

THE NATIONAL SCIENCE FOUNDATION'S FISCAL
YEAR 2011 BUDGET REQUEST

HEARING
BEFORE THE
SUBCOMMITTEE ON RESEARCH AND SCIENCE
EDUCATION
COMMITTEE ON SCIENCE AND
TECHNOLOGY
HOUSE OF REPRESENTATIVES
ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

MARCH 10, 2010

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**THE NATIONAL SCIENCE FOUNDATION'S
FISCAL YEAR 2011 BUDGET REQUEST**

WEDNESDAY, MARCH 10, 2010

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION
COMMITTEE ON SCIENCE AND TECHNOLOGY
Washington, DC.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Daniel Lipinski [Chairman of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY

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Hearing on

The National Science Foundation's FY 2011 Budget Request

Wednesday, March 10, 2010
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witness List

Dr. Arden L. Bement, Jr.
Director of the National Science Foundation

Dr. Steven C. Beering
Chair of the National Science Board

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND SCIENCE
EDUCATION**

**The National Science Foundation's
FY 2011 Budget Request**

WEDNESDAY, MARCH 10, 2010
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Wednesday, March 10, the Subcommittee on Research and Science Education of the House Committee on Science and Technology will hold a hearing to examine the priorities in the National Science Foundation's FY 2011 budget request. In addition, in preparation for reauthorization of the 2007 *America COMPETES Act*, the Subcommittee will examine core activities, initiatives, and policy directions for research, infrastructure, education and workforce training at the Foundation.

2. Witnesses

- **Dr. Arden L. Bement, Jr.**, Director of the National Science Foundation
- **Dr. Steven C. Beering**, Chair of the National Science Board

3. Overarching questions

- What is the status of the National Science Foundation's efforts to implement the provisions of the 2007 *America COMPETES Act*? Are there programs or requirements that NSF was not able to implement as intended? If so, why not?
- What are NSF's priorities for K–12 science, technology, engineering and mathematics (STEM) education, including its STEM teacher training programs? How does the current budget request reflect those priorities? What are NSF's plans for the new Transforming Undergraduate Education in STEM program? What are NSF's priorities for graduate education and training and how does the budget request reflect those priorities? How is NSF's mission to broaden participation in STEM integrated into the full portfolio of education programs? How does NSF evaluate its STEM education and broadening participation programs?
- What is NSF's vision for the role of institutions of higher education in the development or sustainability of regional or national innovation ecosystems that facilitate economic growth through commercialization and creation of new businesses? How do the Partnerships for Innovation program and other programs at the Foundation fit into this vision? How can these programs be designed to include diverse types of institutions and address workforce training needs at all levels of higher education?
- What is NSF's role in helping to maintain research infrastructure and instrumentation that enables the most cutting edge science and engineering research? By what mechanisms does the Foundation support such infrastructure and instrumentation? What challenges did NSF face in implementing the Academic Research Infrastructure (ARI) program under the 2009 Recovery Act? What is the role of the Foundation in supporting mid-size instrumentation that falls between instrumentation allowable under the Major Research Instrumentation program and major facilities funded under the Major Research Equipment and Facilities Construction account?

4. Overview of NSF FY 2011 Budget Request

The National Science Foundation (NSF) budget request for fiscal year (FY) 2011 totals \$7.424 billion, \$552 million or 8.0 percent more than FY 2010 funding (not including any FY 2010 carryover in the \$3.0 billion included for NSF in the Recov-

ery Act). However, when funding for U.S. Coast Guard Icebreakers (\$54 million) is counted appropriately, the real growth is 7.2 percent. This level of funding keeps NSF on a ten-year doubling path. (More detail on the icebreaker discrepancy is provided below.)

Research and Related Activities (R&RA)

Overview

The Administration's budget would provide \$6.02 billion for R&RA in FY 2011, an increase of \$401 million or 7.1 percent over FY 2010 funding. The largest relative increases went to the Engineering Directorate (ENG, +11 percent) and the Computer and Information Science and Engineering Directorate (CISE, +10.6 percent). The Geosciences Directorate (GEO), which funds atmospheric, earth and ocean sciences, including most of NSF's climate change research; and the Biological Sciences Directorate (BIO), which funds 68 percent of all non-medical academic research in the life sciences, including environmental biology, also saw greater than seven percent increases. The Social, Behavioral and Economic Sciences Directorate (SBE) received a 5.3 percent increase, and the Mathematical and Physical Sciences Directorate (MPS), the largest by far at NSF with a proposed budget of \$1.41 billion in FY 2011, received a 4.3 percent increase from FY 2010.

