveness, national security, and overall quality of life. Despite its small size, NSF has an extraordinary impact on scientific and engineering knowledge and capacity. Not only do we provide funding to the best of the best, we prioritize the research funding based on principles that have proven to be both robust and prophetic over the years.

The most successful priorities are set by the research community itself in a bottom-up process that involves the brightest minds in the country advising us about where new opportunities exist. Through workshops, conferences, and professional meetings, proposals for new programs come to NSF from the community. For example, we closely monitor the nearly 50,000 research proposals we receive each year for new ideas and opportunities within our served research communities. Through NSF external Committees of Visitors, Advisory Committees, and review panels, more than 13,000 outside experts regularly review NSF's research programs to help identify new opportunities.

Priorities are coordinated among agencies through the National Science and Technology Council within the White House. Through regular meetings with agency heads and senior management, each agency becomes aware of the research supported by other agencies across the Government. These meetings provide opportunities for collaborative efforts and prevent overlap and duplication.

Congress is also involved in priority-setting. Through both the authorizing and appropriations processes, scarce resources are allocated with attention to inputs from the National Academies, the private sector, as well as interested individuals and professional groups. While this system may appear to be complex, the proof of its effectiveness lies in the outcomes.

Of the 409 recipients of science Nobel Prizes throughout the world since NSF first awarded research grants in 1952, over 40 percent were researchers who received NSF funding at some point in their careers. NSF-funded results permeate our society. From Doppler radar to MRI scans, from the Internet to nanotechnology, from Google to barcodes, and from computer-aided design systems to tissue engineering, NSF investments have had a profound effect on our quality of life and on American competitiveness. Just these examples have added hundreds of billions of dollars to the U.S. economy over the past 15 years.

I would like to point out four other recently funded, less well known developments with equal promise, some of which illustrate the accelerating convergence between the physical and health sciences.

The world's first ultrafast, ultra-accurate laser scalpel was developed by physicists and ophthalmologists at NSF's Center for Ultrafast Optical Science. Called Interlase, it replaces the old LASIK system that required a blade.

An NSF-funded researcher has developed specially coated nanotubes that can be painlessly implanted under the skin. They fluoresce in direct proportion to glucose levels in the blood, potentially eliminating the need for glucose testing using needles.

Both an artificial retina to assist the blind to see and a new ultrasensitive artificial cochlea to assist the hearing-impaired to hear were developed with NSF support. Madam Chair, I hope these brief examples of what basic research can do to help U.S. competitiveness are compelling.

The world-class scientists, technologists, engineers, and mathematicians trained through NSF-sponsored research transfer new scientific and engineering concepts from universities directly to the entrepreneurial sector as they enter the workforce. This may be basic research's most profound and lasting impact. This capability is a strong suit in U.S. competitiveness and one of NSF's greatest contributions to the Nation's innovation system.

Another significant contribution to our Nation's innovation system comes from NSF's coupling with industry and the private sector. NSF's Engineering Research Centers and Science and Technology Centers directly invite private-sector partners to engage in and sponsor related cutting-edge research that can lead to high-leverage innovations.

Furthermore, NSF couples investment in our Small Business Innovation Research and Small Business Technology Transfer programs with high impact emerging technologies such as nanotechnology, information technology, and biotechnology.

Madam Chair and members of the Committee, I have only touched upon the variety and richness of the NSF portfolio. I look forward to working with you in the months ahead, and would be happy to respond to any questions that you may have.

Thank you.

[The prepared statement of Dr. Bement follows:]

PREPARED STATEMENT OF DR. ARDEN L. BEMENT, JR., DIRECTOR, NATIONAL SCIENCE FOUNDATION

Chairwoman Hutchison, Ranking Member Nelson, and members of the Subcommittee, thank you for this opportunity to testify on the National Science Foundation's research and education priorities. For over fifty years, NSF has been charged with being a strong steward of the Nation's scientific discovery and innovation process that has been crucial to increasing America's economic strength, global competitiveness, national security, and overall quality of life.

For many years, the United States economy has depended heavily on investments in research and development—and with good reason. America's sustained economic prosperity is based on technological innovation made possible, in large part, by fundamental science and engineering research.

Innovation and technology are the engines of the American economy, and advances in science and engineering provide the fuel. This underscores the larger rationale for the President's American Competitiveness Initiative (ACI)—in which

NSF will play a significant role. The ACI encompasses all of NSF's investments in research and education.

In short, the NSF mission is to look toward the frontier—to identify the most innovative and promising new research and education projects. NSF specifically targets its investments in fundamental research at the frontiers of science and engineering. Here, advances push the boundaries of innovation, progress, and productivity.

We identify such frontiers by sticking to our proven, "bottom-up" philosophy. The best ideas come directly from the scientific and engineering community. We support workshops, conferences, and symposiums to tap the extraordinary talent of the community in plotting innovative strategies for research and education directions for the future.

Each year, we also see over 40,000 of the best and brightest ideas—which come to us in grant proposals. We engage over 50,000 scientists, engineers and educators in the competitive, merit review of these proposals. All NSF proposals are evaluated through use of two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities. For example, proposals for large facility projects also might be subject to special review criteria outlined in the program solicitation.

Through these processes, which require direct interactions with the scientific and engineering enterprise at large, NSF has an extraordinary impact on scientific and engineering knowledge and capacity—despite the agency's small size. While NSF represents only four percent of the total Federal budget for research and development, it accounts for fifty percent of non-life science basic research at academic institutions. We are the second largest funding source for R&D at colleges and universities behind only the NIH, and provide the majority of Federal support for basic research at colleges and universities in the social sciences, environmental sciences, non-medical biology, mathematics, and computer sciences.

Moreover, NSF is the *only* Federal agency that supports *all* fields of science and engineering research and the educational programs that sustain them across generations. We are among the top three Federal funding agencies for nearly every science and engineering discipline, and the third-largest Federal sponsor of physical sciences research. Specifically for physical sciences and engineering, NSF funds more than 40 percent of all federally-supported academic basic research. These research efforts reach over 2,000 institutions across the Nation, and they involve roughly 200,000 researchers, teachers, and students.

We look forward to providing an even greater reach as part of the ACI. As you no doubt know, the President's request for NSF for 2007 is $6.02 billion, or an 8 percent increase over the appropriation enacted last year. This year's requested increase represents the first step in the Administration's firm commitment to double the NSF budget over the next 10 years.

Before I get into the details of our FY 2007 request, let me first expand upon the question of priority setting at the Foundation. Although my testimony above mentions some of the mechanisms for priority setting for NSF—how they are set both across and within accounts and among agency objectives, let me briefly expand upon those points, as this is an excellent starting point for gaining a proper perspective on NSF, because setting priorities is at the core of what we do every day.

The most important source of information for setting priorities comes from the research communities themselves. The research proposals that we receive help identify the leading edge of research and areas ripe for greater investment. The broader research communities also provide continuous input in the form of advice and analyses from myriad National Academy reports, analyses by professional societies, and national and international workshops and conferences. Our Committees of Visitors provide top-to-bottom reviews of existing programs and help formalize research priorities within and across disciplines. Ultimately the priorities reflected in our budget request are refined through consultations with the Deputy Director, the Assistant Directors, the National Science Board, and the Office of Science and Technology Policy. Finally, they are negotiated with the Office of Management and Budget in developing the President's budget request to Congress.

This year's budget request has four priority areas:

(1) Advancing the frontier;
(2) Broadening Participation in the Science and Engineering Enterprise;
(3) Providing World-Class Facilities and Infrastructure; and
(4) Bolstering K–12 Education

The first of these—*advancing the frontier*—is at the heart of everything NSF does. In a science and technology-based world, to divert our focus from the frontier is to put our Nation's global preeminence in science and engineering at peril.

Frontier research is NSF's unique task in pursuing the Administration's research priorities within the larger Federal research and development effort. Over the years, NSF has advanced the frontier with support for pioneering research that has spawned new concepts and even new disciplines. The NSF budget provides strong support in fundamental research for activities coordinated by the National Science and Technology Council (NSTC).

For example, NSF is the lead Federal agency supporting NSTC's Networking and Information Technology Research and Development (NITRD) program. The 2007 budget includes investments of $904 million in NITRD—an increase of $93 million.

A highlight of the Foundation's contribution to NITRD is a $35 million investment—an increase of $10 million—in Cyber Trust. Cyber Trust supports cutting-edge research to ensure that computers and networks that underlie national infrastructures, as well as in homes and offices, can be relied on to work even in the face of cyber attacks. It's part of a larger effort in cybersecurity research, which totals $97 million.

NSF is also the lead in the multi-agency National Nanotechnology Initiative (NNI). NSF's 2007 investment in NNI is $373 million, an increase of $29 million. Of that total, $65 million will fund Nanoscale interdisciplinary research teams (NIRTs). These awards encourage team approaches to address nanoscale research and education themes, where a collaborative blend of expertise is needed to make significant contributions.

NSF will invest $205 million—an increase of $8 million—in the interagency Climate Change Science Program. NSF supports a broad portfolio of research activities that provides a comprehensive scientific foundation for understanding climate and climate variability. Climate has a pervasive effect on the U.S. through its impact on natural resources, the economy, and the environment, so this is work of great significance to the Nation.

NSF investments in basic research in Homeland Security also increase by $42 million to $384 million. An important new effort will support a program of fundamental research on novel technologies for sensors and sensor systems to improve the detection of explosives, with a particular emphasis on Improvised Explosive Devices (IEDs).

Fundamental research can play a vital role in helping to stem this threat, and at the same time, advance the entire field of sensor research. A focal point of this $20 million dollar activity will be improving the sensitivity and fine resolution of sensors to recognize threats earlier than current technologies.

The International Polar Year (IPY) in 2007 to 2008 will mark the 50th anniversary of the International Geophysical Year. That was a year in which unparalleled exploration of Earth and space led to discoveries in many fields of science—and we hope to emulate that success. The U.S. vision for IPY, articulated by the National Academies,[1] urges the U.S. scientific community and agencies to participate as international leaders.

The Administration has asked NSF to lead U.S. IPY activities. In 2007, we will invest $62 million to address major challenges in polar research. Key research programs include: Observing Environmental Change in the Arctic; Studying Ice Sheet Dynamics and Stability; and Life in the Cold and Dark.

Recent advances in elementary particle physics strongly suggest that we are on the verge of a revolution in our understanding of the nature of matter, energy, space, and time. NSF will expand its substantial investment in elementary particle physics by $15 million. The opportunities for discovery today are greater than at any point in the last half-century, particularly for the study of dark matter, dark energy, and the physics of the universe.

A new research effort to address policy-relevant Science Metrics is funded initially at $6.8 million, through the Social, Behavioral and Economic Sciences Directorate. The goal is to develop the data, tools, and knowledge needed to establish the foundations for an evidence-based science policy. NSF intends to pursue this in close cooperation with other agencies.

To fulfill our ACI obligations, NSF will invest to: (1) generate fundamental discoveries that produce valuable and marketable technologies; (2) provide world-class facilities and infrastructure that will transform research and enable discovery; and (3) help prepare the Nation's scientific, technological, engineering, and mathematics (STEM) workforce for the 21st Century while improving the quality of math and science education in America's schools.

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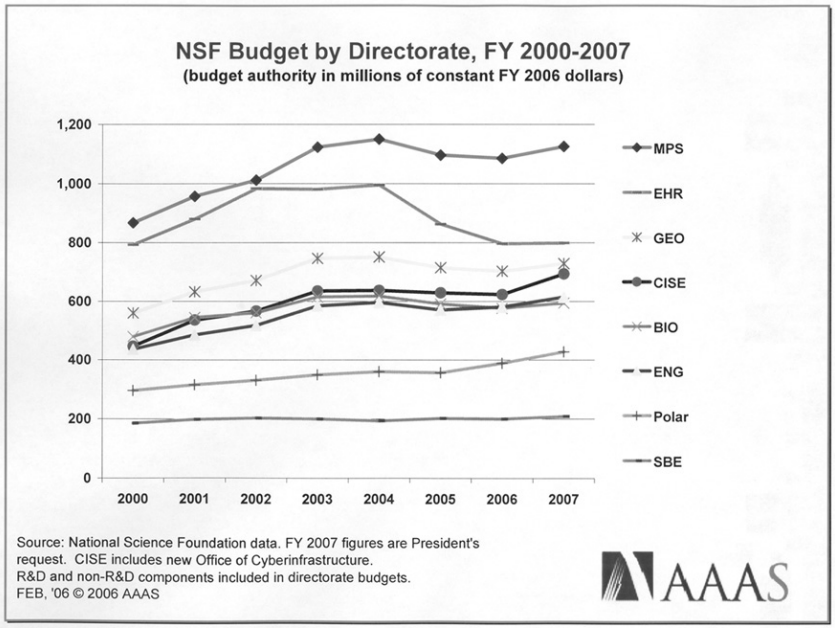
[1] *A Vision for the International Polar Year 2007–2008*; National Academies Press.

In pursuit of these goals, NSF will continue to make major contributions to America's innovation systems by advancing new scientific and engineering concepts. The President's FY 2007 budget for NSF will increase funding for research and related activities by 7.7 percent to $4.7 billion.

Each of our research directorates would receive increases between 5 and 9 percent after several years of flat or declining funding, enabling them to increase average award sizes, numbers of research grants, and success rates for research grant applications. The increase will also enable the directorates to support as many as 500 more research grants and provide opportunities for approximately 6,400 additional scientists, students, post-doctoral fellows and technicians to contribute to the innovation enterprise.



In our efforts to advance the frontier, we also aim to enhance development of the Nation's talent pool by integrating research and education. This longstanding NSF practice facilitates the direct transfer of new concepts to the private sector as graduate students involved in discovery enter the workforce.

It means, however, providing students with significant research experiences throughout their schooling. The world-class scientists, technologists, engineers, and mathematicians trained in this way can transfer new scientific and engineering concepts from universities directly to the entrepreneurial sector as they enter the workforce. This capability is a strong suit in U.S. competitiveness, and one of NSF's greatest contributions to the Nation's innovation system.

As a priority within our overarching educational mandate, NSF will continue to emphasize programs aimed at tapping the potential of those underrepresented in the science and engineering workforce—especially minorities, women, and persons with disabilities. Support for our *Broadening Participation* priority will total over $640 million in 2007.

Three highly successful programs form the core of this investment: the Louis Stokes Alliances for Minority Participation, the Alliances for Graduate Education and the Professoriate, and the Centers of Research Excellence in Science and Technology. These programs increase by $16.2 million—or 24 percent.

Broadening participation also applies to institutions. In 2007, we will increase efforts to ensure that the U.S. enjoys a strong capability in science and engineering across all regions of the country. NSF will invest $100 million in EPSCoR, the Experimental Program to Stimulate Competitive Research.

Providing World-Class Facilities and Infrastructure is our third priority for 2007. NSF has a long-established role in providing state-of-the-art infrastructure to meet major research challenges. Our strategy is to invest in tools that promise significant

advances in a field of research and to make them widely available to a broad cross-section of investigators.

Total funding in the Major Research Equipment and Facilities Construction (MRFEC) account is $240.45 million. This investment funds five on-going projects and two new starts.

Two new projects are the feature attractions of our major equipment investment in 2007: the Alaska Region Research Vessel (ARRV) and the Ocean Observatories Initiative (OOI). Both projects will help to fulfill the Administration's 2004 U.S. Ocean Action Plan, developed in response to the U.S. Commission on Ocean Policy.

ARRV is a ship that will dramatically improve access to Arctic waters. With an operating year as long as 300 days, this ship could accommodate some five hundred researchers and students annually. A variety of complex regional and global ecosystem and climate studies require a technologically advanced oceanographic platform to conduct field research at the ice edge as well as in ice up to three feet thick.

OOI is an integrated observatory network, distributed among coastal and deep-sea sites that will help advance our understanding of oceanographic and geological features and processes. With these fundamentally new tools for local, regional and global ocean science, researchers and students will now have continuous, interactive access to the ocean.

As our facilities increase in sophistication and capability, so does the amount of data they produce. The sheer volume of information is overwhelming our current computational capacity.

Cyberinfrastructure is likely to be a key factor in addressing this problem—and also in establishing and continuing global research excellence for many years to come. That makes it a significant NSF priority. In 2007, funding for cyberinfrastructure research and development will reach $597 million—an increase of $77 million, or 15 percent.

NSF will invest $50 million to begin the acquisition of a leadership-class high performance computing system. This will be our first step on the road toward computation and data processing for petascale-level science and engineering. It will be a major milestone in NSF"s multi-year plan to provide and support a world-class computing environment that will make the most powerful high performance computing assets broadly available to the science and engineering community.

I come to the last, but not least, of NSF"s four priorities for 2007: *Bolstering K–12 Education*. Today's youngsters face a world of increasing global competition. We depend on the excellence of U.S. schools and universities to provide them with the wherewithal to meet this challenge and to make their own contributions to America's future.

We clearly need to do more to build strong research foundations and foster innovation in K–12 science and mathematics education.

In line with the Administration's focus on this vital national priority, NSF will invest $104 million in a new effort named Discovery Research K–12 that aims to strengthen K–12 science, technology, engineering, and mathematics education. We will refocus our efforts on a vital cluster of research in three well-defined grand challenges: (1) developing effective science and mathematics assessments for K–12; (2) improving science teaching and learning in the elementary grades; and (3) introducing cutting-edge discoveries into K–12 classrooms.

We will also increase funding for the Graduate Teaching Fellowships in K–12 Education—better known as GK–12—by nearly 10 percent to $56 million, supporting an estimated 1,000 graduate fellows. By pairing graduate students and K–12 teachers in the classroom, this program has been particularly successful in encouraging effective partnerships between institutions of higher education and local school districts.

Today, I have only been able to scratch the surface of the FY 2007 priorities. With the first installment of the ten-year commitment to double NSF's budget, we will be able to capitalize on the many areas of emerging promise already on the horizon.

That means generating quality programs year, after year, after year—and continuing to lead the Federal momentum toward more robust business practices as we put tax dollars to work for the Nation. NSF is one of three agencies recognized as models of excellence in Grants Management, and we will continue that tradition.

The President's commitment to doubling the NSF budget will allow NSF to concentrate its vision on the frontier and on the talent needed to keep us there. For the foreseeable future, the scientific and engineering community at large must work in a larger global context which includes an increasing international competition, a deepening globalization, and an escalating demand to meet long-standing social needs.

Our priorities and programs at NSF have been shaped by our country's grassroots experts through decades of peer-reviewed, merit-based research. Our 50 years of

basic research investments—in discovery, learning, and innovation—have a long-standing and proven track record of boosting the Nation's economic vitality and competitive strength.

Madam Chair, I hope that this brief overview of NSF's priorities conveys to you NSF's commitment to advance science and technology in the national interest. I am very appreciative of the Subcommittee's long-standing bipartisan support for NSF, and I would be happy to respond to any questions that you have.

Senator HUTCHISON. Thank you very much.

Dr. Washington?

STATEMENT OF DR. WARREN M. WASHINGTON, CHAIRMAN, NATIONAL SCIENCE BOARD

Dr. WASHINGTON. Thank you, Chair Hutchison, Senators Nelson and Stevens, and other Members of the Subcommittee. I appreciate the opportunity to testify before you.

I am Warren Washington, Senior Scientist at the National Center for Atmospheric Research in Boulder, Colorado. In my testimony, I'll be speaking as the Chairman of the National Science Board, and I have the pleasure of serving for 12 years on the Board, and 4 as its Chair. I and seven other members will retire May 10. We are anxious to end our term on a high note, hopefully with an increased budget for NSF.