Innovation at NSF

The Administration's R&RA priorities for FY 2011 include a significant increase in funding for three programs labeled by NSF as "innovation" programs, including **Partnerships for Innovation** (\$19.2 million), **Science and Engineering Beyond Moore's Law** (\$70.2 million), and NSF's **Centers** programs (\$313.8 million across NSF).

Cyberlearning

The Foundation is proposing to establish a new multidisciplinary, multi-directorate research program called **Cyberlearning Transforming Education**, funded at \$41 million in FY 2011. 'Cyberlearning' is defined as the use of networked computing and communications technologies to support learning.

Polar Icebreakers

In 2005, NSF signed a memorandum of understanding (MOU) with the U.S. Coast Guard (USCG) in which NSF agreed to take over maintenance and operations budgetary authority for USCG icebreakers operating in the Arctic and Antarctic. The rationale for the MOU was that the majority of the USCG icebreakers time was dedicated to supporting NSF's science missions at the Poles. In FY 2010, the Appropriators required that budgetary authority be shifted back to USCG, and provided FY 2010 appropriations accordingly. As a result, \$54 million is excluded from the FY 2010 NSF budget total, thereby obscuring the true growth in funding for NSF's programs. This issue remains unresolved between Congress and the Administration.

Research Infrastructure

Approximately 24 percent (\$1.77 billion) of NSF's FY 2011 budget is devoted to research infrastructure. In addition to support for major facility construction under the MREFC account (below), this total includes support from within the R&RA account for: pre-construction design, and maintenance and operations for MREFC projects; major research instrumentation (\$90 million), federally funded R&D centers, and polar facilities and logistics. For a detailed explanation of the challenges of academic facilities modernization and the **Academic Research Infrastructure** (ARI) program in particular, refer to the charter from the February 23 subcommittee hearing on that topic.¹

Education and Human Resources (EHR)

The Education and Human Resources Directorate would be funded at \$892 million in FY 2011, an increase of only \$19.2 million or 2.2 percent over FY 2010 funding. The Administration continues to offer a mixed message regarding this treatment of EHR relative to the healthy increase for R&RA. On the one hand, they point out that funding for EHR alone represents an incomplete picture of the many education

¹<http://science.house.gov/publications/hearings-markups-details.aspx?NewsID=2743>

and training programs and activities distributed across NSF. On the other hand, they maintain that NSF is primarily a research agency and that the Department of Education (ED) has a greater responsibility for education, especially at the K-12 level. Significant funding (\$450 million) is requested for STEM specific programs at ED in the FY 2011 budget. We understand from both NSF and ED staff that the partnership and cooperation between the two agencies has increased markedly in the last year.

COMPETES Programs

In the FY 2011 budget, the **Noyce Teacher Scholarship program** would be funded at \$55 million, the same level since FY 2009, and **Math and Science Partnerships (MSP)** would be funded at \$58.2 million, the same level as in FY 2010 and a small decrease from FY 2009 funding. Both Noyce and MSP received significant funding in the Recovery Act (\$60 million and \$25 million, respectively).

At the graduate level, the Administration has pledged to triple the number of NSF **graduate research fellows (GRF)** to 3000 by 2013, and has provided a 16 percent increase to \$158 million for GRF in the FY 2011 proposal. NSF has an additional graduate student training program called **Integrative Graduate Education and Research Traineeship (IGERT)**, for which the Foundation proposes a decrease of 11 percent to \$62 million in FY 2011. Both programs are funded from both EHR and R&RA, with IGERT split evenly between the directorates and GRF receiving two-thirds of its funding from ERR. GRF is important in that it provides individual students with flexibility in the research they pursue rather than being tied to a particular investigator's grant, but the program does not involve any additional professional development for its fellows or involve the institution in any way. IGERT, on the other hand, creates student cohorts working on interdisciplinary projects that allow them to develop both individual and teamwork skills, and has the additional goal of catalyzing broader, cultural changes in graduate STEM education at participating institutions. In *COMPETES*, Congress required that both of these excellent and important programs grow at the same rate.

Two additional EHR programs highlighted in *COMPETES*, the two-year college **Advanced Technological Education Program** (\$64 million), and the **STEM Talent Expansion Program** (\$32.5 million) were both flat funded in the FY 2011 request.