The Congress established our National Science Board in 1950, and gave it dual responsibilities. The first is to oversee the activities and establish policies for the National Science Foundation, and the second is to serve as an independent national science policy advisory body to the President and Congress on policy issues related to science, engineering, and education.

The Board greatly appreciates the Congressional support for the Board and the Foundation and its programs and activities. The Board and the Foundation have enjoyed the bipartisan legislation that has been introduced by both Houses of Congress to help provide tools to ensure the American science and technology enterprise remains the envy of the world.

I would like to mention the recent decision to establish a National Science Board Commission on Education for the 21st Century in Science, Technology, Engineering, and Mathematics (STEM) to highlight STEM education in the U.S. The commission was established after careful consideration of the value it would add to the national efforts to improve education in these fields. We have held a series of three hearings across the country, and heard from a wide range of stakeholders in the education system. Congressional Member participation in the Board's December hearing on the 21st Century Education in Science, Mathematics, and Technology helped to highlight the very important issues for U.S. education in these fields.

The input that we have received at these hearings and the urging of the Members of Congress and independent stakeholders has led to the Board action to essentially form this commission, whose focus is going to be on actually developing a national action plan. And I want to stress "action plan." It is not going to be another study. We're going to essentially make use of the previous studies to come up with this action plan.

I would like to provide some general comments on the Fiscal Year 2007 budget, and update you on some of the Board's activities over this year.

In August 2005 the Board reviewed and approved the NSF 2007 budget request that was submitted to OMB in September. And we generally support the President's budget request. I should also like to mention that we're greatly encouraged by the overall increase in the Fiscal Year 2007 request. As you know, given the very tough budget situation that the Government is under, we understand the limitations on discretionary spending. In February of last year, the Senate requested that the Board come up with a new bold vision for NSF. And we actually produced this document here—we have completed that action on time. The Board has published this document, and in the process we have gotten a great deal of input before it was actually finalized.

The vision takes into account the sense of our Nation, our knowledge of the trajectory of the global science, engineering research, and our confidence in a promising future. We provided strategic priorities, near-term goals, and enabling strategies for achieving this vision. The President's 2007 NSF budget is a significant step toward achieving that new vision.

We are very appreciative of the 7.9 percent requested in the NSF's budget, which raises the budget to $6.2 billion. This is a very significant increase for the NSF for programs and a very wise use of our Nation's limited Federal budget.

However, it is incumbent on the Board, in our capacity as independent advisory body for the President and Congress, to note that this still represents a significant gap compared with the Congressionally authorized 2007 budget of approximately $7 billion. We still have a long way to go before we get to the authorized doubling level.

The President's American Competitiveness Initiative again calls for the doubling of NSF's budget, but over the next 10 years. And we certainly support that.

We respectfully suggest that implementing these admirable authorizations and initiatives has never been more urgent than now. It is also important that the NSF portfolio of investments be diverse and also balanced.

There are two NSF directorates that we do have concern about, in terms of the balance of the portfolios, and those are the Education and Human Resources, and the Biological Sciences directorates. Should the Congress determine that additional funds beyond the Administration's request can be made available in FY07 the National Science Board would essentially recommend support for a strong and growing NSF budget in these two areas.

I want to point out a couple of other things. First of all, NSF's Math and Science Partnerships Program is an essential long-term component of our coordinated effort to promote excellence in science, mathematics, and engineering. The Board still strongly supports this program at NSF.

With regard to EPSCoR, this is very high priority for the Board. We feel that this is a way we can strengthen the underserved and the underutilized parts of our community.

I would like to end up by emphasizing the Board's general support of the integrated portfolio of investments in science and engineering research and education that is represented in the 2007 budget proposal. It thoughtfully blends support for the core disciplines with encouragement for interdisciplinary initiatives. It also brings together diverse and complementary backgrounds, and provides for infrastructure and education, and strengthens NSF's management of the enterprise.

I will be happy to answer any questions you have. Thank you very much.

[The prepared statement of Dr. Washington follows:]

PREPARED STATEMENT OF DR. WARREN M. WASHINGTON, CHAIRMAN, NATIONAL SCIENCE BOARD

Chairman Hutchison, Senator Nelson, and Members of the Subcommittee, I appreciate the opportunity to testify before you. I am Warren Washington, Senior Scientist and Section Head of the Climate Change Research Section at the National Center for Atmospheric Research. My testimony today is my last with you in my capacity as the Chairman of the National Science Board (the Board). I, along with seven of my fellow Board Members, retire from the Board on May 10. It has been my great pleasure to serve on the Board for 12 years, the last 4 as Chairman.

On behalf of the Board and the widespread and diverse research and education communities that we all serve, I thank the Members of this Subcommittee for your long-term commitment to a broad portfolio of investments in science, technology, engineering, and mathematics (STEM) research and education. While it is critical that our Nation significantly increase our support for this portfolio, it is also important that these investments be diverse and balanced.

The Congress established the National Science Board in 1950 and gave it dual responsibilities:

- Oversee the activities of, and establish the policies for, the National Science Foundation (the Foundation, NSF); and
- Serve as an independent national science policy advisory body to the President and the Congress on policy issues related to science and engineering (S&E) research and education.

The Board greatly appreciates Congressional support of the Board, the Foundation, and their programs and activities. Bipartisan legislation being introduced in both houses of Congress will help to provide additional tools to ensure the American science and technology (S&T) enterprise remains the envy of the world.

Now, I would like to provide some general comments regarding the NSF FY 2007 budget request, then update you on National Science Board activities over the last year and some of our priorities for the coming year.

FY 2007 NSF Budget Request

In August 2005, the National Science Board reviewed and approved an NSF FY 2007 budget request that was submitted to the Office of Management and Budget (OMB) in September 2005. The Board generally supports the President's budget request, and we are greatly encouraged by the overall level of increase in the total NSF FY 2007 budget request. Given the overall cut to non-defense domestic discretionary spending, the Board respects and appreciates that the President's budget request recognizes the importance of returning NSF to significant positive growth. We are cognizant of the current Federal fiscal constraints that our Nation faces and that there are many worthy competing interests for limited resources.

Nearly a year ago, Members of Congress requested that the Board, in its role as the policy making and oversight body of the NSF, develop a bold new vision for NSF. The Board was also requested to factor Federal fiscal realities into its vision for the future of NSF. *The National Science Board 2020 Vision for the National Science Foundation* (NSB 05–142, *www.nsf.gov/nsb/documents/reports.htm*) was delivered to Congress, as requested, four months ago. This document provides a vision statement for NSF that is informed by a sense of our Nation, our knowledge of the trajectory of global science and engineering research, and our confidence in a promising future. We have also provided Strategic Priorities, Near-Term Goals, and Enabling Strategies for achieving this vision.

The Board envisions a prosperous America that is powered by innovations flowing from the latest transformative scientific ideas with a workforce among the most scientifically and technically competent on the planet. We see an America in which every student graduates from high school with a sufficient grasp of the fundamental concepts in S&T to live a full and productive life in an increasingly technological world and whose research and higher education enterprises—among the most creative and fruitful in the world—bring together the best minds for inquiry, discovery, and teaching. The Board also envisions an America whose knowledge, skills, and values are respected and influential in setting the aspirations and policies of the global research and technology enterprise.

The National Science Board's 2020 Vision for NSF establishes broad priorities for the National Science Foundation to:

- Drive the cutting edge of fundamental and transformative research;
- Tap the talents of all our citizens, particularly those belonging to groups that are underrepresented in the science and research enterprise, and continue to attract foreign students and scientists to the U.S.;
- Develop and test new approaches to teaching science to elementary and secondary school students and catalyze partnerships among schools, museums, aquariums, and universities to put these techniques into effective practice;
- Provide the bright minds in our research institutions with the tools and instruments needed to probe the frontiers of knowledge and develop ideas that can transform our understanding of the world; and
- Maintain the financial and talent resources to be an effective agent for excellence in the critical national enterprises of learning, discovery, and innovation.

The President's FY 2007 NSF budget request is a significant step towards achieving the Board's 2020 Vision for NSF. The Board fully supports the FY 2007 NSF budget focus on the four funding priorities that address current national challenges as well as strengthening the core portfolios of NSF's research investment. We also recognize that a budget request of $6.2 billion, representing a 7.9 percent increase over NSF's FY 2006 budget, is a significant investment in NSF.

Nevertheless, it is incumbent on the Board, in our role as an independent advisory body to both the President and Congress, to note that this still represents a significant gap between the existing Congressionally authorized FY 2007 NSF budget of approximately $10 billion that was included as part of the NSF Act of 2002, which sought to double the NSF budget in 5 years. The President's American Competitiveness Initiative again calls for a doubling of the NSF budget over a 10-year period. The Board welcomed the 2002 Congressional authorization to double NSF's budget, the President's new call for a doubling of NSF's budget and all past efforts to double NSF's budget. However, we would respectfully suggest that the time to implement these admirable authorizations and initiatives has never been more urgent than now.

Members of this Subcommittee are familiar with the recent National Academy of Sciences study, headed by Norm Augustine, that described the unique and long-term value of programs in science and engineering research and education, like those at NSF, to ensuring the future economic health of our Nation, maintaining U.S. preeminence in discovery and innovation, and providing valuable contributions to homeland security efforts. A review of the National Science Board's just released *Science and Engineering Indicators 2006* (NSB 06–01, *www.nsf.gov/nsb/*) report should provide ample evidence of troubling trends that the Board, the National Academies and others have been highlighting regarding our Nation's future ability to remain preeminent in the global enterprise of discovery and innovation.

A critical mass of support, at least in principle, seems to have been attained with support from the President, both parties of Congress and the Nation regarding the need to significantly increase our Nation's broad portfolio of investments in science, engineering, mathematics, and technology research and education. It is also important, however, that this portfolio be diverse and balanced. Two NSF directorates, in particular, seem out of balance with the rest of the NSF budget over the last 2 years—Education and Human Resources (EHR) and Biological Sciences (BIO). Should this Congress determine that additional funds, beyond the Administration's request, can be made available to NSF in FY 2007, the National Science Board would recommend support for a strong and growing role for the NSF in the Nation's investment in S&E education, and addressing basic biological research.

Nearly a quarter century ago, the National Science Board's Commission on Precollege Education in Mathematics, Science and Technology assessed the state of U.S. pre-college education in the subject fields and found it wanting. In the intervening years, we have failed to raise the achievement of U.S. students commensurate with

the goal articulated by that Commission—that U.S. pre-college achievement should be "best in the world by 1995"—and many other countries have surpassed us. Not only are they not first, but by the time they reach their senior year, even the most advanced U.S. students perform at or near the bottom on international assessments. There is now an even more pressing need to build a new foundation. The *Science and Engineering Indicators 2006* report clearly describes the extent of the dilemma; the time to act is now.

In 1983 the U.S. Department of Education's National Commission on Excellence in Education published the report, *A Nation At Risk*. This document stated: "By the year 2000, U.S. students will be the first in the world in mathematics and science achievement," expressing alarm on the "rising tide of mediocrity [in education] that threatens our very future as a Nation and a people." Despite these two reports—*A Nation At Risk* sounding the alarm and the NSB Commission report recommending solutions—and many others since then, we continue to slip further behind. The converging trends and stresses within our Nation's K–12 science and system are clearly documented in *Science and Engineering Indicators 2006.*

As the Board has stated in our just released policy report entitled, *America's Pressing Challenge—Building a Stronger Foundation* (NSB 06–02, *www.nsf.gov/nsb/*), if the U.S. is to maintain its economic leadership and compete in the new global economy, the Nation must prepare today's K–12 students better to be tomorrow's productive workers and citizens. Changing workforce requirements mean that new workers will need ever more sophisticated skills in STEM disciplines. This emerging workforce, consisting of degreed and highly skilled technical workers, will need to begin developing their mathematical and science skills early in their educational career. In addition, the rapid advances in technology in all fields mean that even those students who do not pursue professional occupations in technological fields will also require solid foundations in science and math in order to be productive and capable members of our Nation's society. We simply cannot wait until our students reach 18 years old to begin producing the intellectual capital necessary to ensure this future workforce; the time is now to get serious about this problem and better sharpen our efforts at all grade levels, in order to dramatically accelerate progress, lest we find ourselves, as a Nation, unable to sustain our high technology based quality of life.

Education is a core mission of NSF, which not only promotes research, but also shares in the responsibility for promoting quality math and science education as intertwining objectives at all levels of education across the United States. NSF's highly competitive peer-review process is second to none for openly and objectively identifying, reviewing, selecting, funding and providing stewardship for the very best STEM proposals and programs in research and education.

The NSF Mathematics and Science Partnerships (MSPs) are important tools for addressing a critical—but currently very weak—link between pre-college and higher education. The NSF MSP Program provides for the collaboration between pre-college and college to promote excellence in teaching and learning, therefore facilitating the transitions for students from kindergarten through the baccalaureate in STEM disciplines. The added benefit for our Nation is those students who do not choose STEM careers become the informed and scientifically-literate voting citizens we need for the 21st Century.

NSF has the mandate, depth of experience, and well-established relationships to build the partnerships for excellence in STEM education. The Board, therefore, continues to stand by our 2004 formal policy statement (NSB 04–02, *www.nsf.gov/nsb/documents/testimony.htm*) strongly urging that continued, full funding of the MSP Program at NSF be sustained over the long term as an essential component of a coordinated Federal effort to promote national excellence in science, mathematics and engineering. We also note with great concern that the FY 2007 NSF Budget provides for only a 2.5 percent increase from FY 2006 for the Education and Human Resources Directorate—still leaving this important component of our Nation's STEM education initiative over 3 percent below its FY 2005 level.

Another example of an area of NSF's diverse portfolio that would warrant attention should the Congress find additional funds beyond the President's request, is the Biological Sciences Directorate. This directorate essentially had a zero budget increase from FY 2005 to FY 2006, and has the smallest FY 2007 percent increase of any of the NSF Research and Related Activities Directorates.

In general, the Biological Sciences budget of NSF has been small in recent decades, relative to the fact that some of the most spectacular advances in science over the last 50 years have been in this field. The emergence of biology at the forefront of scientific advances began with the discovery of the structure of DNA by Watson and Crick in 1953 and has accelerated ever since. Among the many landmark discoveries was the validation of the universal genetic code in the late 1960s. The work

on determining the genetic code was performed in England using a bacterial virus, a "bacteriophage." These and many other biology-focused discoveries have been recognized by numerous Nobel prizes.

One major factor that may have inadvertently contributed to a perceived lack of need to significantly increase the NSF Biology budget may have been the dramatic budget increases over the last 10 years for the National Institutes of Health (NIH). However, NIH and NSF have different missions and foci in regards to supporting basic research in biological sciences. The NSF physical sciences are well deserving of significant budget increases, but so are the other facets of NSF's diverse portfolio. The spectacular advances in structural biology have depended largely on the development of innovative new technology, some of which has been funded by NSF. Biology today is as basic a science for exploring our world as physics, chemistry, and mathematics have always been. Biologists are by far the largest community of scientists benefiting from synchrotron radiation sources; structural biologists have long been one of the major driving forces for better and bigger computing facilities; and the daily visual imaging technology used in the analyses of proteins or whole cells is on par with needs for this technology in physical sciences. It is also widely recognized that advances in biological sciences are instrumental in fostering applications that often lead to commercial innovation. Yet funding of biology has decreased as a proportion of the NSF budget in the last 8 years.

Notwithstanding the Board's concern regarding NSF's EHR and BIO budgets, I would emphasize that the NSB supports the integrated portfolio of investments in S&E research and education represented in the NSF FY 2007 budget proposal. It thoughtfully blends support for the core disciplines with encouragement for interdisciplinary initiatives, brings together people from diverse and complementary backgrounds, provides infrastructure for research and STEM education, and strengthens the NSF's management of the enterprise.

The Board fully supports the proposed FY 2007 funding for the Major Research Equipment and Facilities Construction (MREFC) account that permits the initiation of three new MREFC projects. Members of the Senate are aware of the exciting opportunities at the frontiers of knowledge that we are unable to pursue without the cutting edge facilities that are funded under this account. The Board reiterates our support and priority order for these three "new start" MREFC projects with highest priority for the Alaska Regional Research Vessel (ARRV), followed by National Ecological Observation Network (NEON) and the Ocean Observations Initiative (OOI).

The process and criteria for establishing priorities for Major Research Equipment and Facilities Construction (MREFC) is described in *A Joint National Science Board—National Science Foundation Management Report: Setting Priorities for Large Research and Facilities Projects Supported by the National Science Foundation* (NSB–05–77, September 2005) *http://www.nsf.gov/pubs/2005/nsb0577/index.jsp*. Briefly, MREFC projects under consideration must undergo a multi-phase internal and external review and approval process. This includes a review by the internal NSF MREFC Panel, which makes recommendations to the NSF Director with attention to criteria such as scientific merit, importance, readiness, and cost-benefit. These criteria have been modified to align with the criteria recommended by the National Academies and approved by the Board.

On at least an annual basis, an overarching cross-discipline context for assessing the value of a proposed facility in comparison to other investments is presented by NSF to the Board. The *Facility Plan* combines in one document a report on major facilities under construction and in various stages of development, together with an extensive discussion of the science objectives and opportunities at the frontiers of science and engineering that provide the context and compelling need for major facilities. The Board believes that the NSF *Facility Plan*, updated regularly and made public, is a valuable planning tool within NSF and the Executive Branch, providing a comprehensive exposition of needs and plans to inform decisions in Congress, and serving as an important vehicle for communicating with our research communities.

The Director selects MREFC candidates to send to the National Science Board for consideration, which then approves, or not, projects for inclusion in future budget requests. On at least an annual basis, the Board reviews all of the Board-approved projects that have not yet received MREFC appropriations to determine if there should be any changes to the priority order of the projects. The Director, in keeping with the Board's prioritization, then develops the annual NSF budget request for the Board's review and approval prior to the Director submitting the budget to OMB. In this year's budget, the increased funding in the MREFC account for three new starts, already approved by the Board to seek funding, is in accord with our well supported finding of an urgent need for increased Federal and NSF investment in infrastructure in our 2003 report, *Science and Engineering Infrastructure for the 21st Century: The Role of the National Science Foundation* (NSB 02–190) *http://*

www.nsf.gov/nsb/documents/2002/nsb02190 /msb02109.pdf, and our approval of these particular projects as ready to seek funding, in priority order, under the MREFC account.

The President's budget request for NSF also continues to foster S&T that enhances our homeland security. NSF activities in this area include Critical Infrastructure Protection, Research to Combat Bioterrorism, Cybercorps Scholarships for Service, Counterterrorism, and Physical/Information Technology Security. By enabling future discovery and innovation, NSF supports our Nation's long-term prosperity and security. The requested funding for Homeland Security related projects is $384.21 million, representing a 12.4 percent increase over FY 2006. Nearly half of the requested increase will support a new NSF-wide activity that seeks to advance fundamental knowledge in new technologies for sensors and sensor networks, and in the use of sensor data in control and decision-making across a broad range of applications, particularly those that bear on the prediction and detection of explosive materials and related threats.

Overview of NSB Activities During the Last Year

During the last year, the Board accomplished a great deal, even while going through a continuing evolution in terms of its operation. I will not attempt to describe all of our accomplishments, but I would like to briefly highlight some of these accomplishments.