Broadening Participation

Of particular note in the EHR budget is the proposed restructuring of programs to broaden participation in STEM at the undergraduate level. NSF is proposing a new comprehensive broadening participation program that builds on three existing programs: **Historically Black Colleges and Universities Undergraduate Program** (HBCU-UP), **Louis Stokes Alliances for Minority Participation** (LSAMP) and **Tribal Colleges Undergraduate Program** (TCUP), and newly invites proposals from Hispanic Serving Institutions, citing the mandate in Sec. 7033 of the *COMPETES* Act. Funding for this newly consolidated program would be \$103 million in FY 2011, a \$13 million or 14.4 percent increase from the total FY 2010 funding for HBCU-UP, LSAMP and TCUP.

In the budget narrative, NSF describes this consolidation as "combining expertise developed previously in separate programs in order to promote opportunities to build sustainable partnerships and alliances among [institutions] with a strong track record in producing underrepresented STEM graduates, thereby building capacity for the STEM field across a range of institutions." Members of various constituent communities have expressed concern about possible unintended consequences of this consolidation and about the lack of transparency by which the consolidation was conceived and developed. On March 16, our subcommittee will hold a hearing to examine Federal programs to broaden participation in STEM.

Major Research Equipment and Facilities Construction (MREFC)

The MREFC account supports large, multi-user facilities, distributed instrumentation networks, or large pieces of equipment such as telescopes, research vessels, or accelerators that benefit an entire scientific discipline and could not be achieved without significant Federal support.

The MREFC request for FY 2011 is \$165 million, an increase of \$41 million from FY 2010. MREFC also received \$400 million in the Recovery Act to initiate construction on three projects: The Alaska Region Research Vessel, the Advanced Technology Solar Telescope, and the Ocean Observatories Initiative, two of which will continue to receive funding in FY 2011. The only new start in FY 2011 is the Na-

tional Ecological Observatory Network (NEON), which passed final design review in November.

NSF FY 2011 BUDGET REQUEST

NSF Program Activity	FY 2009 Actual*	FY 2010 Plan	FY 2011 Request	Change over FY 2010	
				Amount	% Change
Research and Related Activities (R&A)	7215.0	5563.9	6018.8	455	8.2%
Biological Sciences	916.6	714.5	767.8	53	7.5%
Computer S&E (CISE)	809.5	618.8	684.5	66	10.6%
Engineering	930.0	743.9	825.7	82	11.0%
Geosciences	1155.5	889.6	955.3	66	7.4%
Math & Physical Sciences	1718.9	1351.8	1409.9	58	4.3%
Social, Behavioral and Economic Sciences	325.5	255.3	268.8	14	5.3%
Cyberinfrastructure	279.2	214.3	228.1	14	6.4%
International S&E	61.4	47.8	53.3	5	11.4%
Polar Programs	645.4	451.2	528.0	76.8	17.0%
Education and Human Resources (EHR)	930.5	872.8	892.0	19.2	2.2%
Research on Learning	226.7	242.0	247.9	5.8	2.4%
Undergraduate Education	368.1	292.4	290.0	-2.4	-0.8%
<i>MSP</i>	<i>86.0</i>	<i>58.2</i>	<i>58.2</i>	0.0	0.0%
<i>Noyce Scholarships</i>	<i>115.0</i>	<i>55.0</i>	<i>55.0</i>	0.0	0.0%
Grad Research and Education	181.7	181.4	185.3	3.8	2.1%
Human Resources Develop.	154.1	156.9	168.9	12.0	7.6%
MREFC	414.8	117.3	165.2	47.9	40.8%
Agency Operations (AOAM)	294.1	300.0	329.2	29.2	9.7%
Inspector General (OIG)	12.0	14.0	14.4	0.4	2.5%
Nat. Science Board (NSB)	4.0	4.5	4.8	0.3	6.6%
AGENCY TOTAL	6468.8	6872.5	7424.4	551.9	8.0%

* includes ARRA funding

NSF Participation in Major Interagency Initiatives (USGCRP, NNI, and NITRD)

U.S. Global Climate Change Research Program (USGCRP)