NSF Oversight and Policy Direction

A significant example of the Board's effort to provide oversight and policy direction to NSF was the completion of a revised process for the identification, review, approval and prioritization of large facilities projects. Under the revised process, the Board approved six major NSF awards totaling over $540 million, and approved the termination of an MREFC project.

The Board also approved a policy statement on Respective Roles of NSF Management and the Office of Inspector General in the Settlement of Administrative Investigatory Matters, as well as approved Guidance for NSF Centers Programs, and carried out a *Review of the NSF Merit Review System* (NSB 05–119, *www.nsf.gov/nsb/documents/reports.htm)*

Perhaps most importantly, we approved the *National Science Board 2020 Vision for the National Science Foundation.*

Advice to the President and Congress

In terms of advice to the President and Congress, the Board published and disseminated several important reports, including:

- *Long-Lived Digital Data Collections* (NSB 05–40, *www.nsf.gov/nsb/documents/reports.htm*).
- *Science and Engineering Indicators 2006* report.
- The Board's S&E Indicators "Companion Piece" policy report that focuses on STEM education, entitled *America's Pressing Challenge—Building a Stronger Foundation*.

Further, the NSB provided testimony to Congressional hearings, and responded to other specific questions and inquiries from Congress.

Improved Outreach and Communication by the Board

The Board also continues to increase and improve our direct outreach and communication with OMB, OSTP, Congress, other Federal agencies, various interest groups and the external science and engineering research and education community.

For example, the Board held:

- three public hearings (with simultaneous Web casts) on 21st Century Education in Science, Mathematics and Technology with Members of Congress testifying in two, on Capitol Hill; in Boulder, Colorado; and Los Angeles, California;
- two public workshops on Transformative Research (Arlington, VA and Santa Fe, NM);
- three public workshops on Hurricane Science and Engineering (Arlington, VA; Boulder, Colorado; and Pensacola, Florida;
- a public workshop on Engineering Workforce Issues and Engineering Education (Massachusetts Institute of Technology);
- two public presentations on Capitol Hill on *Science and Engineering Indicators 2006* (NSB 06–02) and its Companion Piece, *America's Pressing Challenge—Building a Stronger Foundation* (NSB 06–02), February 23 to the media and general public and April 6 to the House R&D and STEM Caucuses; a presen-

tation to Colorado to State legislators on *Science and Engineering Indicators* and the Education Commission hearings for the American Electronics Association, March 23; and two presentations at the National Science Teachers Association (NSTA) in April in Anaheim, California on *Indicators* and the Companion Piece; and

- sponsored informational booths at both the American Association for the Advancement of Science (AAAS) meeting in February in St. Louis, Missouri and NSTA.

In an effort to facilitate more openness of Board meetings in accord with the Sunshine Act, we expanded our practices for:

- providing public notice of all our meetings in the *Federal Register* and on the NSB Web site;
- treating teleconferences of committees as "meetings," subject to the requirements of the Government in the Sunshine Act;
- providing much more information to the public in a more timely manner regarding meeting discussions and decisions; and
- encouraging public comment during the development of Board publications.

The National Science Board Office (NSBO) is contracting to develop monitoring and evaluation tools, to expand outreach, and measure the impacts of NSB statements, resolutions and reports; and to redesign the NSB website to promote transparency, accessibility, and utility for the public. The Board's practice of holding its data gathering workshops around the country will be expanded in FY 2006 and 2007 to increase opportunities for the public to attend Board activities.

The Board has also continued its recognition of outstanding science, engineering and science education accomplishments through the Vannevar Bush Award, Alan T. Waterman Award, and Public Service Awards.

Ongoing and Future Board Activities

The Board has much to do in 2006 and 2007. Perhaps one of the most important actions is to oversee the implementation of the Board's 2020 Vision for NSF and approval of the new NSF Strategic Plan, which articulate the broad priorities for the National Science Foundation. At our March 2006 Board meeting we approved the creation of a Board Commission on 21st Century Education in Science, Technology, Engineering, and Mathematics (NSB 06–03) (attached charge). We expect to complete the appointment of members to this Commission by the time of our May 9–10 Board meeting.

Two of our Task Forces, Transformative Research and Hurricane Science and Engineering will hold additional workshops and present the Board with draft final reports for Board approval. Both involve broad, multidisciplinary questions on the broad frontiers of science and engineering and across the portfolios of NSF's science, engineering and education directorates. Hurricane Science and Engineering in particular requires an integrative, multidisciplinary approach across a wide span of disciplines, including physical, social, behavioral, economic, biological, ecological, information technology and other appropriate sciences, as well as engineering (e.g., civil, environmental, mechanical), to address *deep fundamental science questions regarding hurricanes as natural disasters*. Fundamental social, behavioral and economic sciences play an especially critical role in understanding the impacts of such natural disasters, and in other areas of human behavior and risk-taking. In this context, it is worth noting that the 2005 Nobel Prize in Economic Sciences was awarded to American economist Thomas C. Schelling and American/Israeli economist Robert J. Aumann for enhancing "understanding of conflict and cooperation through game-theory analysis."

Our Task Force on International Science Partnerships will literally be taking the Board around the world in 2006 and 2007, and our ad hoc Task Group on Engineering Education is poised, after additional data gathering, to present us with recommendations that will impact university engineering programs and the future engineering workforce.

In addition to the Board matters of oversight and policy direction to NSF and providing advice to the President and Congress, there will also be significant transitions taking place on the Board itself. In a few short months, eight Board Members, four of whom have served on the Board for 12 years, will leave the Board. The Board will also be electing a new Chairman and Vice-Chairman, with committee chairmanships open to new appointments by the new Chairman of the Board.

FY 2007 NSB Budget

The Board's Budget Request for FY 2007 seeks resources to carry out its statutory authority and to strengthen the Board's oversight responsibilities for the Foundation. Effective communications and interactions with our constituencies contribute to the Board's work of identifying priority S&T policy issues, and developing policy advice and recommendations to the President and Congress. To this end, the Board will continue to increase communication and outreach with the university, industry and the broader S&E research and education community, Congress, Federal S&T agencies, and the public. The Board's activities will aim to support global leadership in discovery and innovation based on a continually expanding and evolving S&T enterprise in this country, and will ensure a principal role for NSF programs in providing a critical foundation for S&E research and education.

Among other activities in FY 2007, the Board expects to complete its study of NSF identification, development, review and funding of transformative research, and provide new guidance for NSF policies regarding such research. It will also provide national policy recommendations following completion of the work of its Commission on 21st Century Education in Science, Technology, Engineering and Mathematics. While many of these recommendations will be at a national system level, a number will also focus specifically on the role NSF can and should play in supporting the development of an adequate and diverse S&E workforce for the future. The Board's examination of university level engineering education will also be completed and recommendations provided in FY 2007. The Board's Task Force on Hurricane Science and Engineering will also be producing a final report that is expected to outline a specific role for NSF in addressing interdisciplinary needs of an integrated national research program. The NSB International Task Force expects to complete its examination of the role of the Government in international science and engineering in response to the changes that have occurred in recent years to the global dynamics for S&E research, education, politics, and workforce. The Board will continue to review and approve NSF's actions for creating major NSF programs and funding large projects. It is also expected that the Board will be reviewing a new NSF Strategic Plan and guiding its implementation that is expected to address the Board's 2020 Vision for NSF.

Essential to the conduct of Board business is a small and independent, yet adequate, core of full-time senior policy, clerical and operations staff, supplemented by short-term temporary contractual support as needed for various Board endeavors. This core of Board support is augmented by the Foundation as it continues to provide accounting, logistical and other necessary resources in support of the NSB and its missions. In addition to the NSBO's essential and independent resources and capabilities, external advisory and assistance services are especially critical to support production of NSB reports and supplement the Board staff's general research and administration services to the Board. These external services provide the Board and its Office with the flexibility to respond independently, accurately and quickly to requests from Congress and the President, and to address issues raised by the Board itself.

By statute, the Board is authorized five professional positions and other clerical staff as necessary. In consultation with the Congress, the Board has defined these five professional positions as its senior S&E policy staff, and the clerical positions as Board staff that support Board operations and related activities associated with the conduct of its meetings and oversight responsibilities. At my direction, the NSB Executive Officer, who reports directly to the Board Chair and also serves as the NSBO Director, has identified options for broadening the NSBO staff capabilities to better support the broad mission of the Board. The NSBO staff provides both the independent resources and capabilities for coordinating and implementing S&E policy analyses and development, and the operational support that are essential for the Board to fulfill its mission.

The full impact of increasing the number of professional positions to the statutory level, along with necessary clerical and support staff, is expected to occur in FY 2007, with increased attention to addressing new skill requirements. Nevertheless, the results of a strategic restructuring of NSBO management and operations over the last 2 years (since implementation of the changes incumbent in the December 2002 NSF Re-Authorization Act), has led to more efficient use of appropriated resources while retaining the ability to support an active Board agenda. More efficient operations, in combination with a completion of Board Office equipment upgrades in FY 2006, has positioned the Board to propose an FY 2007 budget that represents a reduction of $40,000, or –1.0 percent, over the FY 2006 Current Plan. However, it is important to note that our proposed FY 2007 budget provides the minimum level of support for essential Board activities.

Closing Remarks

This is a difficult time for Federal S&E research and education budgets and the organizations and individuals that rely on Federal support. For over 50 years the Federal Government has sustained a continual, visionary investment in the U.S. research and education enterprise in the expectation that such investment would benefit all Americans. That Federal effort has expanded the horizon of scientific discovery and engineering achievements far and wide, leading to the realization of enormous benefits to the Nation's prosperity and security.

We know what works—we have a very long history of success to draw on. In 1946, legislators contemplating the creation of a national science foundation were disturbed by the relative weakness of America in basic scientific discoveries. This weakness was evidenced by several factors, including the scarcity of U.S. researchers awarded Nobel Prizes in chemistry, physics, and medicine and a serious deficit of trained American scientists. By the 1960s, evidence of the success of the Foundation they established was abundant: U.S. researchers were regularly honored for their accomplishments in the sciences by many authorities, including the Nobel Foundation, and the American education enterprise that trained scientists and engineers became the envy of the world.

We know the expanding frontiers of knowledge offer enormous opportunities for research and innovation. We also know that the education of all our citizens in the fundamentals of math, science and engineering must continue to be enhanced if the U.S. is to remain eminent in critical S&T disciplines. As other nations ramp up their investment in the infrastructure for S&E research and innovation, we cannot be complacent. The Federal investment in the Nation's S&T is a necessity for the Nation's future prosperity and security. The U.S. must sustain its advantages through continued wise, adequate Federal support for our S&E enterprise.

In recognition of fiscal realities, the National Science Board pledges that we will guide NSF by setting priorities, to make difficult programmatic budget decisions and, as a result, to obtain the best return on the taxpayers' investment. However, even in a time of budget constraints, we cannot ignore the Nation's growing dependence on innovation for economic prosperity and the ever-improving quality of life Americans have come to expect. The Board recognizes that competing priorities may impose fiscal constraints that limit the Foundation's, and so the Nation's, aspirations. In weighing these competing priorities, the Nation must realize that the challenges we defer today will be faced by our children, and the opportunities we forego today will be charged to their future. The Board therefore urges that the Congress take the long view in its annual budget decisions on the funding of U.S. science and engineering capabilities through the National Science Foundation.

NSB/EDCOM–2006–03, MARCH 30, 2006—CHARGE TO THE NATIONAL SCIENCE BOARD COMMISSION ON 21ST CENTURY EDUCATION IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS

Background

Over the last two decades, numerous reports and statements from eminent bodies representing the broad range of national interests in science and technology literacy in U.S. society and skills in the U.S. workforce have sounded alarms concerning the condition of pre-K–16 education in science and technology areas. Nevertheless, our Nation's education competitiveness continues to slip further behind the rest of the world. A number of spokespersons for the science and engineering education communities have urged the National Science Board (the Board) to undertake an effort similar to the 1982–1983 Board Commission on Pre-college Education in Mathematics, Science, and Technology. Congressional Appropriations Committee report language for FY 2006 stated that they strongly endorse the Board taking steps to "establish a commission to make recommendations for the National Science Foundation (NSF) and Federal Government action to achieve measurable improvements in the Nation's science education at all levels," and expects the Board to "report the commission's findings and recommendations to the Committee at the conclusion of the commission's work." Subsequently, the Board held three public hearings to explore the merit of establishing a special Commission on Education for the 21st Century. By approving this charge, the Board has decided to establish such a Commission to develop a national action plan addressing issues that have inhibited effective reform of U.S. science, technology, engineering, and mathematics (STEM) education.

Statutory Basis under the NSF Act

Under 42 U.S.C. § 1862(d): "The Board and Director shall recommend and encourage the pursuit of national policies for the promotion of . . . education in science and engineering." 42 U.S.C. § 1863(h) authorizes the National Science Board "to es-

tablish such special commissions as it may from time to time deem necessary for the purposes of this chapter." The Board Commission on 21st Century Education in Science, Technology, Engineering and Mathematics (the Commission) will conduct its activities according to the Federal Advisory Committee Act (FACA) and other authorities, including applicable conflict-of-interest laws and regulations.

Objectives

The Commission will make recommendations to the Nation through the Board for a bold new action plan to address the Nation's needs, with recommendations for specific mechanisms to implement an effective, realistic, affordable, and politically acceptable long-term approach to the well-known problems and opportunities of U.S. pre-K–16 STEM education. The objective of a national action plan is to effectively employ Federal resources cooperatively with those of stakeholders from all sectors including but not limited to: Federal, State and local government agencies; parents, teachers and students; colleges—including community colleges; universities, museums and other agents of formal and informal education outside the K–16 systems; industry; and professional, labor and public interest organizations to encourage and sustain reform of the national pre-K–16 STEM education system to achieve world class performance by U.S. students, prepare the U.S. workforce for 21st century skill needs, and ensure national literacy in science and mathematics for all U.S. citizens.

In developing a national action plan, the Commission will address the following issues and identify the specific role of NSF in each:

- *Improving the quality of pre-K–16 education related to both general and pre-professional training in mathematics, engineering and the sciences*, including, but not limited to: the availability of competent teachers; the adequacy and currency of curricula, materials, and facilities; standards and trends in performance, as well as promotion, graduation and higher-education entrance requirements; and comparison with performance and procedures of other countries.
- *Identifying critical aspects in the entry, selection, education and exploitation of the full range of potential talents, with special attention to transition points during the educational career where loss of student interest is greatest*; and recommend means to assure the most effective education for all U.S. students as well as future scientists, engineers and other technical personnel.
- *Improving mathematics and science programs, curricula, and pedagogy* to capitalize on the Nation's investment in educational research and development and appropriate models of exemplary education programs in other countries.
- *Promulgating a set of principles, options and education strategies that can be employed by all concerned, nationwide, to improve the quality of secondary school mathematics and science education in the 21st century*, as an agenda for promoting American economic strength, national security, employment opportunities, and social progress that will support U.S. pre-eminence in discovery and innovation.

MEMBERSHIP AND STRUCTURE

The Board Commission will consist of up to fifteen (15) members appointed by the Chairman of the Board, in consultation with the full Board, the Executive Branch, Congress and other stakeholders. The Board Chairman will designate a Commission chairperson and vice chairperson from among the members. No more than three Commission members will be appointed from current Board membership. Commission members will be persons whose wisdom, knowledge, experience, vision or national stature can promote an objective examination of mathematics, science and technology education in the pre-K–16 system and develop a bold new national action plan for the 21st century.

A quorum of the Commission will be a majority of its members. Terms of service of members will end with the termination of the Commission. The Commission may establish such working groups, as it deems appropriate. At least one member of each working group shall be a member of the Commission. A Commission member will chair each working group, which will present to the Commission findings and recommendations for consideration by the Commission. Timely notification of the establishment of a working group and any change therein, including its charge, membership and frequency of meetings will be made in writing to the Executive Secretary or his/her designee. Management (including Executive Secretary and Designated Federal Official (DFO)) and staff services will be provided by the Board Office under the direct supervision of the Board's Executive Officer. Commission work-

ing groups will act under policies established by the Commission, in accordance with FACA and other applicable statutes and regulations.

Meetings

The Commission will meet as requested by the chairperson. Working groups will report to the full Commission and will meet as required at the call of their chairperson with the concurrence of the Commission chair. Meetings will be conducted, and records of proceedings will be kept, in accordance with applicable laws and regulations.

Expenses

Per diem and travel expenses will be paid in accordance to Federal Travel Regulations.

Reporting

The future action plan will especially focus on the appropriate role of NSF in collaboration and cooperation with other Federal agencies, State government, local school districts, gatekeepers, business and industry, informal STEM educational organizations, professional associations, scientific organizations, and parents and other citizens interested in improving education in mathematics, science and technology for our Nation's children. In addition to its final report, which is expected 12 months from the initial meeting, the Commission will submit to the Board periodic progress reports at least every 4 months. The Commission will develop an action plan that includes a plan for public dissemination and outreach for Commission activities, recommendations, and reports.

Senator HUTCHISON. Thank you very much, Dr. Washington.

Dr. Bement, I continue to have concerns that, at a time when our Nation is trying to meet a very important challenge for scientists and engineers and technology experts, that we are spending millions of dollars to support research in areas that may be valuable, and certainly are very interesting, but don't contribute to the push that we now have for science and engineering. And I don't mean to in any way belittle the great contributions that the NSF is making in scientific research. But even though it is a smaller part of the budget—millions are being spent on sociology, political science, areas where I just wonder if it is the right place for the National Science Foundation to be spending its valuable dollars.

Dr. BEMENT. Yes, Madam Chairman. Let me point out that the National Science Foundation currently funds about 50 percent of the research being done at universities in what we call the social, behavioral, and economic sciences.

First of all, this field is very broad. It's very difficult science. And it's also a field that gets very high returns, economic returns for the Nation. And I'd like to illustrate that, if I may.

First of all, in its breadth it includes such fields as sociology, economics—in fact, in economics, the SBE directorate has supported 34 of the 57 Nobel laureates in economics. It does include political science, archeology, anthropology, geology, geography, which is essential for navigation and mapping technology from a GPS, linguistics, psychology, and neuroscience. And, through neuroscience, we learn about human cognition and child development, especially in a digital age, for which there is a great lack of learning.

Also within this directorate is our Science Resources Statistics Division, which is responsible for our Science and Engineering Indicators Report, the Report on Education for Women and Minorities, and also a new initiative, which is very much tied to the American Competitiveness Initiative, which has to do with science metrics to determine how best to determine both the quantitative and the qualitative returns to the economy through investments in

basic research. And just as an example of high returns that come from this research, NSF-supported abstract auction theory in experimental economics, which provided the Federal Communications Commission with its current theory-derived system for appropriating the airwaves. Since their inception in 1994, FCC spectrum auctions have netted over $45 billion in revenue for the Federal Government, and more than $200 billion in worldwide revenues. That return, by itself, more than returns the investment in the SBE sciences since the beginning of the Foundation, in 1952.

It's also very difficult science. If you look at just the field of neuroscience, it engages some of the most sophisticated instrumentation that we currently have—namely, electron encephalography, positron emission tomography, functional MRI, and many other tools. So, at the frontier, almost all the sciences converge, in one way or another, and we see convergence of the physical sciences with the social and behavioral sciences, and also with the biosciences. And they all leverage off one another, so that if you were to take one leg away from that chair, it would be a great loss.

Senator HUTCHISON. Dr. Bement, I think some of these areas in this particular SBE directorate are quite valid—certainly, archeology, geography, linguistics. I think what concerns me is that at a time when we are trying to get every dollar directed toward the research that will keep America in the forefront economically, I look at this area—for instance, in political science, you have $238,000 for a study for the U.S. Senate election database to examine the behavior of State legislators in selecting U.S. Senators before the 17th amendment. You have almost $8 million in two awards to continue a study on, Why did America vote as it did on Election Day? This one will focus on the November 2006 elections. And I just question, when there is such a wide journalistic field, and books come out from journalists who cover these elections on a daily basis, sometimes for years, if that is $8 million that is well spent. $243,000 for studying, do Presidents' veto threats matter? I would just have to question where that would really lead a very narrow group, the President, and Congress, to determine a difference in behavior. $284,000 to study the quality of elections based on the respective candidates' policy positions. I think that can be done in a very realistic judgment call by how the ballots are cast on Election Day. There are others like that. That's just in the political science arena.

And in the sociology arena, you have a study on religious involvement and mortality in the United States, the impact of global and national economic changes in Bangladesh on 300 urban women workers. I just point those out, not that they aren't interesting. And if we had excess money, perhaps we could look at things like that.

But I ask you two questions. Do you think that we should, in any way, reassess what the mission of the National Science Foundation is, and perhaps, if we are going to study political science and social science, that it might go into another department which is not going to be, hopefully, our key foundation for our competitiveness initiative for the next century to make sure that America stays in the forefront in the hard sciences? And, second, do these merit the

priority, given the other focuses that we have to have now for our engineering and science base?

Dr. BEMENT. Madam Chairman, you raise some very important and interesting questions. Clearly, the mission of the Foundation is very broad. We support all the sciences and engineering fields. Clearly, the mandate intended of the Foundation is to deal not only with the economic development of the Nation, but also the quality of life. So, it does get into how society operates and how it functions and how its political institutions work, as well.

I'd have to read into the details of these proposals, because oftentimes the title doesn't tell the whole story, but you're quite aware that we now have gone to national voting standards, and that involves new technology, but it also involves better understanding of human-technology interaction, and also ballot design and many other issues e.g., software development that also play a role. So, even though there is a technology component, you can't exclude the social and the economic impact, as well, of these voting standards.

So, since the passage of that bill, the National Science Foundation has supported basic research in the process of voting. And some of these proposals that you cite, I would guess, are part of the body of knowledge that we're developing in that area.

Senator HUTCHISON. Well, I certainly hope that we can look at that. If we are going to create a doubling of the NSF budget, I would certainly, for one, like to see that doubling go to the hard sciences, which is our priority, our mission, our focus right now, to bring America back into the forefront, and make sure we don't lose the lead that we have had. And I don't want the engine, which is the National Science Foundation that is going to be driving this mission, to be in any way burdened or—maybe you wouldn't call it "burdened," but losing its total focus on this initiative. So, I hope we can explore that.

Dr. BEMENT. Yes, well——

Senator HUTCHISON. I do want to support the doubling of the budget, but I don't want to support what I might consider interesting research, but not experiments or research that would further the mission that we are trying to accomplish.

Dr. BEMENT. One area that I have a particular interest in—and I think this is where we have common ground—is to pay particular attention to those areas in the social, behavioral, and economic sciences that enable science and compress the lead time from discovery to application. And as we move into the digital age, there are new ways in which scientists work together, and many of those are social interactions. And if there are ways in which we can further that, make it more productive, then that would very much be at the heart of the American Competitiveness Initiative, and those are the areas that I would like to see us focus on.

Senator HUTCHISON. Thank you, Dr. Bement.

Senator Stevens?

The CHAIRMAN. Thank you very much, Madam Chairman.

Senator Nelson and Senator Sununu didn't get an opening comment. If they wish to make an opening comment, I'll be glad to yield—before they start.

Senator BILL NELSON. I will just put one in the record, Madam Chairman.

Senator SUNUNU. Well, I have a few questions that I'd like to ask, but I certainly would defer to you.

The CHAIRMAN. Thank you. I just wanted to make sure you had a chance, in case you were going to have to leave.

Dr. Washington, we're all familiar with the Augustine report that has been mentioned here. I found very interesting the comment that you made in your long statement, which I assume will be printed in full in the record. And let me read this, "Nearly a quarter of a century ago, the National Science Board's Commission on Pre-College Education in Mathematics, Science, and Technology assessed the state of U.S. pre-college education in the subject fields, and found it wanting. In the intervening years, we have failed to raise the achievement of U.S. students commensurate with the goal articulated by that commission that the U.S. pre-college achievement should be, "the best in the world by 1995," and many other countries have surpassed us. Not only are they not first, but, by the time they reach their senior year, even the most advanced U.S. students perform at or near the bottom on international assessments. There is now an even more pressing need to build a new foundation."

Now, I think that's really what the Augustine report was aimed at. And I know both your entities cooperated extensively with them. But tell me, out there in the community—part of the community that you interact with, what's the feeling about that report? Is there a feeling of necessity that some of us up here feel about changing the way we do business?

Dr. WASHINGTON. Yes, I would say so. In fact, the Board has published a number of studies, and most recently Science and Engineering Indicators, which came out in January. It essentially showed that those trends that we've seen in the past are still operating the same way, and we're not doing a good job. And, in fact, the commission I mentioned earlier is supposed to actually try to come up with an action plan that we can present to the President and to Congress for what needs to be done. And it should be a very prescriptive type document that will actually lay out all the way from kindergarten through grade 16, which is undergraduate education, it should essentially lay out what needs to be done to improve the science and engineering technology education in our society. And we're not doing a good job. I think you can read in the newspaper almost every day that we're falling behind certain other countries, and I think it's going to hurt us in the long run.

The CHAIRMAN. Well, it's back in the last century, but I remember my high school experience, and the fact that the teachers of science and mathematics made the subjects come alive. Today, you know, as a father of six, I was surprised to see the comment that most high school students would rather take out the trash or clean their bedroom or wash dishes than study math or science. Now, what's caused the change in attitude of the teaching profession or approach that has taken out the spark in our basic education?

Dr. WASHINGTON. Well, I think I had the same experience as you did. I was turned on by a high school chemistry teacher. She was just very fantastic in making science exciting, interesting. And that's what really got the spark in me to actually go into science. And I think that we need teachers of that type. But we need to

support our teachers, and we need to train them better, give them more opportunities to get in-service training so that they can be more effective in the classrooms. So, there's no simple silver bullet that will solve this problem. It's going to require a lot of different things happening to turn things around.

The CHAIRMAN. Well, I know my time is running out. I don't know if you have any comment about it, Dr. Bement, but my kids tell me that the difference is that we had to look up the things in books; they just press buttons on the computer and out come the answers, and they don't have to think about what gave them those answers. They get them automatically. Because of the new systems we use to teach, are we straying away from the personal contacts that have to be achieved between teachers and students to give them that incentive to excel and to explore? What do you think, Dr. Bement?

Dr. BEMENT. Yes, Senator, I think you've put your finger on several key issues. We focus pretty much on encouraging inquiry-based learning, where the students take an interest in asking questions and pursuing knowledge surrounding math or science, discovery-based knowledge, where they have the opportunity to do some hands-on activities, so they learn as they discover, and also to develop a stronger base of conceptual knowledge. Now, that takes a teacher that has not just pedagogical knowledge, but has content knowledge, and knows how to integrate the two, and motivate, and deal with the various cognitive skills of the students. In other words, she has to address all the students in the class, not just a small fraction. Those are the kind of advances that we're trying to support through our education initiatives in K through 12. And, as an important element of that, we're also investing in trying to improve undergraduate training of teachers, especially in the STEM fields, where they do get math content and science content, not in the schools of education, but in the schools of arts and science, where they take a much more rigorous preparation.

We also have scholarships, some of which are identified in the Alexander-Bingaman bill. One of them is the Noyce Scholarship, where we provide scholarship support for students in undergraduate education who are taking STEM preparation that will also add to that preparation 2 years of education and then get certified, and then bring that content knowledge into the classroom.

Through our Math and Science Partnership Program, just last year, we increased the number of STEM-prepared teachers in math and science by over 400. Well, that's a small increment. We need to build that increment across the Nation. And that will take additional resources. But at least we know, and we have measurements, and we have data, to indicate that that really does have a positive impact.

The CHAIRMAN. My time's up. I've got a lot more questions, but my time's up. I really think the problem is the stimulus have to come from the contact of the teaching profession, and it's not there today, like it used to be.

Dr. BEMENT. You're right. I agree.

Senator HUTCHISON. Thank you, Mr. Chairman.

Senator Nelson?

STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Senator BILL NELSON. And, if you will, Madam Chair, put my opening statement into the record?

Senator HUTCHISON. Without objection.

[The prepared statement of Senator Bill Nelson follows:]

PREPARED STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Madam Chairman, I thank you for calling this important hearing and I welcome the panelists. I am very interested in the work of the National Science Foundation and happy to see a requested budget increase for NSF in Fiscal Year 2007.

I believe our country is at a crossroads. For generations the United States has been the envy of the world with its innovations, inventors, and new markets that were created as a result. More recently however, we have seen erosion in the numbers of students going into math and science fields, the loss of high technology jobs overseas, and an overall reduction in investment in basic research that spawns invention. Rather than dwell on the losses however, I am optimistic that we can turn things around.

I am encouraged by the thoughtful discourse we have been having over the past year on the issues of innovation and competitiveness. I believe NSF programs are a key part of bringing this country back to the forefront of science and technology discovery and innovation—specifically with NSF investment in education and basic research programs.

It is imperative that we replenish our Nation's pipeline of young scientists and engineers, and re-fill the well of basic research knowledge that will bring the innovations of tomorrow. If America does not, others surely will.

Much of the NSF's mission dovetails nicely with key features in the two sets of landmark bills that I co-sponsored: The Protecting America's Competitive Edge (PACE) Act and the National Innovation Act of 2005.

The PACE legislation focuses on retaining America's science and technology edge; sets the path for keeping the U.S. competitive in the world marketplace; and provides for investments in math and science education. The National Innovation Act legislation specifies the development of American scientists, mathematicians, and engineers; increases funding toward multidisciplinary and frontier research; secures a strong advanced manufacturing base in the United States; and makes innovation a fundamental economic priority for our country.

I am excited about the provisions that are in these bills. I will continue to work with my colleagues in Congress to see that these important pieces of legislation become law.

By fully funding NSF, enacting the PACE and National Innovation Acts into law, I believe our country will be making appropriate and vital course corrections to retain our scientific and technological leadership on the world stage.

I look forward to hearing your ideas and recommendations for NSF and its science priorities.

Senator BILL NELSON. And I want to follow up on Senator Stevens' question. I agree with him, but that doesn't explain why China's graduating 600,000 engineers; India, 350,000; and the U.S. is graduating 70,000. Why?

Dr. BEMENT. Well, I think, as Lenin said, quantity has a quality of its own. They have the quantity, they are making the investment. They're investing in the universities and colleges. And they see that their future is educating their workforce and that the greatest asset that they have is human resources. And so, they're going to educate those human resources. And, quite frankly, they're making very good progress. And so, we have to learn how to compete.

Senator BILL NELSON. Well, if we recognize that, then in light of exactly what Senator Stevens said, we want to promote math and science. Why aren't we spending more on education programs? Why

is there a 20-percent cut below 2004 in real terms in your budget request?

Dr. BEMENT. Senator, the total budget for education is both in our EHR directorate, as well as in our Research and Related account directorates. And if you look at all the investment in education, it is actually a plus. It's not only a plus for K–12 education, but it's a plus for undergraduate education. But the program change that really dominates those figures is the reduction in our Math and Science Partnership and the determination by the Administration that we will not do new starts, that that will continue to sustain the program that we currently have, which, incidentally, is the largest math and science education program that the Foundation has ever undertaken. It involves as many as 4 million students, 500 school districts, and a large number of schools. And it also——

Senator BILL NELSON. Let me interrupt you, because we're going to have to go to a vote. Do you know a Dr. Leshner?

Dr. BEMENT. I do know him, very well. He's a——

Senator BILL NELSON. Chief executive——

Dr. BEMENT.—very good friend.

Senator BILL NELSON.—officer of the——

Dr. BEMENT. He's sitting in back of me.

Senator BILL NELSON.—American Association of the Advancement of Science.

Dr. BEMENT. Yes, of course. I'm——

Senator BILL NELSON. OK. Well, listen to what——

Dr. BEMENT. I'm a card-carrying member.

Senator BILL NELSON.—listen to what he writes, "We are concerned that the NSF's Education and Human Resources budget, in contrast to the research budget, would increase just 2.5 percent. This means that it would remain 20 percent below the 2004 funding level in real terms. Small increases in graduate education and human resource development programs would be offset by cuts to undergraduate education programs, and research on how students learn would be flat-funded." That's opposite of what you just said.

Dr. BEMENT. Well, I don't necessarily disagree with those statements, as it applies only to the Education and Human Resources directorate. But, again, I would call attention to the fact that we make substantial investments in our Research and Related account directorates to education, to broadening participation, and to fellowships. A lot of the fellowship support and research experience for undergraduate support comes out of R&RA, not out of the EHR account. So, if you add up all the components that contribute to education and broadening participation, it's much greater than 2.5 percent.

Senator BILL NELSON. What do you think are the areas the United States is lacking in basic research investment?

Dr. BEMENT. That is a relative question that is very difficult to answer, because it's relative to where we stand with the rest of the world and where we choose to compete. And it's also a question that changes almost daily. I think I'd like to take a crack at addressing that for the record.

Senator BILL NELSON. OK. When you do, please address what kinds of innovations would be lost to foreign markets as a result.

Dr. BEMENT. Very good.

[The information referred to follows:]

The U.S. accounts for approximately one-third of global research and development (R&D) spending (more than the rest of the G–8 nations combined). In 2004, the United States performed an estimated $58.4 billion of basic research. Universities and colleges have historically been the largest performers of basic research in the U.S., and in recent years have accounted for over half (55 percent in 2004) of the Nation's basic research. Most basic research is federally funded.

Because it is not possible to predict the area of science and engineering that will be responsible for the next breakthrough technology, investment is needed across all science and engineering fields. Today's transforming technologies and most popular consumer items have deep roots in basic and applied research.

Among the National Science Foundation priority areas are Networking and Information Technology Research and Development (R&D) and Nanoscale Interdisciplinary Research where additional investments are expected to yield new discoveries. Although NSF is making significant investments in basic research across all areas necessary to maintain our position at or near world leadership, many good ideas go unfunded. The 2005 success rate for research grant proposals in Molecular and Cellular Biology, for example, was 13 percent. In the Information and Intelligent Systems division the success rate was 11 percent and in Bioengineering and Environmental Systems it was 10 percent. All of these areas are significant for laying the groundwork for discoveries that could have enormous economic implications. We also see opportunities for research in neuroinformatics, nanobiotechnology, environmental biotechnology, applications of biotechnology to bio-based products and fuels, and in the developing area of synthetic genomics.

The American Competitiveness Initiative seeks to increase investments in basic research and support more of the quality ideas such as those represented in proposals that are currently submitted to NSF.

While it is not possible to forecast what innovations might be lost to foreign markets, the nature of S&T is global. There are a rising number of companies' international alliances devoted to joint R&D or technology development. The number of new international alliances rose from under 100 in 1980 to 183 in 1990 and 342 early in the new century. Historically, U.S. companies have been involved in 75 percent to 86 percent of these alliances. Speed to market is currently a strategy used by many U.S. companies to assure comparative advantage of innovations in a global market.

The CHAIRMAN. [presiding] Senator, let Senator Sununu in here. We all have to go vote in a minute.

Senator BILL NELSON. Sure.

The CHAIRMAN. Thank you.

Senator Sununu?

STATEMENT OF HON. JOHN E. SUNUNU,
U.S. SENATOR FROM NEW HAMPSHIRE

Senator SUNUNU. Thank you, Mr. Chairman.

The CHAIRMAN. Have you turned on your mike?

Senator SUNUNU. I am on.

Dr. Bement and Dr. Washington, I don't know you especially well. I certainly have information here about your background. But I'm a little bit troubled by all of this discussion, its general focus. And I'm going to go through a number of points, and then, by all means, you can have ample time to express some commentary for the record.

We can begin with Senator Nelson's last question, which I think is a very good question. What area of basic science do you think we ought to apply additional resources? And when the head of the National Science Foundation comes before this Committee or Subcommittee and has trouble answering that question, or at least presenting an answer to that question, I, frankly, have to wonder exactly what you're spending your time on, because that's exactly the

question that we expect you to come here and, whether it's presenting an Administration overview or your own opinion, at least be able to discuss what key areas of basic science that you think we ought to be allocating more funds.

Conversely, you seem to have no trouble in defending studies that look at how and why people vote for the United States Senators, which, although that is my profession at the current time, I don't think is a good expenditure of National Science Foundation resources.

This is the one central organization that we have to make investments in peer-reviewed science. And you talked about a broad science agenda. Well, I would disagree, in this respect. You've mentioned psychology and neurosciences and health sciences. That's what we have the NIH for. And the NIH right now has $28 billion a year to invest in precisely those areas. And if I were in your position, I would be guarded and protective of those areas that I, as the National Science Foundation was chartered to research and to allocate funds to, and I would be very reluctant to provide resources in areas like neurosciences or psychology that are right in the front of the NIH agenda, as they should be—mental health and physical health. That's exactly what we have the NIH for. There are some people that think, well, you know, maybe $28 billion a year is ample funding, at least to the extent as we ought to begin redirecting resources to the National Science Foundation. But I don't think it helps your cause when you describe your agenda as being sort of broad and amorphous. Agricultural sciences, that's why we have Department of Agriculture research; Ocean sciences, NOAA; space sciences, NASA.

Your charter is to focus on fundamental sciences—physics, chemistry, material science, computational mathematics, and a few other core areas—through a peer-reviewed process. And I know, in this day and age, everyone loves to talk about education. And it makes us, maybe, popular. It makes it sound like we care. We care about education, we care about the children, we care about the future. But to start diverting resources to K–12 education in the National Science Foundation, I also think is unproductive, when we're spending $40 billion in the Department of Education. You talked about going forward with your advisors in the National Science Foundation and making recommendations on K–12 math and science. Now, I would imagine some people at NSF have good perspective, an interesting perspective in this area, but what are we doing in the Department of Education if they're not able to put forward such a proposal?

It is very difficult to feel confident and comfortable about the direction that you're taking the National Science Foundation, when it seems that your own emphasis on its core mission, in my opinion, leaves a little bit to be desired.

Dr. BEMENT. Well, Senator, let me——

Senator SUNUNU. I would be happy to hear your comments.

Dr. BEMENT. Yes. Let me respond to those, straightaway.

Clearly, there was a time when the United States could dominate in every field of science. That day is long past. We have to now select those areas where we need to be dominant in science. And one might argue, well, national needs is an area where we really need

to be dominant in science. But the national needs are broad. One can cite defense, national defense or national security. Clearly that's important. One can select homeland security. And we are investing in those areas, as far as the basic science is concerned. And those are the ones that I would cite as are being very critically important. As far as human——

Senator SUNUNU. I'm sorry, I just want to be clear. So you're making investments in defense R&D, in particular, right now?