Started in 1989, the USGCRP is an interagency effort comprised of 13 departments and agencies. Activities of the USGCRP are grouped under the following areas: improving knowledge of Earth's past and present climate variability and change; improving understanding of natural and human forces of climate change; improving capability to model and predict future conditions and impacts; assessing the Nation's vulnerability to current and anticipated impacts of climate change; and improving the Nation's ability to respond to climate change by providing climate information and decision support tools that are useful to policymakers and the general public. Overall, the Administration proposes \$2.56 billion for USGCRP in the FY 2011 budget, a \$439 million (21 percent) increase over FY 2010 enacted. Likewise, climate change science is the cross-cutting area of research at NSF that received the most significant boost in the FY 2011 budget request. The Foundation's investment in USGCRP would increase by \$50 million (16 percent) to \$370 million in FY 2011. The most significant increase (\$27 million) would go toward research on climate variability and change across temporal and spatial scales.

National Nanotechnology Initiative (NNI)

The Science and Technology (S&T) Committee was instrumental in the development and enactment of the 21st Century Nanotechnology Research and Development Act of 2003 (P.L. 108–153), which authorizes the National Nanotechnology Initiative (NNI). The NNI focuses on R&D that creates materials, devices, and systems that exploit the fundamentally distinct properties of matter as it is manipulated at the nanoscale. Currently, 13 agencies report a nanotechnology R&D budget. Overall, the Administration proposes \$1.8 billion for NNI in the FY 2011 budget, a \$5 million decrease from FY 2010 enacted. The Foundation's investment in NNI would decrease by \$16 million (3.9 percent) to \$401 million in FY 2011. However, two specific research areas under NNI would receive an increase at NSF: nanomanufacturing and environmental, health and safety research.

Networking and Information Technology R&D Program (NITRD)

Similarly, the S&T Committee was instrumental in the development of the multi-agency Networking and Information Technology R&D (NITRD) program through the High Performance Computing Act of 1991 (P.L. 102–194). The mission of the NITRD program is to accelerate progress in the advancement of computing and networking technologies and to support leading edge computational research in a range of science and engineering fields. Currently, 13 Federal agencies report a NITRD budget. Overall, the Administration proposes \$4.3 billion for NITRD in the FY 2011 budget, a decrease of \$9 million from FY 2010 enacted. The Foundation's investment in NITRD would increase by \$80 million (7.3 percent) to \$1.17 billion in FY 2011. This increase is spread across all but one of the NITRD program component areas.

Chairman LIPINSKI. This hearing will now come to order.

Good morning, and welcome to this Research and Science Education Subcommittee hearing on the National Science Foundation's fiscal year 2011 budget request. In addition to reviewing the budget request, we will be examining the status of NSF programs authorized under the 2007 *America COMPETES Act* and discussing opportunities to further strengthen NSF's research and education missions through targeted programs and policies.

I was very pleased to see the President's strong increases for NSF being proposed in the President's budget, especially in these tough budget times. I believe that overall, this reflects the President's commitment to our future economic growth and his understanding that such growth is tied very strongly to the investments we make in science and innovation today. I look forward to hearing from Dr. Bement and Dr. Beerling about some of the new research initiatives and directions being proposed in this budget.

But before I begin, I would like to spend a couple of minutes laying out some of my concerns. First, this Administration, and the President himself, has made a strong commitment to STEM [Science, Technology, Engineering, Math] education, and I do not underestimate the impact of having the President himself publicly engaged on this critical issue. But once again the Administration is proposing a budget for NSF's Education directorate that barely keeps pace with inflation. I support an increased role for the Department of Education in STEM education and am happy to hear that collaboration between the agencies has increased markedly in the last year. But NSF has a long, rich and successful history in supporting STEM education activities and programs, and a unique expertise that the Department of Education cannot effectively duplicate. I worry about both the statement being made by the request and the consequences flat funding would have for NSF's excellent programs.

Second, this subcommittee held a hearing just a couple of weeks ago on academic research infrastructure. I know that we are still waiting to see what impacts the Recovery Act ARI [Academic Research Infrastructure] program will have, and that there are some concerns that infrastructure funding could potentially cut into research funding. But I also have concerns that we are not investing our research dollars as effectively as we could be if we invested first in modernizing our research facilities. So I look forward to discussing ways that the Federal Government can help support the critical modernization of academic research infrastructure. This is an issue that is becoming increasingly critical as state universities have seen significant budget cuts and all universities have experienced shrunken endowments and an increased need to provide financial aid.