Dr. BEMENT. No, we're not making investments in defense R&D. But the question that Senator Nelson asked me was, Where are the most important areas of basic science? And I'm just trying to illustrate a point, that one has to put that question in context. If you put it in the context of national needs, clearly I can give you a litany, or I can give you a long list of areas where we really need to be dominant in science, because of national interests. But there are many fields of emerging technologies that deal with economic development. And if you cite economic development as a major national need, I can give you another list, in terms of biotechnology, nanotechnology, information technology, and all the science——

Senator SUNUNU. And I'm going to respond——

Dr. BEMENT.—that undergirds that.

Senator SUNUNU.—that if you can tell me what the economic value of a specific piece of research is, you shouldn't be putting any money into it, because that's exactly what we have a venture capital community for. And the National Science Foundation is the one part in the Federal Government, and the one area of research, where I don't want to hear about the specific job creation impact, because you can't tell me, just as those that were looking at the mathematics of either multi-tiered or multi-person or multi-vote—or multi-choice auctions couldn't just tell exactly what the applications would be and what its benefit would be when they were doing it. Those that were looking at cryptography or computational mathematics in the 1970s, early 1980s, they didn't have the World Wide Web in mind, because it didn't exist yet. And yet, now those are all central to the e-commerce that we enjoy today. If you can tell me what the economic value of a specific piece of research is, then it probably ought not to be funded by the National Science Foundation.

Dr. BEMENT. Well, I couldn't agree with you more.

Senator SUNUNU. I'm relieved to hear that.

Dr. BEMENT. I think the point you're making is that the National Science Foundation should be doing frontier research. We should be focused on the frontier. We shouldn't be dealing with downstream-type developments or applied research. I don't think I have any disagreement with that.

Senator SUNUNU. Well, I appreciate your candor, and I think this is an extremely important hearing. I have long been an advocate for doubling funding for the National Science Foundation, because certainly until recent years, at the very least, the money went to peer-reviewed basic research. And today, I think, partly because of the vague message that some people have been sending, we have proposals on the table to take 8 or 10 percent of the funding of the National Science Foundation out of the peer-review process. We have people who are proposing to expand the educational mission

of the National Science Foundation. And I want to do as much as possible for math and science education, but we should do it through the Department of Education, where we're expending resources specifically for that purpose. And if we're not clear that you and Dr. Washington and others aren't willing to stand up and defend and protect the mission in the peer-review process, and the commitment to basic sciences, then there's going to be no one left to fulfill that important goal.

Dr. BEMENT. Well, I can assure you, Senator, that I am very committed to that, and that we're going to protect the peer-review/merit-review process.

Senator SUNUNU. Thank you very much.

Senator HUTCHISON. [presiding] Thank you very much, Senator Sununu.

I appreciate very much the interest that we have had in this hearing, and I hope that you are getting the gist of some of the Members of Congress anyway.

Basically, I think what we're trying to say is that we're getting ready to embark on a huge new initiative to bring America back to the forefront. We see—not that America has fallen second, but that if we don't do more, we will fall behind others—other countries that are emerging. And if the National Science Foundation is going to be the body in which we put our faith that you can help us deliver this kind of result, we want the National Science Foundation to be meticulous in focusing on that mission.

And let me just ask you, If we double the funding, as I'm a cosponsor of the bill to do, of the National Science Foundation, for research into the hard sciences and technology and engineering and math, are you—would you be committed to keeping that focus there for that doubling——

Dr. BEMENT. Yes.

Senator HUTCHISON.—in line with the mission that we are trying to accomplish?

Dr. BEMENT. I can assure you of that.

Dr. WASHINGTON. Yes, I can say the same.

Senator HUTCHISON. Thank you.

Let me ask you one other question. And this is related to NASA. One of the things that I have been trying to do is keep the basic science research in NASA. And when we reauthorized NASA, which was the first reauthorization bill we had had in 5 years for NASA, to give it the Congressional mandate to go to the Moon, and beyond, to Mars, unfortunately what was beginning to suffer was the basic science, the commitment to the Space Station. We created a national lab for the American part of the Space Station, so that we could have other resources for funding the basic sciences. We also required 15 percent of NASA's research budget to go to the hard sciences, not just the research that was the life-sciences research on the body and how it responds to space. That is a priority for NASA, and we understand that. But it is also a priority to have the basic science research on the Space Station. We spent billions of dollars to build the Space Station, and the biomedical research that is being done there has already proven to be hugely productive. And now, that is what is being cut. So, we are mandating the 15 percent set-aside for hard sciences.

So, this is my question. To what extent is there cooperative research with the NSF and NASA? I know there is some, but I'd like to know what priority you put on it and if you have looked at your science and research activities in relation to NASA to see where there could be joint activities that would be productive for hard sciences using the International Space Station and NASA resources.

Dr. BEMENT. Yes. Let me answer that question in three parts, since I think there are three questions there.

First of all, we have a number of memorandums—memoranda of understanding with NASA. And we have sent a package over to Chairman Stevens, as of this morning, that delineates all of those memorandums of understanding. Some of them have to do with EPSCoR, cooperation in EPSCoR. A lot of them have to do with understanding atmospheric science and understanding Earth sensing and elements that deal with long duration balloon flights. But those are only examples of a number of areas where we're actively cooperating.

The second part, I do have an understanding of the importance of the International Space Station, because I served on NASA's Space Station Utilization Subcommittee that dealt with just how we were going to spend that 15 percent. So, I do have a direct understanding of some of the important research that can be done there.

I can also say that the Foundation does accept unsolicited proposals. About half our proposals are unsolicited. And we would entertain proposals for doing research on the Space Station. We would treat them like any other proposal, and we would peer review them the same way.

Senator HUTCHISON. Thank you.

I'm very pleased that you are on that committee, because I think that——

Dr. BEMENT. I'm not on the Committee, presently. I was on the Committee.

Senator HUTCHISON. Well, maybe we need to put you back on the Committee. I have to say, in the NASA authorization, and in the defense authorization bill, I required the Department of Defense and NASA to jointly look at their research projects to see if there was duplication and to try to work together to stretch the dollars, because in government we shouldn't be duplicating efforts. I think the National Science Foundation and perhaps now the Department of Energy could also be coordinated with NASA and do more with our dollars if we put all of the good minds together on the projects that can be done jointly.

Dr. BEMENT. Yes, ma'am, I understand that. We've had a longtime close working relationship with NASA.

Senator HUTCHISON. Well, I hope you will, after this hearing, make it a point to look at other areas, and perhaps meet with Michael Griffin, and put your teams together to see if we could do even more.

Dr. BEMENT. In fact, we have an embarrassment of riches. Actually, my deputy, Dr. Olsen, is the former chief scientist of NASA. So, we do have a lot of internal knowledge about NASA programs.

Senator HUTCHISON. Well, ask him——

Dr. BEMENT. Her.

Senator HUTCHISON.—her—oh, good——

[Laughter.]

Senator HUTCHISON.—I wasn't sure—ask her, please, to start putting her creative juices to work and seeing if there is more that can be done, because, frankly, in the President's initiative, the Competitiveness Initiative, I immediately thought that we should be coordinating our basic science in NASA and the National Science Foundation in this initiative because NASA has been responsible for inspiring so many young people to go into science, and I want to make sure that we are putting the two major science government initiatives together, I guess, along with the defense—DARPA research component as well as NIH. I mean, there are a number of them, but I think particularly if we put all of those together as we are looking at the big picture of competitiveness, and where we stand, and where we need to go, that we should be coordinating better all of our basic science research arms to coordinate——

Dr. BEMENT. Yes.

Senator HUTCHISON.—results.

Dr. Washington?

Dr. WASHINGTON. I was just going to make the point that the Board is actually starting a study to look at the international aspects of science and engineering. We know that the science is becoming more global and that we need to make changes in our way of thinking. So, I would say that as part of our exercise to look at the international aspects, that we will be looking at the NASA/NSF partnership.

Senator HUTCHISON. Great. I'm very pleased that you are looking at that, because I believe that with the Augustine report, that has really been the red flag to all of us. I think it is incumbent on us to look at every place we are doing basic research. And, you know, in a way, I think we could even do more international cooperation so that we're not duplicating efforts that are being done elsewhere, and use our resources to go into new fields, more creative fields. But one of the examples that was given in a hearing that the Commerce Committee had by Dr. Ting, the Nobel laureate from MIT who said that he believes the most forceful source of energy that we don't understand is cosmic radiation, which you can see in its natural state in space, and study it for clues to help guide us to the next generation of energy producers, that the Space Station and space might be the place to look. And it happens that that is one of the experiments of the International Space Station that might not be completed. Senator Stevens and I are both very concerned about that. And we want to make sure that we do have all of the capabilities to look for every source of energy at a time when we know what is happening in the world; and 25 years from now, if we don't do something about it, we will crowd out all of the energy in the world, and we will all be deficient. So, that's what we're facing.

Well, I thank you. We do have a second panel, and I want to call that panel, but I want to be clear that the National Science Foundation has a great reputation. And the research that is and has been done is totally respected and well regarded. We are now into

the next generation of commitment to science for our country, and I just want to make sure that we are not dissipating resources, that we're not wasting resources, and that maybe we should look at other places to go for some of the peripheral or other types of scientific research and let National Science Foundation do what we know it does best, and put all the resources there for that purpose. That was my mission today.

Thank you.

Did you have any further questions of this panel?

The CHAIRMAN. No. I would like to visit with you sometime. We do still have a problem finding a way to upgrade science and technology in the total government—Congressional system, and I would like to get your viewpoints, particularly you, Dr. Washington—you're going to step down, but you, too, Dr. Bement. I look forward to it.

Thank you.

Dr. BEMENT. Thank you.

Senator HUTCHISON. Thank you very much. I appreciate your being here and your candor.

I would now like to ask Dr. Alan Leshner, the Chief Executive Officer of the American Association for the Advancement of Science, and then Dr. Jerome Odom, the Professor of Chemistry and Former Provost of the University of South Carolina, the Chairman of the IdeA Foundation.

[Pause.]

Senator HUTCHISON. Dr. Leshner, welcome.

STATEMENT OF ALAN I. LESHNER, PH.D., CHIEF EXECUTIVE OFFICER, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Dr. LESHNER. Thank you very much. Good afternoon—thank you. Good afternoon, Madam Chair and Senator Stevens. It's really a pleasure to be here. Thank you for this opportunity to testify on behalf of the Fiscal Year 2007 budget request.

I'm here representing the American Association for the Advancement of Science, which we call AAAS. We're the world's largest general scientific society, and publisher of the journal *Science.* AAAS was founded in 1848. We have 262 affiliated societies and academies of science, altogether representing some 10 million scientists around the world.

I'd like to start by saying we applaud the Administration's recognition, in its budget proposal for NSF, of the importance of a broad, balanced portfolio of R&D investments. The need for strong support across all scientific fields comes both from the increasing interdependence of physical, biological, behavioral, and social sciences, and from the importance of all these fields to innovation and to the improvement of the economy, health, and quality of life of all Americans.

In fact, based on the opportunities that will still go unmet, in spite of the increases proposed by the President, we believe even greater support would be well justified. After all, the proposed increases are only a beginning in redressing some of the real-dollar declines in NSF's budget that have occurred over the course of the last few years.

Moreover, as pointed out in the landmark reports from the National Academies and the bipartisan Congressional Summit on Competitiveness, it's exactly the kind of research and education supported by NSF that underpins future innovation, economic growth, and the health of all citizens in this science- and technology-dependent era.

We're particularly concerned that NSF's Education and Human Resources budget would increase just 2.5 percent in 2007. This means that it would remain 20 percent below the 2004 funding level in real terms. Ironically, this low education budget is proposed at the same time as we are recognizing just how important improving math and science education is to guaranteeing the United States future economic competitiveness. NSF, as an organization of scientists, is best suited to develop techniques to improve the teaching of how science really works. NSF has a demonstrated record of excellence in science education, and it's important that the agency receive the funding it needs to take advantage of this expertise.

More generally, NSF is the second-largest funding source for research and development at colleges and universities, behind only NIH. NSF provides the majority of Federal support for basic research at colleges and universities in the social sciences, environmental sciences, nonmedical biology, mathematics, and computer sciences. For the physical sciences and engineering, NSF funds more than 40 percent of all federally-supported academic basic research.

Unfortunately, even with the proposed 2007 budget increases, the agency would still fund fewer than 25 percent of the proposals it receives. This matters because it means a great amount of very important work will go unfunded. Greater contributions to society could be reaped with a larger investment. According to a report recently issued by the National Science Board, of which, I should say, I am a member, NSF had to turn down almost $1.8 billion in proposals that had been rated as highly as had been those projects it funded. This almost $2 billion in declined proposals represents a rich portfolio of unfunded research opportunities, and it's unfortunate for the country that we can't support them.

As examples of opportunities that could be lost, in July 2005 our journal, *Science*—I think you have copies of this—celebrated its 125th birthday by publishing a special issue on "125 questions: What Don't We Know?"—rather than, What do we know? Answering virtually every one of those questions depends on NSF-supported research. Examples of *Science's* 125 important unanswered questions include things like: What are the limits of conventional computing? What are the limits of learning by machines? Can researchers make a perfect optical lens? Are there earthquake precursors that can lead to useful predictors? What's the biological basis of consciousness? How do organs and whole organisms know when to stop growing? Why do some countries grow and others stagnate?

Importantly, every NSF directorate, from the behavioral and social sciences through the life sciences, to math and physical sciences and engineering, plays a critical role in this important work. At a minimum, we urge you to support the President's re-

quest for NSF. If it's possible to provide an increase above the President's request, it would be a sound investment in the future of our country and the quality of life of our citizens.

Thank you very much.

[The prepared statement of Dr. Leshner follows:]

PREPARED STATEMENT OF ALAN I. LESHNER, PH.D., CHIEF EXECUTIVE OFFICER, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Introduction

Good afternoon, Madam Chairwoman and Members of the Subcommittee. Thank you for this opportunity to testify before you today on the FY 2007 research and development (R&D) budget request for the National Science Foundation.

The American Association for the Advancement of Science (AAAS) is the world's largest general scientific society and publisher of the journal, *Science (www.sciencemag.org).* AAAS was founded in 1848, and includes some 262 affiliated societies and academies of science, representing 10 million individuals. *Science* has the largest paid circulation of any peer-reviewed general science journal in the world, with an estimated total readership of over one million. The non-profit AAAS (*www.aaas.org)* is open to all, and our members come from the entire range of science and technology disciplines. AAAS fulfills its mission to "advance science and serve society" through initiatives in science education; science policy; international programs; and an array of activities designed both to increase public understanding and engage the public more with science.

From our unique perspective, AAAS recognizes, as does the Administration in its budget proposal for NSF, the importance of a broad, balanced portfolio of R&D investments. The need for strong support across all scientific fields comes both from the increasing interdependence of physical, biological, behavioral, and social sciences, and from the importance of all these fields to innovation and to the improvement of the economy, health and quality of life of all Americans.

In fact, based on the scientific and, therefore societal, opportunities that will still go unmet, we believe even greater support would be justified than that proposed in the President's budget for the kind of cutting-edge, breakthrough research that universities and national laboratories are uniquely qualified to conduct. As pointed out in the landmark report from the National Academy of Sciences, "Rising Above the Gathering Storm", and the bipartisan Congressional Summit on Competitiveness, it is this kind of research and education in these fields that underpin future innovation, economic growth, and the health of all citizens in this science and technology dependent era.

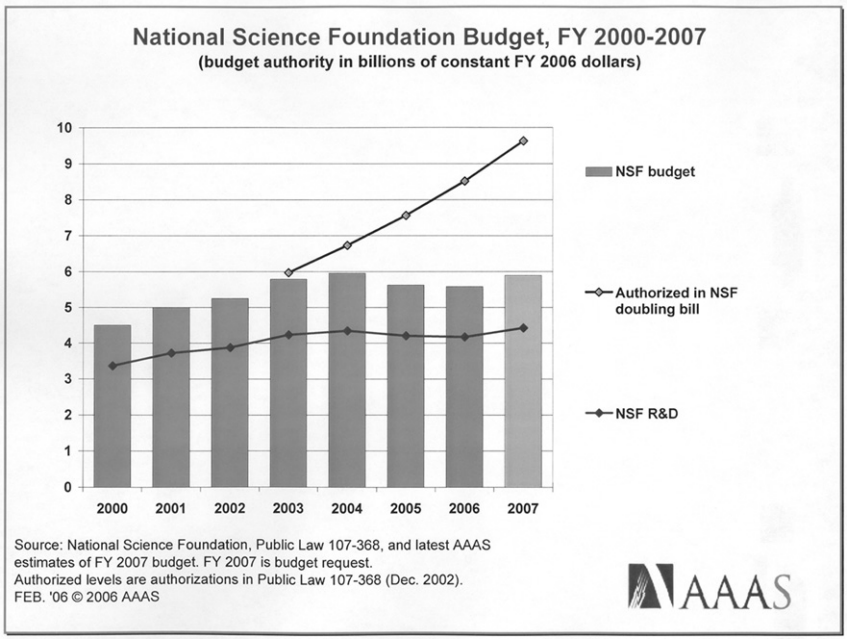
This perspective is consistent with the President's request to increase support for the National Science Foundation (NSF), because the Foundation plays such a special role in ensuring that America will continue to lead the world in scientific discovery and technological development. Given its singular ability to support broad-based transformational basic research, distinct from the many mission-oriented Federal agencies and departments, we are delighted by the emphasis that the White House gives to the NSF in fiscal year 2007. We only regret that additional funds have not been proposed, since even with these increases, a large array of very exciting and important opportunities across the many fields of science will go unmet.

NSF and the ACI

President Bush's proposed FY 2007 budget recommends increases for key physical sciences research agencies as part of the "American Competitiveness Initiative" (ACI) that begins to respond to the growing wave of concern about the state of U.S. innovation. The ACI proposes to double funding for three agencies over the next decade, and the 2007 budget requests the first installment of this ambitious plan. The National Science Foundation (NSF) is one of the three favored agencies (the others are the DOE Office of Science, and the National Institute of Standards and Technology laboratories), and would receive a significant increase in the 2007 budget that would begin to turn around the decreases that came with the past two years of declining funding.

As part of the ACI, NSF would receive a 7.9 percent increase for a total budget of $6.0 billion in FY 2007. The R&D portion of NSF's budget would total $4.5 billion, a gain of $348 million or 8.3 percent. This would bring the R&D total slightly above 2004 levels in inflation-adjusted terms after cuts in 2005 and 2006. It is important to note that the proposed increases go not only to NSF's investment in the physical sciences but across the entire NSF research portfolio, which spans the range of

science and engineering disciplines. This translates into increases between 5 and 9 percent for most research directorates after several years of flat or declining funding. Unfortunately, when viewed in constant dollars the President's proposed budget would still not restore the total NSF budget to pre-2004 levels (see Chart 1).



Research and Related Activities (R&RA) would receive $4.7 billion, an increase of $334 million or 7.7 percent above the FY 2006 level. The research directorates and offices would receive the following:

- Biological Sciences (BIO): $608 million (up $31 million or 5.4 percent).
- Computer and Information Science and Engineering (CISE): $527 million (up $30 million, or 6.1 percent).
- Engineering (ENG): $629 million (up $48 million, or 8.2 percent).
- Geosciences (GEO): $745 million (up $42 million, or 6.0 percent).
- Mathematical and Physical Science (MPS): $1.15 billion (up $65 million, or 6.0 percent).
- Social, Behavioral and Economic Sciences (SBE): $214 million (up $14 million, or 6.9 percent).
- Office of Polar Programs (OPP): $438 million (up $49 million, or 12.5 percent).
- Office of Cyberinfrastructure (OCI): $182 million (up $55 million, or 43.5 percent).
- Office of International Science and Engineering (OISE): $41 million (up $6 million, or 17.6 percent).
- Integrative Activities: $131 million (down $6 million, or 4.2 percent).

NSF and Math and Science Education

We are concerned that the NSF's Education and Human Resources (EHR) budget, in contrast to the research budget, would increase just 2.5 percent to $816 million in 2007. This means that it would remain 20 percent below the 2004 funding level in real terms. Small increases in graduate education and human resource development programs would be offset by cuts to undergraduate education programs, and research on how students learn would be flat funded.

In addition, the budget request for the Math and Science Partnership (MSP) would decline, marking the third straight year that this program has been unable to provide any new awards. Despite expressions of national concern that we must

enhance science and math education, the MSP program request for FY 2007 is merely $46 million, a reduction of $17 million from last year.

As the National Academies recognized in "Rising above the Gathering Storm," improving math and science education is crucial to guaranteeing the United States' future economic competitiveness, and therefore I believe math, science and engineering education merit greater support than has been provided in the President's budget.

AAAS's Project 2061 has found that, too often, science students simply memorize vocabulary words and facts instead of gaining a deep understanding of the concepts and processes of science. NSF, as an organization of scientists, is best suited to develop techniques to improve the teaching of how science really works. NSF, and EHR in particular, has a demonstrated record of excellence, and it is important that the agency receive the funding it needs to take advantage of this expertise. NSF's connections with working scientists ensure that students can be exposed to science in a manner that goes beyond memorizing textbooks and parroting responses of standardized testing.

In addition, investing in the activities of the EHR directorate will allow our students to benefit from NSF's merit review system. There also are lessons that are learned uniquely from competitively awarded grants that link research with evaluation, and thus, inform us of what works and what does not in education.

NSF Trends

NSF is the third-largest Federal sponsor of physical sciences research, after DOE and NASA, and is among the top 3 Federal funding agencies for nearly every science and engineering discipline. It is also the second largest funding source for R&D at colleges and universities behind only the NIH and provides the majority of Federal support for basic research at colleges and universities in the social sciences, environmental sciences, non-medical biology, mathematics, and computer sciences. For the physical sciences and engineering, NSF funds more than 40 percent of all federally-supported academic basic research.

As I have mentioned previously, the increases for NSF would go to support programs throughout the agency's portfolio. In the attached chart (see Chart 2)* you can see that between 2000 and 2007 the majority of the NSF directorates have followed more or less parallel paths as the agency's budget authority has increased or decreased.

Unfortunately, even with the proposed 2007 budget increases, the agency would still fund fewer than 25 percent of the proposals it receives. This is significant because according to a report issued by the National Science Board (of which I am a member), in "FY 2005, close to $1.8 billion of declined proposals were rated as high as the average rating for an NSF award (4.1 on a 5-point scale). These declined proposals represent a rich portfolio of unfunded research and education opportunities."

Conclusion

We at AAAS applaud the increases proposed by the Administration for the National Science Foundation, particularly during this time of tight budget constraints. However, we also want to emphasize that this is only a beginning in redressing some of the real-dollar declines in NSF's budget of recent years. A great amount of very important work will still go unfunded and greater contributions to society could be reaped with even greater increases.

For example, in July 2005, the AAAS journal, *Science* celebrated 125 years of providing the scientific community with the latest in peer-reviewed research. In recognition of this important year, AAAS published a special issue on "125 Questions: What Don't We Know?" Answering virtually every one of those questions depends on NSF supported research! Examples of *Science's* 125 most important unanswered questions include:

What are the limits of conventional computing?
What are the limits of learning by machines?
What is the most powerful laser researchers can build?
What is the ultimate efficiency of photovoltaic cells?
Will fusion always be the energy source of the future?
Can researchers make a perfect optical lens?
What causes ice ages?
Are we alone in the universe?
How does Earth's interior work?

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*See chart on page 7 of this hearing.

Are there earthquake precursors that can lead to useful predictors?
How much can the human life span be extended?
What is the biological basis of consciousness?
What controls organ regeneration?
How do organs and whole organisms know when to stop growing?
Why has poverty increased and life expectancy declined in sub-Saharan Africa?
Why do some countries grow and others stagnate?

Importantly, every NSF directorate—from the behavioral and social sciences through the life sciences, to math and physical sciences and engineering—plays a critical role in this important work. At a minimum we urge you to support the President's request for NSF. If it is possible to find the money to provide an increase above the President's request, it would be a sound investment in the future of our country and the quality of life of our citizens.

Senator HUTCHISON. Thank you, Dr. Leshner.
Dr. Odom, welcome.

STATEMENT OF DR. JEROME D. ODOM, EXECUTIVE DIRECTOR, UNIVERSITY OF SOUTH CAROLINA FOUNDATIONS

Dr. ODOM. Thank you, Madam Chair, Chairman Stevens. I'm really sincerely grateful for the opportunity to testify regarding the National Science Foundation's Experimental Program to Stimulate Competitive Research. This is better known as EPSCoR. Also, I'm happy to testify on efforts to enhance our Nation's competitiveness.

I have been a faculty member in chemistry at the University of South Carolina for 37 years. I'm currently the Executive Director of the University of South Carolina foundations. I have served as Chair of the Department of Chemistry and Biochemistry. I have served as a Dean of the College of Science and Mathematics. And I've also served as Executive Vice President and Provost at the University of South Carolina.

I'm also Chair of the EPSCoR/IDeA Foundation, a non-profit organization that promotes research and technology activities in the 25 States and 2 territories that are served by the NSF's EPSCoR program.

I mention my background because I have had the opportunity to view the significant impact of NSF's EPSCoR program from several career vantage points in South Carolina. And in my role as EPSCoR/IDeA Foundation Chair, I have been able to confirm my positive views on the program, and they are shared by my colleagues throughout the community of EPSCoR states. I also mention my background because it has enabled me over the years to examine and participate in university and statewide research infrastructure development from several different viewpoints.

I want to thank this Subcommittee, as well as the Committee as a whole, for its continuing and solid support for the National Science Foundation and for the EPSCoR program. We have found your interest and assistance over the years both gratifying and invaluable in growing and strengthening our programs. I would also like to thank Dr. John Marburger, the President's Science Advisor, for his support and for the meetings he convened at OSTP on our behalf.

I am here today to endorse the American Competitive Initiative, the doubling of the NSF budget, and efforts to ensure that our Nation's research base continues to lead scientific and technological development. I share the concerns of those who believe that we

must make new investments in basic research, particularly in the physical sciences and in engineering, if we are to mine the promises of 21st-century science. We are at a threshold of scientific potential unknown to previous generations. We are also at the threshold of changes in the research community wrought by a globalization of science, demographic changes in the universe from which we draw our talent, new competition for foreign students, an aging, and almost certainly to retire, academic and scientific professorate, and a workplace that draws master's and Ph.D. students who might have once remained in the academic research environment.

I'm also here today to strenuously argue that in the surge to respond to competitiveness and innovation needs, that the contributions and potential of 25 States, half of our States, and two other jurisdictions cannot be ignored. Instead, this community of EPSCoR/IDeA States can, and must, play a prominent role in our knowledge-driven research community, society, and economy.

I submit that the EPSCoR States have recognized areas of research excellence, students well positioned to pursue careers in science and engineering, increasing clusters of high-tech and small businesses often centered around our universities, faculty recruited nationally, and mounting success at securing NSF, NIH, and other Federal funding.

I should also point out that we are exceedingly pleased that the National Science Foundation has asked the EPSCoR community to organize a workshop to develop a new vision for the EPSCoR program. I have been working with Dr. Kathie Olsen, the Deputy Director of NSF, and Dr. Nathaniel Pitts, the Director of the Office of Integrative Activities, to organize this workshop. We anticipate recommendations consistent with the American Competitiveness Initiative, the National Science Board's 2020 Vision, and other recent reports.

Half of the states should not be missing from these initiatives. Every state needs to benefit from Federal support that creates a scientific research infrastructure that can respond to the special needs of that state. Every state should profit from the educational, economic, and technological benefits that come from having a strong research presence. Every state's students, most of them who will attend college within 100 miles of home, deserve an opportunity to participate in scientific research activities. And every state's research universities can contribute their own unique scientific expertise to our Nation's science and technology priorities.

The benefits of strong academic research infrastructure must be more widely dispersed than they are today. NSF EPSCoR operates under the premise that by building merit-reviewed academic science research infrastructure, EPSCoR states' universities will develop a competitive research base with the people, equipment, and focus to become competitive for NSF and other Federal R&D funding.

Madam Chair, I've put some examples of the impact that EPSCoR has had in South Carolina in my written testimony. I can tell you that there are examples throughout the 25 EPSCoR States that could be cited. And, in fact, we give those successes to NSF each year.

The President's budget for FY07 calls for significant increases in the overall NSF research budget. The EPSCoR States fully support that increase. And we hope that this committee will direct NSF to make sure that all States are given the opportunity to participate in agency programs as the budget increases.

Again, I thank you very much for your attention this afternoon.

[The prepared statement of Dr. Odom follows:]

PREPARED STATEMENT OF DR. JEROME D. ODOM, EXECUTIVE DIRECTOR, UNIVERSITY OF SOUTH CAROLINA FOUNDATIONS

Mr. Chairman and members of the Subcommittee, thank you for the opportunity to testify today regarding the National Science Foundation's Experimental Program to Stimulate Competitive Research Program (EPSCoR) and efforts to enhance our Nation's competitiveness.

I am Jerome Odom and I am Executive Director of the University of South Carolina Foundations. I have previously served as Chair of the University of South Carolina Department of Chemistry and Biochemistry, as Dean of the College of Science and Mathematics, and as Executive Vice President for Academic Affairs and Provost of the University of South Carolina. I also am Chair of the EPSCoR/IDeA Foundation, a non-profit organization that promotes research and technology activities in the 25 states and 2 territories that are served by the National Science Foundation's EPSCoR program.

I mention my background because I have had the opportunity to view the significant impact of the NSF EPSCoR program from several career vantage points in South Carolina and, in my role as EPSCoR/IDeA Foundation Chair, have been able to confirm that my positive views of the program are shared by my colleagues throughout the community of EPSCoR states. I also mention my background because it has enabled me, over the years, to examine and participate in university and statewide research infrastructure development from several different viewpoints.

I want to thank this Subcommittee as well as the Committee as a whole for its continuing and solid support for the National Science Foundation and for the EPSCoR program. We have found your interest and assistance over the years both gratifying and invaluable in growing and strengthening our programs. I would also like to thank Dr. John Marburger III, the President's Science Advisor, for his support and for the meetings that he convened at OSTP on our behalf. And finally, I would like to thank the NSF for its new approach to the EPSCoR budget. For many years, Congress would increase the EPSCoR budget in the appropriations process, only to see it reduced in the following year's budget. This practice has been abandoned and we appreciate it.

I am here today to endorse the American Competitiveness Initiative, the doubling of the NSF budget and efforts to ensure that our nation's research base continues to lead scientific and technological development. I share the concerns of those who believe that we must make new investments in basic research, in the physical sciences and engineering in particular if we are to mine the promises of 21st century science. We are at a threshold of scientific potential unknown to previous generations—and we are also at a threshold of changes in the research community wrought by a globalization of science, demographic changes in the universe from which we draw our talent, new competition for foreign students, an aging and almost certainly soon to retire academic and scientific professorate, and a workplace that draws Master's and Ph.D. students who might once have remained in an academic research environment.

I am also here today to argue strenuously that in the surge to respond to competitiveness and innovation needs, that the contributions and potential of 25 states—half the states—and two other jurisdictions—cannot be ignored. Instead, this community of EPSCoR/IDeA states can and must play a prominent role in our knowledge driven research community, society and economy. I submit that the EPSCoR states have recognized areas of research excellence, students well positioned to pursue careers in science and engineering, increasing clusters of high tech and small businesses—often centered around our universities, faculty recruited nationally and mounting success at securing NSF, NIH and awards from other funding agencies.

The EPSCoR states graduate about 20 percent of our scientists and engineers annually. Several of our institutions have fine records in winning Goldwater Fellowships, NSF Graduate Fellowships and other prestigious research based fellowships. A number of our institutions ranked in the first tier of the recently announced Car-

negie classifications. The current director of the National Science Foundation is, in part, a product of an EPSCoR state—although he probably would not recognize it today. And EPSCoR states have helped produce a number of other NSF directors and deputy directors as well as other leaders in the research community.

Unfortunately, we still need help in rising above the 10 percent of Federal R&D funding that the 27 EPSCoR jurisdictions currently receive from NSF—and most other Federal departments and agencies. These 25 states still need help in building our research infrastructure, broadening our representation on panels and advisory boards, enhancing our high speed computing and networking capabilities and pursuing new opportunities.

I should point out that we are exceedingly pleased that the NSF has asked the EPSCoR community to organize a workshop to develop a new vision for the EPSCoR program. I have been working with Dr. Kathie Olsen, the Deputy Director of NSF, and Dr. Nathaniel Pitts, the Director, Office of Integrative Activities, to organize this workshop and we anticipate recommendations consistent with the American Competitiveness Initiative, the National Science Board's 2020 Vision and other recent reports. Half the states should not be missing from these initiatives.

For the record, let me provide some background on the EPSCoR program and the states that participate. This is one successful Federal program which has addressed the past and current research funding disparity. This program was first established at the National Science Foundation in 1980 to assist in the development of a competitive research infrastructure in those states with a less intensive academic research capability and in response to Congressional concerns over the geographical imbalance in the allocation of funds for academic research and development (R&D).

The National Science Foundation plays a pivotal role in academic research in our nation. The benefits of scientific research are central to improving our lives, and the lives of future American generations in areas related to energy, health, economic security, and national defense. Unfortunately, however, not all states benefit fully from NSF—and other Federal—research funding, which is relatively uneven. In FY 2005, for example, the 27 EPSCoR jurisdictions (25 states and 2 territories) received only about 10 percent of all NSF research funding, even though the EPSCoR states have about one-fifth of the U.S. population and about the same shares of both doctoral universities and scientists who are engaged in research. By contrast, five states received 43 percent of all NSF R&D funding. As previously mentioned, NSF is not alone. Other research funding departments and agencies of the Federal Government have similar distributions.

Every state needs to benefit from Federal support that creates a scientific research infrastructure that can respond to the special needs of that state. Every state should profit from the educational, economic and technological benefits that come from having a strong research presence. Every state's students—most of whom will attend college within 100 miles of home—deserve an opportunity to participate in scientific research activities, and every state's research universities can contribute their own unique scientific expertise to our Nation's science and technology priorities through research. The benefits of a strong academic research infrastructure must be more widely dispersed than they are today. There are indeed two sides to the benefit coin—the states deserve the opportunities which a strong research base provides and the Nation, I would submit, requires the participation of these states if it is to meet the challenges to research and talent production described in the 2006 Science and Engineering Indicators.

NSF EPSCoR operates under the premise that, by building academic science research infrastructure, EPSCoR states' universities will develop a competitive research base with the people, equipment and focus to become competitive for NSF and other Federal R&D funding. The centerpiece of NSF EPSCoR is the Research Infrastructure Improvement (RII) awards, which are granted only after an intensive "merit review" by nationally competitive scientists and administrators. NSF EPSCoR also uses a "co-funding" mechanism under which funds appropriated to the EPSCoR program are utilized to match funds from the research directorate programs in order to fund proposals (including SBIR proposals) that were meritorious but might not be otherwise funded. Finally, NSF EPSCoR provides technical assistance and outreach efforts.

The "centerpiece" support mechanism of the NSF EPSCoR effort is the Research Infrastructure Improvement (RII) awards, which have been highly successful. The reason most of the EPSCoR states are less competitive than they should be for NSF and other funding is that they do not have the research infrastructure—the facilities, the equipment, the number of researchers needed for competitive clusters or all the relevant expertise required for a cluster, the start-up packages for new hires, the time releases to pursue grants and collaborations that the more developed institutions have. Creating that infrastructure takes time and resources. The RII awards

are a proven mechanism for advancing research infrastructure development. I would suggest that EPSCoR states, like the more developed states, need a minimum of 10 years of individual RII support to build up the targeted science research areas. This time period is also used by NSF's Engineering Research Centers to develop focused areas. If given sustained support over time, remarkable results can be achieved.

I would like to provide some examples of how NSF EPSCoR support has made a fundamental difference in the quality of academic research in South Carolina, and how this scientific research will impact the state's citizens:

South Carolina's strategy to develop its intellectual resources has been to provide support for new junior faculty who bring with them access to specific technologies not represented within our targeted areas of S&T excellence and achievement: materials/nanoscience; biomaterials, engineering and technology; structural, chemical and cellular biology; and neuroscience and imaging. The following highlights illustrate the ongoing success of this statewide strategy. At the University of South Carolina, NSF EPSCoR program resources were used in the late 1980s for the hire of Dr. Michael Myrick and several other young faculty having expertise in new materials. Dr. Myrick has achieved full professor and is the innovative force behind Ometric, a 2005 high-tech USC spin-off concentrating on the pharmaceutical, chemical and oil industries. Ometric is engaged with the world's top ten pharmaceutical companies, including Roche in Switzerland to enable inline control of chemical processes for pharmaceutical production. The company has recently attracted venture capital investments in excess of $8.5 million.

Dr. Karen Burg, a hire in bioengineering at Clemson University who received an NSF PECASE Award (2002), was named to MIT Technology Review's 100 Young Innovators List for 2003 and was also granted tenure and promoted to the rank of Associate Professor two years early. At the Medical University of South Carolina, 5 new tenure-track faculty members have recently been hired into the Department of Physiology and Neuroscience, including one minority member. Extramural research funding in the department has grown over ten-fold. This growth has resulted in establishing internationally-recognized research teams with expertise in cellular mechanisms of visual and auditory systems.

Mr. Chairman, I am happy to report that there are many more of these examples in South Carolina and the other states. In fact we report these successes to NSF each year.

The President's Budget for FY 2007 calls for significant increases in the overall NSF research budget. The EPSCoR states fully support this increase. We also hope that this Committee will direct NSF to make sure that all states are given the opportunity to participate in agency programs as the budget increases. For example, in the area of cyber infrastructure, NSF is clearly positioned to play a lead role in advancing cyber research issues that will ultimately impact our Nation's wealth creation process. If only a few large universities in a small number of states are allowed to meaningfully participate in new cyber infrastructure programs, the Nation as a whole will lose. Similarly, benefits from basic research in areas that ultimately have an impact on energy or homeland security should accrue to all regions and states.

As I mentioned previously, NSF has invited the EPSCoR community to provide a bottoms up recommendation to the NSF Director on what the NSF EPSCoR program should look like over the next 10 to 15 years. The EPSCoR states greatly appreciate this invitation and have submitted plans for a June 2006 Workshop on this topic. The willingness of NSF to engage its science and engineering client communities in planning strategic processes should be commended. We will provide a report to NSF on the Workshop outcomes, with copies to the Committee.

I want to thank you for the opportunity to address the Subcommittee today. Thank you.

Senator HUTCHISON. Well, I want to thank both of you for coming.