Finally, I would like to understand the justification for the decrease in funding for nanotechnology research under the NNI [National Nanotechnology Initiative] program. In 2007, \$60 billion in nano-enabled products were sold, and it is predicted that the number will rise to \$2.6 trillion by 2014. That is a pretty staggering number. Surely we should be investing more, not less, in this important area of research.

And finally, Dr. Bement, and Dr. Beering, I want to take this opportunity this morning to thank you for your service. As most of you know, Dr. Bement will be leaving his post as the Director of NSF on June 1st. I want to take this opportunity to congratulate Dr. Bement on his new position at Purdue and thank him for his years of service to the government and to the entire scientific community. You are not leaving quite yet, Dr. Bement, and we are still planning to pass the COMPETES reauthorization in the House before your departure date, so I look forward to working with you closely as we develop this legislation over the next several weeks.

I understand that Dr. Beering is also coming to the end of his term as Chair of the National Science Board this May, and I thank you, Dr. Beering, for your service and wish both of you success in your future endeavors.

[The prepared statement of Chairman Lipinski follows:]

PREPARED STATEMENT OF CHAIRMAN DANIEL LIPINSKI

Good morning and welcome to this Research and Science Education Subcommittee hearing on the National Science Foundation's fiscal year 2011 budget request. In addition to reviewing the budget request, we will be examining the status of NSF programs authorized under the 2007 *America COMPETES Act* and discussing opportunities to further strengthen NSF's research and education missions through targeted programs and policies.

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Dr. Bement, and Dr. Beering, thank you for taking the time to appear before the subcommittee this morning. As most of you know Dr. Bement will be leaving his post as the Director of NSF on June 1. I want to take this opportunity to congratulate Dr. Bement on his new position at Purdue and thank him for his years of service to the government and to the entire scientific community. You're not leaving

quite yet Dr. Bement, and we are still planning to pass the *COMPETES Reauthorization* in the House before your departure date, so I look forward to working with you closely as we develop this legislation over the next several weeks.

I understand that Dr. Beering is also coming to the end of his term as chair of the National Science Board this May. Thank you Dr. Beering for your service, and I wish both of you success in your future endeavors.

Chairman LIPINSKI. With that, the Chair will now recognize Dr. Ehlers for an opening statement.

Mr. EHLERS. Thank you, Mr. Chairman.

In the fiscal year 2011 budget request, the Administration has requested substantial increases in funding for the National Science Foundation. I am pleased the funding request continues the Foundation on a path to doubling its budget, although that path has had a rather bumpy start over the last several years. I do join with my colleague in thanking the President for increasing the funding for the National Science Foundation and for his support of science in general.

I do, however, express the same concerns he has about the funding of the education area. The budget request proposes some targeted investments at the National Science Foundation in the areas of innovation, cyberlearning and graduate education. It also proposes some restructuring of the programs targeted at broadening participation at the undergraduate levels in science and engineering. I look forward to learning more about these proposals from our witnesses today, but I am very disappointed with the funding provided in the request for K-12 educational activities within the Education and Human Resources directorate. Although the NSF has defended the successes of the Math and Science Partnership program, no increase is requested for this program or for the Noyce program, which also focuses on training teachers for K-12 positions. This is a longstanding problem. Under the previous Administration as well, funding for NSF in this area was cut on the basis that the Department of Education was taking over. The programs are totally different, and just because they are both sometimes called Math and Science Partnership programs doesn't mean they are identical. We must continue to support the good work that the National Science Foundation does in this area and recognize that that good work is foundational to whatever the Department of Education wishes to do.

I have met with the Secretary of Education on this and also his new assistant in this area, Michael Lach, who is a marvelous person and has done great things in various school systems, particular the Chicago school system, and they understand the issue. We have to make sure that the President and the Office of Management and Budget understand the issue as well and continue strong support for the National Science Foundation activities in STEM education.

So although the NSF has defended the successes of the program, no increase is requested for this program, as I said, or for the Noyce program, which is of very long standing, and I hope that we can reverse that through the appropriations process.

Several other programs focused on our innovative workforce, such as the Advanced Technological Education program, are also flat funded. As we consider reauthorization of the *COMPETES Act*, these NSF programs have the potential to make great impacts on science, technology, engineering and math education in this coun-

try, and I would also add, even though it fits within the math part of the STEM program, I want to emphasize the importance of getting caught up in computer science again. We are not doing well in that particular area in this Nation. We must increase the interest in computer science in the elementary and secondary schools and certainly must increase the number of computer scientists that we are developing, particularly as we as a Nation worry more about cybersecurity.