Let me just say that both of you have said we need to have more going into research, and you've cited the amount that can't be funded that is legitimate research. I would just like to ask you two, after hearing the testimony earlier, if you think the right balance of resources at the National Science Foundation is there, or if you think there should be an even stronger, more targeted focus on the mission for American competitiveness for the future.

Dr. LESHNER. Why don't I begin?

I believe that it's critically important to support basic research across the entire spectrum, from the behavioral and social sciences all the way through to the physical sciences and engineering. First of all, every major issue facing modern society, and every major issue facing our economic competitiveness will ultimately be multidisciplinary in nature. No single discipline will be able to answer all of the critical questions. Issues like innovation, the processes of innovation, the processes of technology transfer, the processes of translating basic research into applied findings, or even applied research, requires the integration of physical sciences or biological sciences with the behavioral and social sciences. So, I would be very uncomfortable if we were to give short shrift to those areas that are needed to help facilitate the actual implementation of the kinds of basic research that we're talking about supporting. And I have to say that there is no other agency that does this kind of research and that, in fact, is equipped to bring together the kinds of physical science initiatives that we all agree are necessary with the sophistication in behavioral and social science activities that will, in fact, make these innovations work.

Senator HUTCHISON. If you are committed to America regaining and retaining our emphasis and our creativity that has spurred our economy for all these years, how can you say that over a billion dollars of legitimate research has not been funded, and yet we are funding a study on how large Hungarian firms have altered their ownership structures during rapid economic changes from 1989 to 2000, or how State legislators picking United States Senators before the 17th amendment would outweigh the focus that we're all committed to, and that is regaining America's strength in science and technology?

Dr. LESHNER. I would have to say that, from my perspective, that, in fact, we can't focus only on one national need or only on one national problem. I apologize, my wife is actually Hungarian, and I have spent a great deal of time, myself, looking at what's happened in Hungary. And I think, ultimately, there will be many lessons to be learned that will be applicable to our own future economic development. So, that one is relatively easier for me to justify. But I think that our country has had many other societal problems and many other national needs toward which basic science across the board should be applied. I don't think we should have only one priority. I'm in favor of the priority toward innovation. Please don't get me wrong. But I think, at the same time, that we would be lax if we didn't, in fact, devote substantial resources to the basic research that will help us meet and solve other kinds of national needs that will plague us into the future.

Senator HUTCHISON. Dr. Odom, do you have anything to add——

Dr. ODOM. I would——

Senator HUTCHISON.—on balance?

Dr. ODOM.—basically say that I do agree, in general, with Alan, but I would point out that I asked that we target more money into the physical and engineering science, and I certainly would ask you to do that.

I could give you a good example, though, of a social phenomenon that we are studying at the University of South Carolina. We have a major nanotechnology area. Nanotechnology, as you know, is per-

vasive across all areas of science. Our philosophy department is leading a study on the societal impact of nanotechnology. And I think it's very relevant to what's happening in the science research that we understand how nanotechnology may affect society's behavior. And some of the things where we need to decide whether we want to go there or not.

Senator HUTCHISON. I think there's a difference between the behavior that comes from technological innovation versus studying a history of a country that has just come into a democracy, versus one that has had 200 years of it. I think there is a difference between studying—a very interesting historical point, perhaps, but we're not going to elect Senators in State legislatures in the future, and I don't know how that could crowd out research from the foundation that we are looking to be the one that guides us into the next century of science and math. And if there is a mentality that political science and—having studies on elections when we have journalists that are covering it much better than someone who is looking at it for 6 months, I just, respectfully, disagree. And I——

Dr. ODOM. Madam Chair, I certainly see where you're coming from, but I have to agree with Dr. Bement that you really need, probably, to look at the proposal, because I know from personal experience, in looking at some of my faculty's titles, that I said, "You cannot retain this title. You have to change the title. Do you understand what this title is saying to the person that doesn't look at the proposal?" So, it's very important, I think, to look at the proposal, as well.

Senator HUTCHISON.—well, what I think we ought to be looking at, speaking only for myself, is where these types of resources would best be used. And I'm looking at a lean, mean fighting machine in the National Science Foundation that is given a mission, and can accomplish a mission. I think the National Science Foundation has that capability, but I am concerned that it would be getting into things and spending this valuable money that would not be in pursuit of this mission. And I, for one, am going to try to see that we stay on target and we look for other places to do the sociology and the political science experiments.

Senator Stevens?

The CHAIRMAN. Yes, thank you, Madam Chairman.

You know, I see a dichotomy here. And I understand what you're saying, Dr. Leshner, about the budget. In actual dollars, these budgets are up. And we have not inflation-proofed science. We have not inflation-proofed defense. And we certainly haven't inflation-proofed the Senate. So, I don't know how accurate or fair the criticism is of this budget. This budget is up, I'm told, 7.9 percent over 2006. And that's a pretty good increase for any entity.

But here's my dichotomy. I look at this, for instance, in—there's money in this request for the construction of an Alaska region research vessel. This is a time when I'm called upon to support that, this is a time when I would like to see more kids going to college. I've seen more emphasis on high school trying to attract students to be interested in pursuing science and mathematics in college and go on to graduate school. I don't want to be offensive, but are you people thinking about just those who are already trained and what we can do for projects for them, or are we looking at how can

we get more American students into college, get them more interested in high school? As a matter of fact, I'd like to get them interested before they even go to grade school. I think we could. The more that we can interest them in—when they're very young, in pursuing science and technology, I think the better off we'll be. What's the balance here?

Dr. LESHNER. Well——

The CHAIRMAN. You're both talking about money for projects for people that have their Ph.D.s. I'm talking about money to attract children and students all the way up. And so, we have an expanding process for the future. Now, which is most important?

Dr. LESHNER. Both are most important, but——

The CHAIRMAN. Well, you can't have that luxury.

Dr. LESHNER. Well——

The CHAIRMAN. You only have so much money.

Dr. LESHNER. Well, my concern—our concern—and we express that, in fact, your point is right, that is, that we need to make a substantial investment in young people—and the younger, the better—and, in fact, that's why we're so concerned that, in fact, the proposed budget for science education at NSF is pretty meager. And——

The CHAIRMAN. What about it, Dr. Odom? What do you think?

Dr. ODOM. I, personally, think there certainly is a pipeline problem. There are a lot of students here. By the time we get to the end of high school, there are not very many. I think one of the things we need to do is, we need to look at our colleges of education, schools of education. We have recently, at the University of South Carolina, done away with an education major for middle schools and high schools. If you're going to teach biology or chemistry, then you have to major in that area. We need, in some way, as has been said previously, to generate teachers who excite students again. And that's not happening right now. And I think that has to do much with the preparation of the teachers that we have in science and mathematics.

The CHAIRMAN. Well, you know, I heard one of our colleagues, Senator Sununu, address some of the things that money has been spent for. If that had been something I had done on the floor, it would have been called "pork." It would have been called an "earmark." How do we get to this process now? We want an emphasis on the future. We want to expand the interest of this country in training our young people in science and technology. We want to catch up with what's happening in China and India and the rest of the world, and we want a generation to come along who, when they come out of it, they're not at the bottom of the rung, as we heard before from Dr. Washington. What do we do to do that? How do we bring about the emphasis we want if we continue to give money to NSF and to other agencies—and money is spent where the people involved think that that is an interest we should follow? And, with due respect, Dr. Leshner, I don't really care what's going on in Hungary. I care what's going on in the grade schools of America.

Now, I think we have got to find some way to constrain this down so you spend the money where we tell you that it should be spent.

Dr. LESHNER. Well——

The CHAIRMAN. Is that unfair?

Dr. LESHNER. I think that Congress, of course, has the right to set priorities. You are elected by us to do that. I think that your point is absolutely right. And I think that NSF is actually a wonderful example of a government agency that has devoted tremendous resources toward not only helping to develop future scientists and engineers, but to educate all young people and try to bring them into the possibility of being full, productive citizens in this science- and technology-heavy economy. And so, that investing in NSF science education, in fact, accomplishes exactly the kind of a goal that you're talking about. And, you know, frankly, I think you're totally right. I think it's a major national need. I think the "Rising Above the Gathering Storm" spoke about it, the Summit on Competitiveness spoke about it, and NSF has given great attention to this over the years. You're right.

The CHAIRMAN. Well, thank you very much to both of you.

Thank you. I've got another appointment.

Senator HUTCHISON. Thank you, Mr. Chairman.

Well, I thank all of you. This has been a very important hearing. We are looking to the National Science Foundation to be really good and really focused.

Another study, determinants of husband-initiated and wife-initiated divorces, should that have crowded out one of your basic science research projects that didn't get funded at the National Science Foundation, or could that be done by private groups? There are many charitable groups. There are social groups, all kinds of opportunities for studying husband-initiated and wife-initiated divorces that don't take away from research that we need to make America more science oriented, more technology oriented, to prepare our children. Tell me that we can bring the National Science Foundation in better focus to take this mission.

Dr. LESHNER. Well, I'm convinced that the National Science Foundation and its leadership is well equipped to shepherd and to steer the direction in which the research that they are supporting is being done. And I, for one, have great confidence in their ability to meet exactly the kinds of goals that you're talking about. I can't account for any individual project, as was suggested, without knowing much more about it. But, overall, if we look at the over-50-year track record of NSF and its programs, it has yielded fantastic benefits for the country in virtually every sphere. So, I think we're giving you some of that assurance, I hope.

Senator HUTCHISON. Dr. Odom, I think that what you just described as going on in the University of South Carolina with regard to education degrees is really at the forefront of what we are seeing in our studies of how we can better educate our teachers to teach. And one of the ways, certainly, is to get them to major in the courses that they are going to teach our children. Middle and high school, I think that's certainly a valid distinction from elementary school. But——

Dr. ODOM. It is.

Senator HUTCHISON.—that is something that I have championed for a long time, and it is also in the report, that we have to equip our teachers. In fact, we put in the report scholarships for teaching

teachers to get master's and Ph.D. degrees in their course subjects, so that they can be better teachers and encourage our young people to go into science and math and technology.

So, I hope we can see that as another of the successes that this initiative will bring. And I think you're ahead of the curve.

Dr. ODOM. Thank you.

Senator HUTCHISON. Thank you very much for coming. We appreciate it. We hope that we can all work together for our mutual goal. Thank you.

Our hearing is adjourned.

[Whereupon, at 4:06 p.m., the hearing is adjourned.]

A P P E N D I X

PREPARED STATEMENT OF HON. DANIEL K. INOUYE, U.S. SENATOR FROM HAWAII

Today we will hear about the budget and priorities of the National Science Foundation (NSF). I am pleased to see a healthy increase of nearly 8 percent proposed for the Foundation. I am particularly pleased that with this budget NSF will be able to begin clearing its construction project backlog, making way for some truly exciting projects like the Advanced Technology Solar Telescope (ATST) to be funded in future budgets.

The NSF has a remarkable record of success. Since its inception in 1950, it has funded Nobel prize winners, contributed to the development of products from the Internet to Magnetic Resonance Imaging or MRI, and expanded the boundaries of human knowledge.

Like most of my colleagues, I believe NSF works. Whether it's understanding how people respond to warnings, radically improving fuel cell technology, or understanding the environmental impacts of nanotechnology, NSF research can improve our lives and our economy. But the agency's focus is not, and should not be, the immediate problems of the day. Rather, NSF researchers are looking at problems and issues that will occur fifteen or twenty years into the future, before the rest of us know what they are.

I look forward to hearing how NSF intends to move forward, particularly on ensuring that small states, like Hawaii, can share in NSF's growing budget.

PREPARED STATEMENT OF NEAL LANE, MALCOLM GILLIS UNIVERSITY PROFESSOR; SENIOR FELLOW, JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY AT RICE UNIVERSITY; FORMER DIRECTOR, NATIONAL SCIENCE FOUNDATION

Madam Chair and Members of the Committee. My name is Neal Lane, and I am the Malcolm Gillis University Professor and a Senior Fellow of the James A. Baker III Institute for Public Policy at Rice University. As a former Director of the National Science Foundation (NSF) and Science Advisor to former President Clinton, I particularly appreciate having this opportunity to comment, for the record, on the NSF budget request for FY 2007. I regret that I was unable to accept the invitation to appear in person at the NSF hearing on May 2.

Let me say at the outset that I am very pleased with the President's request for NSF, as a key part of his *American Competitiveness Initiative*. The future of America's economic competitive position depends critically on innovation that comes from new knowledge, new technologies, and a highly skilled workforce. NSF is the only Federal agency with the mission to pursue the furthest frontiers of science and engineering research across all disciplines and to assure that the Nation has a high caliber science and engineering workforce. By all accounts it has carried out that mission efficiently and effectively.

The success of NSF can be traced to three factors: (1) an ambitious but flexible mission that is clearly in the national interest; (2) access to many of the world's best and brightest researchers, primarily in our universities, who serve as peer reviewers, compete for grants and carry out excellent research; and (3) an outstanding staff, comprised of accomplished and dedicated professionals, including experienced scientists, who believe in NSF and work hard to ensure its success. For these reasons, NSF has enjoyed strong bipartisan support over the decades, regardless of which party controls the White House or the Congress. This committee is no exception, and I thank you for that support.

I would like to offer comments on two issues, the role of NSF in the President's *American Competitiveness Initiative* and the general matter of how NSF sets priorities.

In the President's State of the Union address, he stated the purpose of his *American Competitiveness Initiative (ACI)* to encourage American innovation and strengthen our Nation's ability to compete in the global economy noting that "this

ambitious strategy will increase Federal investment in critical research, ensure that the United States continues to lead the world in opportunity and innovation, and provide American children with a strong foundation in math and science."

These three goals, which I'll simply refer to as "research, innovation, and education" are related and, in fact, interdependent. No Federal agency addresses those interconnections better than the NSF. Research requires creativity and innovation at the "laboratory bench." That innovative process results in the discoveries of new knowledge and new technologies that lead to industrial innovation—new methods, new products and new services—in U.S. companies.

Research in the Nation's universities also leads to the best educated and trained science and engineering graduates in the world. They are the true "translators" of innovation and technology from the research laboratory to the marketplace. Many of them also go on to educate and train the next generation of innovators for America's future.

Thus, it is entirely appropriate that NSF, whose mission is squarely at the heart of this bold initiative, and whose laser-like focus is on "ideas, people, tools, and organizational excellence" (its GPRA goals), has been chosen to have a key role in the ACI. By employing its successful competitive, peer review system to evaluate unsolicited proposals from the Nation's brightest scientists and engineering researchers, NSF can assure the Congress and the American people that scientific merit and excellence, not political interests, set the ultimate priorities for the ideas and people that receive support. That system has worked well for half a century to provide science and engineering excellence for the Nation. The highest priority must be to insure that this "gold standard" system continues to work.

That said, it is entirely appropriate for Congress to ask the NSF how, at the programmatic level, the agency determines its priorities—how much it invests in the natural and social sciences, in education and human resources development, in research facilities and other areas and, at least in broad terms, what the "returns" on those investments are likely to be. Since questions were raised at the hearing about NSF's programs in education and in the social sciences, let me comment on these two areas.

NSF's Education Programs

I do not find anyone who disagrees with the notion that U.S. K–12 education, including math and science education, is in serious need of reform and that the future of the Nation's competitiveness depends on having a well educated and well trained workforce. I have not looked in detail at the current portfolio of NSF programs in Education and Human Resources (HER) development. But, traditionally, NSF's HER programs have been focused on research and science-based educational reform—on determining how children learn, how teaching is best done, what science and math curricula work best, and how best to manage change in these areas. And, NSF has approached some of these questions by working in partnership, as appropriate, with teachers and school systems. NSF has managed its HER initiatives by defining programs to stimulate new ideas and, then, by evaluating through peer review the unsolicited, competitive proposals in the same way it does for research. My impression is that many of these programs have been quite effective. Those that were not were evaluated and modified or terminated. That's as it should be; and not much different from how the science and engineering research programs are managed. Unless NSF is allowed to take risks in devising programs and funding proposals to address such a critical national need as science and math education, we are likely to miss the most important breakthroughs. The Department of Education, of course, has a very large Federal role in K–12 education. But, because of statutory limitations and other constraints, it cannot do many of the things in HER that NSF does so well.

I encourage the Subcommittee to continue to work with NSF to understand the objectives of its programs in HER and how those objectives relate to the larger goals of the agency and the ACI.

NSF's Support of the Social Sciences

During the time I was Director, I was called upon to explain NSF support of the social sciences. I am not an expert in any area of the social sciences, as my Rice faculty colleagues will be quick to tell you. But, I do have a sense from my years as Rice Provost and my tenure at NSF of the complexity of the disciplines, the challenge of ensuring that the highest standards are applied in evaluating and performing the research, and the quality of the researchers who have chosen to work in these areas. I also understand that some project titles and descriptions may seem irrelevant to many of today's challenges, particularly those addressed by the ACI. But, what I found, when I looked into many of these areas and projects more closely,

was that the researchers were asking important questions that could help us better understand people, institutions, and societies in ways that did, indeed, address important implications faced by businesses, governments, schools and caregivers. In reality, all societies are human, community, and institution driven. Understanding and improving their behaviors can only benefit individuals and nations in their diverse and complex relationships.

I encourage the Subcommittee to continue to work with NSF to understand the objectives of its programs in the social sciences and how those objectives relate to the larger goals of the agency and the ACI.

Finally, Madam Chair, I want to express my appreciation to you for your personal commitment and to the Subcommittee for its interest in science and engineering research and education and its support for the President's *American Competitiveness Initiative*. Thank you as well for allowing me the opportunity to offer these comments for the record.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. KAY BAILEY HUTCHISON TO DR. ARDEN L. BEMENT, JR.

American Competitiveness Initiative

Question 1. Within the proposed funding for the American Competitiveness Initiative (ACI), how much new money would you expect to be able to apply to basic research in the hard sciences, assuming the entire requested amount is appropriated?

Answer. NSF's FY 2007 Budget Request includes approximately $3.67 billion in support of basic research. In general, 40 to 50 percent of these funds are available for new awards and activities. In addition to basic research, NSF funds support applied research, R&D facilities, non-investment activities (such as Polar Logistics), and education and training.

Question 2. As you know, the Gathering Storm report addresses issues beyond those which are the focus of the ACI. What new activities or projects do you plan to undertake to address those additional concerns, and do you have sufficient resources to support those activities within your FY 2007 Budget Request?

Answer. NSF's FY 2007 Budget Request provides support to boost the momentum of discovery in areas of exceptional promise and to capitalize on emerging opportunities. NSF will emphasize four priorities that will strengthen the science and engineering enterprise:

Advancing the Frontier
Broadening Participation in the Science and Engineering Enterprise
Providing World-Class Facilities and Infrastructure
Bolstering K–12 Education

Within these priorities, increased support will be provided for research efforts in areas such as cyber trust and cybersecurity, nanoscale science and engineering, sensors for the detection of explosives, polar research, elementary particle physics, and science metrics. NSF is committed to fostering the fundamental research that delivers new knowledge to meet vital national needs and to improve the quality of life for all Americans.

NASA Cooperative Research

Question 3. In years past, and currently, NSF has engaged in cooperative research activity with NASA, perhaps most notably in joint and supporting activities in the Antarctic. As NASA realigns its own research priorities to support the Vision for Exploration, some science activities are being delayed or discontinued altogether, and yet much of the planned NASA research has much to offer. This question is two-fold:

(a) To what extent are any existing cooperative research activities with NSF and NASA being affected by the shifts in NASA programs, and

(b) Is there any effort by NSF to review science and research activities reduced or cut by NASA for its relevance to NSF science priorities, and consider whether NSF may be in a position to assume support for that research?