The current budget, despite providing for the doubling of the overall NSF budget, does not emphasize the importance of STEM education to our country's economic competitiveness. That is a very, very important point. I look forward to hearing from our excellent witnesses today about the new additions proposed in the fiscal year 2011 budget and how we can work together to strength the COMPETES Act.

Thank you very much. I yield back.
[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

In the fiscal year 2011 budget request, the Administration has requested substantial increases in funding for the National Science Foundation (NSF). I am pleased the funding request continues the Foundation on a path to doubling its budget, although that path has had a rather bumpy start over the last several years.

The budget request proposes some targeted investments at the NSF in the areas of innovation, cyberlearning, and graduate education. It also proposes some restructuring of the programs targeted at broadening participation at the undergraduate levels in science and engineering. I look forward to learning more about these proposals from our witnesses today.

Finally, I am disappointed with the funding provided in the request for K-12 educational activities within the Education and Human Resources (EHR) Directorate. Although the NSF has defended the successes of the Math and Science Partnerships program, no increase is requested for this program, or for the Noyce Program, which also focuses on training teachers for K-12 positions. Several other programs focused on our innovative workforce, such as the Advanced Technological Education program, are also flat-funded. As we consider reauthorization of the *COMPETES Act*, these NSF programs have the potential to make great impacts on science, technology, engineering and math (STEM) education in this country. The current budget, despite providing for the doubling of the overall NSF budget, does not emphasize the importance of STEM education to our country's economic competitiveness.

I look forward to hearing from our witnesses about the new initiatives proposed in the FY 11 budget and how we can work together to strengthen the *COMPETES Act*.

Chairman LIPINSKI. Thank you, Dr. Ehlers, and if there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman.

The National Science Foundation funding request of 7.424 billion supports a vision to double its budget within ten years.

As the only Federal agency dedicated to the support of basic research and education across all fields of science and engineering, NSF funds approximately 20 percent of all federally funded basic research by America's colleges and universities.

I am convinced that an investment in NSF will help ensure our future viability and competitiveness as a nation. In order to strengthen our science and technology workforce, infrastructure, and spark the curiosity of young minds to innovate the next technological feat, we must strengthen these critical programs.

It is a mistake to underestimate the importance of basic research in the physical sciences. A basic, fundamental understanding of all branches of science is needed in order to lay down the foundation for applied science.

Our country is falling behind in graduating students with advanced STEM degrees because they are falling behind at an early age. In order for America to regain its global competitive leadership in the sciences it's going to take an effort from us all to rebuild our workforce from the ground up. We need higher salaries and better preparation for teachers. We need better resources and access to technology available to all of students can have the same opportunities. We need a commitment from those who do graduate in these disciplines to reach back down the pipeline and help inspire more to enter these fields. We need effective legislation that can be the spark towards increased STEM interest, study, and practice. We have to cultivate, sustain, and prepare students from the beginning to ensure they make it through to the end.

Dr. Bement, on February 25, 2010 it was my pleasure to address the seventh annual NSF ITESST Summit. I enjoyed speaking with some of the personal investigators, and the ITESST project personnel in attendance. Allowing students to use the same technology as scientists and engineers at an early age will help inspire our youth to believe in themselves.

There are many examples of critical support that NSF has provided to Texas researchers. NSF grants are extremely important for researchers in my homestate of Texas.

Mr. Chairman, I believe this committee is tasked with helping NSF do its job well.

If we want to cultivate domestic, home-grown talent in the sciences, we simply must increase the funds NSF can use for research grants, Mr. Chairman.

We must strengthen our workforce diversity. Women and minorities need greater attention in NSF's programmatic agenda. Although blacks, Hispanics, and American Indians as a group are more than 23 percent of the U.S. population, they are only 13 percent of science and engineering bachelor's degree recipients.

By NSF's own calculations, underrepresented minorities as a whole are only six percent of the science and engineering labor force.

This is unacceptable. Doctor Bement and Doctor Beering, I know the task of prioritizing the many aspects of NSF's mission is difficult. I ask that you increase efforts to increase minority participation and to help young investigators. Tomorrow's workforce is counting on you.

Thank you, Mr. Chairman. I yield back.

At this time I would like to introduce our witnesses. Dr. Arden Bement is the Director of the National Science Foundation, and Dr. Steven Beering is Chair of the National Science Board. As our witnesses certainly know, you will each have five minutes for your spoken testimony. Your written testimony will be included in the record for the hearing. When you all have completed your spoken testimony, we will begin with questions. Each Member will have five minutes to question the panel.

We will start here with Dr. Bement.

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

Dr. BEMENT. Chairman Lipinski, Ranking Member Ehlers and Members of the Subcommittee, I am pleased to appear before you today.

The essence of the President's 2011 budget request for the National Science Foundation is to reaffirm the agency's roots as the Nation's wellspring of scientific innovation. NSF's 2011 request is \$7.4 billion, an increase of eight percent over 2010. This keeps us on the road to the President's goal in the *America COMPETES Act* to double NSF's budget. But as with any budget, this request reflects tough choices and clear priorities. It recognizes NSF's unique national responsibility for supporting basic research, our catalytic role in education, and the ongoing need for investments in stewardship.

NSF's research and education agenda is both multifaceted and well rounded. It is designed very deliberately to support the Administration's plan of making innovation a centerpiece of economic strength and future well-being. The main driver for this investment is the National Innovation Strategy. Nothing speaks more to what NSF is and does than the Administration's commitment to fundamental research, and it is emphasized throughout the budget. When you talk about the building blocks of innovation, you talk about NSF. You will also see NSF at the forefront of educating the next generation with 21st century knowledge and skills. Let me highlight the programs that are central to this goal.

The Advanced Technological Education [ATE] program supports new and enhanced two-year college programs that educate technicians for the high-technology workforce. The Graduate Research Fellowship [GRF] and Faculty Career Development programs support students and early career investigators to foster the Nation's next generation of scientists and engineers. Climate Change Education addresses learning at all levels and is designed to stimulate interest in careers in climate science. NSF programs also support next-generation information technology and secure cyberspace. NSF will support the interagency Networking and Information Technology R&D program at \$1.17 billion.

Overcoming challenges inherent in today's great scientific questions will require a new computer revolution to overcome the physical restrictions of today's silicon chip-based technology. NSF's Science and Engineering Beyond Moore's Law is a multidisciplinary research program designed to enhance our Nation's economic competitiveness. The program's name refers to the proposition that computer processing power based on semiconductor integrated circuits doubles about every 18 months. We are rapidly reaching the physical limitation of that progress.

NSF must continue to innovate in tracking the large-scale scientific and engineering challenges of our age, including understanding the nature and scope of changes in the earth's climate. NSF contributes multiple resources to support the U.S. Global Change Research program and other interagency initiatives that are helping us understand and confront the global challenge of a changing climate. NSF's contribution to the U.S. Global Change Research program is proposed to increase by 16 percent to \$370 million.

Also in 2011, NSF will spend \$766 million on a portfolio of activities called Science, Engineering, and Education for Sustainability. It will seek integrated approaches to increased U.S. energy independence, enhanced environmental stewardship and reduce energy use and carbon intensity while generating continued economic growth.

Re-gaining our Energy Science and Engineering Edge, or RE-ENERGYSE, is a new \$19 million program to help the Nation regain its leadership in science and engineering by attracting and educating future scientists in the clean energy field. NSF will jointly fund RE-ENERGYSE with the Department of Energy to prepare as many as 8,500 highly trained young scientists and engineers for clean energy careers by 2015. Additionally, RE-ENERGYSE will provide training of technicians for clean energy industries.

NSF's request includes \$20 million in its Major Research Equipment and Facilities Construction account to begin construction of the National Ecological Observatory Network, or NEON. NEON is a multifaceted project with a total projected budget of \$434 million spread out over the next six fiscal years. NEON will collect data on the effects of climate change, changes in land use, and invasive species on national resources and biodiversity. NEON will be the first observatory network designed to detect and enable forecasting of ecological change at the continental scale over multiple decades.

As with any budget, the most important information is the message beyond the numbers. In fiscal year 2011, that message is the Administration's commitment to innovation and economic growth through science and engineering. The Foundation is pleased to be playing an important role in that effort.

Mr. Chairman and Members of the Committee, as this will likely be the last time I testify before you before leaving on June 1st, I want to make certain that you are aware of how deeply appreciative I am of your support over the past nine years as director at NIST and NSF. I also want to make a special note of wishing well Congressman Ehlers and Congressman Baird in their future activities as they leave this committee, and I have enjoyed a very long and close relationship with both of you and I hope that will continue in our new activities. Thank you.