Answer. (a) The effect of NASA's research reorientation on existing NSF–NASA cooperative activities are varied. In some instances, such as interagency working groups, these changes have little impact on NSF. (Existing cooperative research activities between the NSF Office of Polar Programs and NASA have thus far been unaffected). However in other instances, usually where substantial NASA support is involved, programs may be greatly affected. These impacts can be direct (cancellation of programs) and indirect (proposals submitted to NSF as a "back up" to NASA

requests). One emerging trend is a shift to NSF of funding requests for science previously supported by NASA. In some disciplines, such as the Ocean Sciences and Astronomy, the increase is marked. Additionally, for some science communities one of the greatest concerns is NASA's ability to support follow-up missions in areas clearly outside of NSF's charge (e.g., satellites). NSF cannot support such activities and their transition to other Federal agencies does not look encouraging. Yet, the data produced from these programs are crucial to basic research that NSF can and does support.

(b) Currently NSF has no formal agency-wide plan to review programs previously supported by NASA. Principal investigators are free to compete for funding of "NASA-type" research through NSF's well-established merit review process. The likelihood of receiving NSF support is no different than in other areas, which means some outstanding science will be delayed or not done at all and NSF's funding rate will likely decrease.

Homeland Security: Cyber Trust and IEDs

Question 4. In your written testimony, you make reference to several items in the FY 2007 budget request which support research essentially intended to enhance the Nation's ability to counter threats to our homeland security:

> (a) $35 million within the Networking and Information Technology Research and Development (NITRD) program for Cyber Trust. This is to ensure that computers and networks that support our national infrastructure, as well as in homes and offices, can function in the face of a cyber attack. You indicate this is part of an overall effort in cybersecurity research totaling $97 million.
>
> (b) $384 million in Homeland Security basic research, including fundamental research on sensors to improve the detection of explosives, including Improvised Explosive Devices (IEDs).

These are obviously important research activities that should be undertaken. The question is, what is the reasoning for them being funded through the National Science Foundation and not directly by the Department of Homeland Security? Or, in the case of the IEDs, by the Department of Defense?

Answer. For both cyber security and sensor technology, the National Science Foundation's investments are part of broader, coordinated interagency efforts that complement work being carried out by the Department of Homeland Security, Department of Defense, and others.

(a) NSF, Homeland Security, and Defense all play key roles in cyber security research and development. Federal support for cyber security R&D must include the civilian, military, and intelligence sectors in order to be comprehensive. A February 2005 report by the President's Information Technology Advisory Committee, *Cyber Security: A Crisis of Prioritization,* urges a rethinking of the Federal investment balance between military/intelligence and civilian cyber security R&D. The military and intelligence communities rely on the commercial Internet and commercial providers of computing systems and software for the bulk of their own operations. It is only through fundamental research in civilian cyber security that we can hope to address the strategic and pervasive vulnerabilities of our national IT infrastructure.

NSF has the only substantial Federal program in civilian cyber security research, an activity it has supported for many years. The majority of the work is undertaken at academic institutions and is unclassified. As at earlier stages of the digital revolution, Federal investment in fundamental research is required to fill the pipeline with new concepts, technologies, infrastructure prototypes, and trained personnel. Research supported by the military/intelligence sectors and the private sector mainly has a narrow focus and requires short-term results. The security of our Nation's IT infrastructure that affects our society and economy at large depends on the fundamental research in civilian cyber security supported by NSF.

(b) NSF's investment in new technologies for sensors and sensor systems is a vital component of our nation's portfolio directed at the prediction and detection of explosives and related threats. Related research will target advances in the analysis, interpretation, and evaluation of data gathered from sensors, as well as the integration of this data with information available from a wide variety of other fields and sensing systems. NSF focuses on frontier science and engineering research, which establishes fundamental principles and uncovers new knowledge. Other mission agencies, such as the Departments of Homeland Security, Defense, Energy, and Justice are primarily involved in device development and system integration, and they benefit greatly from NSF's innovative approaches and potential breakthrough discoveries. As explosives and similar threats become more sophisticated and more

prevalent, cutting-edge discoveries will be critical to remaining ahead of the curve. NSF also will establish interagency working groups to ensure that efforts are not duplicated, and that each mission agency is able to leverage the results of the entire R&D community.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. KAY BAILEY HUTCHISON TO DR. JEROME D. ODOM

Question 1. What are the greatest challenges currently facing the EPSCoR program (Experimental Program to Stimulate Competitive Research) and the IDeA program (Institutional Development Award)?

Answer. The Experimental Program to Stimulate Competitive Research (EPSCoR) at the National Science Foundation and the Institutional Development Award (IDeA) Program at the National Institutes of Health are each faced with the challenge of building academic basic research infrastructure in a huge segment of the Nation's research universities with limited resources. For example, NSF EPSCoR works with universities in 25 states and 2 territories that employ about 20 percent of academic U.S. scientists and engineers who are engaged in research. Yet, the FY 2006 budget for NSF EPSCoR was $100 million, and the NSF EPSCoR office has less than a dozen staff members. It is highly unlikely that this small group can effectively reform science and technology in half of the U.S. states with an average of less than $4 million per year. The IDeA program essentially has had a flat budget for the last two years, while tasked with building up the bio-medical research infrastructure in a comparable number of states that have traditionally not received significant NIH support.

Recently, senior NSF management recognized this problem and provided support to the University of South Carolina to host an EPSCoR 2020 Workshop, to address how best to reform NSF EPSCoR and bring more of the Foundation's resources to bear in creating a competitive research environment in this large segment of U.S. institutions of higher education. As part of this exercise, the need for NSF EPSCoR to coordinate with the NIH IDeA program and other agencies with EPSCoR-like programs was recognized. The key findings of this Workshop are provided below in the answer to *Question 3*.

Question 2. What do you see as the greatest potential contribution of EPSCoR and IDeA to the Nation's emerging crisis in competitiveness, innovation and "STEM" (Science, Technology, Engineering and Mathematics) education programs and initiatives?

Answer. The EPSCoR/IDeA states have an important role to play in the American Competitiveness Initiative (ACI) and other areas of national priority. Over the last century, the Nation's research universities have always played an essential role in providing science and technology (S&T) support in addressing challenges related to defense, health, agricultural reform, etc. The Congress and Administration have both recognized that (1) the strength of the Nation's academic S&T enterprise is going to once again help the Nation maintain its competitive edge in world markets, and (2) this U.S. higher education S&T enterprise is itself under tremendous strain from competition abroad.

The "greatest contribution" that the EPSCoR/IDeA states' universities and researchers can make is to once again provide essential S&T expertise and support in addressing the National challenges. Efforts to reform STEM education, increase competitiveness, and further develop S&T-based innovations require that all the universities in the U.S. must be engaged. EPSCoR/IDeA states contain approximately one-fifth of U.S. academic researchers, and nearly one-quarter of U.S. science doctoral institutions. It is time to recognize that this significant segment of the Nation's S&T arsenal must be employed to enhance the basic research infrastructure that supports the Nation's S&T enterprise.

Additionally, the EPSCoR states and their research universities provide a unique capability at this time in our nation's competitiveness endeavors. The NSF requires that state committees be involved in the EPSCoR programs. These committees, by necessity, are involved in state economic development and strategic plans. They have a good understanding of how to work with both legislators and industrial interests and they understand setting metrics, evaluation and assessment. All of these factors are vitally critical to being competitive in a global S&T economy.

Question 3. In your view, are the programs and science priorities of NSF currently in an appropriate balance? What improvements do you believe could be made in either the content or the process for establishing those priorities?

Answer. As mentioned earlier, NSF recently sponsored an EPSCoR 2020 Workshop that addressed this (and other) issues. The Workshop achieved consensus on the following issues:

- NSF should transform EPSCoR from a traditional RFP process (RII Solicitation guidelines) to one that responds to a new method in which the guidelines encourage each state to develop its unique research capabilities. The NSF EPSCoR's RII guidelines should be more general, leaving states latitude to select their strengths, partnerships, strategies, investments, endpoints, and themes. This approach recognizes that states are at different places along the "success trajectory" and that they have different levels of resources to invest.
- If EPSCoR states are to become more competitive, they must be involved in the current themes that are recognized as important by the broader research community. In reciprocal fashion, these national themes will move forward more rapidly and with more credibility if there is broad participation from the Nation's research community. It is to the advantage of both NSF and EPSCoR to intentionally involve EPSCoR in NSF's programmatic themes. EPSCoR states could be organized into a "test bed" for national themes because there is an existing organization (mentioned in Question 2. above) among these states which could be efficiently mobilized to test ideas, program initiatives, parts of a theme, etc.
- In order for the EPSCoR community to achieve our capacity-building objectives and contribute to the American Competitiveness Initiative we must restructure EPSCoR's basic research infrastructure (RII) program to be longer in duration, larger in size and with more flexibility. The current Research Infrastructure Improvement (RII) awards which have been EPSCoR's core funding mechanism have increasingly been diminished in recent years in terms of funding levels, and are now dwarfed by other NSF and NIH funding awards such as Centers-type grants and COBRE grants. Perhaps most importantly, the recent effort to narrow the focus of RII grants accompanied by a proliferation of grant requirements has reduced their effectiveness. A revitalized RII award structure would help to stimulate new state commitments to long-term science and technological reform.
- The NSF EPSCoR "co-funding" mechanism needs to be strengthened. We have become aware, through our interactions with the NSF Research Directorates that within NSF there is a limited understanding, especially by new Program Officers, of how the co-funding mechanism functions. We would like to see a more aggressive approach on the part of the EPSCoR Office in pursuing co-funding opportunities, educating new NSF program staff about its purpose, as well as more transparency in how the money is distributed.
- We would like to see senior NSF management, the EPSCoR Office, and others at NSF help our researchers become more integrated into NSF and other Federal S&T agencies' activities. We are pleased to see recent progress in this area. EPSCoR states now have two National Science Board members, a member of PCAST, and three members of the Cyber Infrastructure Advisory Committee. This is a good beginning. We would also like to see an increase in the number of NSF "rotators" from EPSCoR states, as well as in the number of our researchers who are invited to serve on NSF merit review panels and oversight committees.
- NSF and OSTP are positioned to encourage greater coordination among Federal agencies with EPSCoR-like programs. In a time of scarce Federal S&T resources, it is imperative that the seven agencies with EPSCoR-like programs ensure that their efforts are coordinated, where appropriate, at both the state and Federal levels.
- There is strong support within the EPSCoR community to relocate the EPSCoR Office so that it is in better alignment with the Research Directorates. EPSCoR's primary mission has been, and continues to be, to build basic research infrastructure in our universities. For many years, the community has felt that EPSCoR's placement within the Education and Human Resources (EHR) Directorate was inconsistent with its research mission. We recommend moving EPSCoR to an organization (e.g., OIA) with a greater scientific research orientation.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. KAY BAILEY HUTCHISON TO DR. WARREN M. WASHINGTON

Question 1. What steps are you taking at the National Science Board to evaluate the proposed American Competitiveness Initiative (ACI) and the Gathering Storm report and other assessments of the state of U.S. science, innovation and competitiveness, and to determine whether a reassessment of NSF research priorities is required to better address the problems identified in those reports and proposals?

Answer. The Board applauds the recommendations for research in the American Competitiveness Initiative, reflecting the National Academies report, *Rising Above the Gathering Storm*, to increase federal investment in long-term basic research by 10 percent each year over the next 7 years; and to double the NSF budget in 10 years. We continue to also strongly support the NSF Authorization of 2002, which currently authorizes a doubling of the then NSF budget to approximately $10 Billion by 2007.

We support in concept the recommendation of *Rising Above the Gathering Storm* to encourage funding of high-risk, high payoff research, with the understanding that such research also presumes a high failure rate. Among other activities in FY 2007, the Board expects to complete its study of NSF identification, development, review and funding of transformative research, and provide new guidance for NSF policies regarding such research. Previously, in 2004, in response to the NSF Authorization Act of 2002 the Board released *A Report to Congress on the Budgetary and Programmatic Expansion of the National Science Foundation "Fulfilling the Promise"* (NSB 2004–15) (*http://www.nsf.gov/nsb/documents/reports.htm*), providing its recommendations for allocation of the authorized increase in the NSF Budget provided for under the Act. To enhance innovation through research, the Board recommended that increases in the budget in the amount of $1B be allocated to increasing the average size and duration of research grants to enable them to pursue more complex and innovative research, while reducing the time needed to prepare proposals. The Board recommended an additional $1B specifically to pursue novel ideas and research approaches with the potential to transform S&E fields.

The Board has recently released its *2020 Vision for the National Science Foundation* (NSB 05142) (*http://www.nsf.gov/nsb/documents/reports.htm*), in which we reinforce our support of additional funding toward the two aforementioned objectives among others. We are currently working with the Foundation management to develop and implement a new NSF Strategic Plan designed to achieve the Board's 2020 Vision for NSF.

The Board and Foundation support early career grants, recommended by *Rising Above the Gathering Storm*, and expansion of the NSF CAREER program, with the caveat that such expansion is not "carved out" from the existing NSF R&RA budget. Rather we support expansion of this program through additional appropriations, so as not to sacrifice other priorities for expansion of NSF's budget (*i.e.*, increasing the size and duration of awards and increasing funding for novel ideas and approaches). The Board applauds the additional new funding support for physical sciences, engineering, mathematics and computer sciences, which were identified for attention in the Board's 2003 report, *The Science and Engineering Workforce/ Realizing America's Potential* (NSB–03–69) (*http://www.nsf.gov/nsb/documents/reports.htm*).

NSF has been selected to play major roles in research support under the President's American Competitiveness Initiative including:

- Investing in the generation of fundamental discoveries that produce valuable and marketable technologies;
- Providing world-class facilities and infrastructure that are essential to transform research and enable discovery.

Both roles in support of frontier research are fundamental to NSF's mission in research and education. In the new NSF Strategic Plan now under development, the Board and Foundation will continue to set priorities for research based on guidelines provided by Congress and the President, interagency coordination, input from the scientific communities—including reports such as *Rising Above the Gathering Storm*, and NSF's highly competitive merit-review process, second to none for openly and objectively identifying, reviewing, selecting, funding and providing stewardship for the very best STEM proposals and programs in research and education.

Question 2. Are there any challenges or obstacles in the structure and implementation of the relationship between the Board and the Foundation that this Subcommittee should be aware of or which we should examine in more detail in our oversight responsibility?

Answer. Beginning with the Fiscal Year 2003 appropriations act and the National Science Foundation (NSF) Authorization Act of 2002 Congress provided new staffing

and budgetary authorities to ensure the National Science Board could effectively fulfill its statutory responsibility to provide independent oversight of the NSF and independent advice to the President and Congress on national policy issues related to science and engineering research and education. In August 2003, the Chairman of the Board exercised these new authorities by hiring a new Board Executive Officer, who reports directly to the Chairman and serves as the Director of the National Science Board Office. Since that time, the Board has provided various updates to Members of Congress on the Board's progress in implementing those authorities.

Essential to the conduct of Board business is the small, yet adequate, core of full-time senior policy, clerical and operations staff of the Board Office who are hired by and report to the Board's Executive Officer. The Board Office staff provide both the independent Board resources and capabilities for coordinating and implementing S&E policy analyses and development, and the operational support that are essential for the Board to fulfill its mission. This core of Board Office capabilities is augmented by NSF for some administrative accounting, contract processing, purchasing, personnel, logistical and related support. In addition, the Board Office augments it own capabilities with short-term temporary contractual support as needed for various Board endeavors. These external advisory policy research and assistance services are especially critical to support production of Board reports and supplement the Board Office's general research and administration services to the Board. External contractual services provide the Board and its Office with the flexibility to respond independently, accurately and quickly to requests from Congress and the President, and to address issues raised by the Board itself. The Board's rationale for securing outside consultants to supplement Board Office staff also comes in part from the Board's interest in obtaining additional analyses, perspectives, and opinions concerning various Board issues, unencumbered by any potential conflict of interest that may derive from NSF staff that are hired and supervised by NSF management. The Board is currently in discussion with NSF management concerning some previously reported administrative delays with NSF processing of a Board Office contract for such external services. We believe that resolution to this matter will be made shortly and in a manner that will not adversely impact the Board's ability to conduct independent policy analyses and oversight of NSF.

Question 3. In your statement, you indicated some concern that funding for the Educational and Human Resources Directorate and the Biological Sciences Directorate are not being as well funded as they might be. What, in general, are the kinds of research that you would like to see expanded in those directorates?

Answer. Even as the Congress and President show their strong commitment to a significant increase in funding for science, engineering, mathematics and technology to support discovery and innovation, the Board urges attention to the need for balance in NSF"s broad portfolio of investments. We are especially concerned that the President's FY 2007 NSF Budget request provides for only a 2.5 percent increase from FY 2006 for the NSF Education and Human Resources Directorate, which remains more than 3 percent below its FY 2005 level. STEM Education is a core mission of NSF, which not only promotes research, but also shares in the responsibility for promoting quality math and science education as intertwining objectives at all levels of education across the United States.

The NSF Mathematics and Science Partnerships (MSPs) are important tools for addressing a critical—but currently very weak—link between pre-college and higher education, as well as between K–16 education and other organizations in the community, including business and informal science. The NSF MSP Program provides for collaboration between pre-college and college to promote excellence in teaching and learning, therefore facilitating the transitions for students from kindergarten through the baccalaureate in STEM disciplines. The added benefit for our Nation is those students who do not choose STEM careers become the informed, scientifically-literate voting citizens we need for the 21st century.

NSF has the mandate, depth of experience, and well-established relationships to build the partnerships for excellence in STEM education. The Board, therefore, is concerned with the decision to fund no new starts in the NSF budget for MSPs. We stand by our 2004 formal statement (*http://www.nsf.gov/nsb/documents/testimony.htm*) urging that continued, full funding of the MSP Program at NSF be sustained over the long-term as an essential component of a broader coordinated Federal effort to promote national excellence in science, mathematics and engineering.

With respect to the Biological Sciences, we note that the funding has decreased as a share of the NSF budget over the last 8 years, and this year's budget proposal again provides for the lowest increase to the Biological Sciences of any of the research directorates. This directorate essentially had a zero budget increase from FY 2005 to FY 2006. We are concerned that the perceived generous funding for life sciences, due to the dramatic budget increases over the last 10 years for the Na-

tional Institutes of Health (NIH), may in fact color the perception of the adequacy of the support for basic research in the biological sciences in the NSF budget. We would like to point out the widespread recognition that advances in biological sciences foster applications that often lead to commercial innovation. The relationship between NSF and NIH in the biological sciences is similar to the relationship between NSF and the Department of Defense or the Department of Energy in the physical sciences. NSF funds basic research in the biological sciences, while the NIH funds biomedical research, which is, by its nature, one step further toward applications. Without basic research. there is no foundation for future biomedical research. We urge recognition of the importance of the basic biological sciences, in which some of the most spectacular advances in science have occurred over the last 50 years, beginning with the discovery of the structure of DNA by Watson and Crick in 1953. This and many other biology-focused discoveries have been recognized with numerous Nobel prizes.

We underscore that our concern for funding levels of the NSF Biological Sciences and Education and Human Resources directorates is completely compatible with a balanced National STEM research and education investment portfolio and our support for much needed increases in the budget for the physical sciences, engineering and mathematics and computer sciences.