[The prepared statement of Dr. Bement follows:]

PREPARED STATEMENT OF ARDEN L. BEMENT, JR.

Chairman Lipinski, Ranking Member Ehlers, and Members of the Subcommittee, I am pleased to appear before you this morning.

My testimony will focus principally on NSF's FY 2011 Budget Request. In doing so, however, I will highlight those aspects of the Request that have direct bearing on the upcoming reauthorization of the *America COMPETES Act (ACA)*. Since its enactment in August 2007, the ACA has informed the priorities and investment strategies at NSF. There are countless aspects of the FY 2011 request—from the commitment to young investigators to new approaches to fostering high-risk, high-reward research—that directly reflect the ACA.

This begins with the bottom line: The National Science Foundation (NSF) proposes a fiscal year 2011 investment of \$7.42 billion, an increase of \$552 million—or 8 percent—over the fiscal year 2010 amount. This increase reflects the Administration's continued resolve to double funding for three key science agencies, including NSF.

The National Science Foundation is the only Federal agency dedicated to the support of basic research and education across all fields of science and engineering. For 60 years, we have been exploring the frontiers of scientific knowledge and extending the reach of engineering by encouraging, identifying, and funding the best ideas and most promising people. The high-risk, potentially transformative investments we make generate important discoveries and new technology, create and train a dynamic workforce, and spark the curiosity and creativity of millions. Our investments in research and education help ensure that our Nation remains globally competitive, prosperous, and secure.

An investment in the National Science Foundation is a direct investment in America's economic security. In fact, without a solid basic research foundation for our high-tech economy, no economic security is possible. Basic research underpins all of the technology that constitutes the lifeblood of today's global market. America's sustained economic prosperity is based in part on technological innovation resulting from previous fundamental science and engineering research. Innovation and technology are engines of the American economy, and advances in science and engineering provide the fuel.

While the United States still far outpaces the world in its level of public and private R&D investment and research output, our counterparts around the globe are well aware of the importance of funding R&D. As is highlighted in the just released 2010 Science and Engineering Indicators, the world's R&D expenditures have been

on an 11-year doubling path, growing faster than total global economic output. While the growth of annual U.S. R&D expenditures averaged around six percent, China, for example, has invested in R&D at an annual growth of over 22 percent during the same period of time.¹

Most recently, Norman Augustine, former CEO of Lockheed Martin, released a follow-up to “The Gathering Storm” report entitled, “Is America Falling Off the Flat Earth?” His message is clear: “Unless substantial investments are made to the engine of innovation basic scientific research and development—the current generation may be the first in our country’s history to leave their children and grandchildren a lower sustained standard of living.”²

For sixty years, NSF has been a steward of the nation’s science and engineering enterprise. NSF investments in discovery, learning, and innovation have been important to increasing America’s economic strength, global competitiveness, national security and overall quality of life.

With its relatively small size, NSF delivers an enormous “bang for the buck” of Federal Government research and development (R&D) investment. NSF represents just four percent of the total Federal budget for research and development, but accounts for over sixty percent of Federal support of non-life science basic research at academic institutions. For example, NSF’s share of Federal support for basic research in computer sciences at academic institutions in FY 2008 was over 80%. NSF is the research funding lifeline for many fields and emerging interdisciplinary areas at the frontiers of discovery. In fact, NSF is the only Federal agency that supports all fields of basic science and engineering research.

NSF-funded research is characterized by its breadth. NSF prioritizes the integration of education into its research programs, and takes into account the broader societal impacts of the work it funds, such as the training that students and young researchers receive in the research process, and the educational opportunities the work and its people can then provide to the larger community of K–16 students and teachers and the general public.

NSF’s comprehensive and flexible support of meritorious projects with broad societal impacts enables the Foundation to identify and foster both fundamental and transformative discoveries within and among fields of inquiry. NSF has the latitude to support emerging fields, high-risk ideas, interdisciplinary collaborations, and research that pushes, and even transforms, the very frontiers of knowledge. In these ways, NSF’s discoveries inspire the American public—and the world.

NSF’s organization mirrors science and engineering. Its portfolio spans the biological sciences, computer and information science and engineering, engineering, geosciences, mathematics and physical sciences, and social, behavioral, and economic sciences—encompassing both research and education in these areas. NSF also carries out specific national responsibilities for polar programs, cyberinfrastructure, international science and engineering, and a range of responsibilities related to the nation’s overall capabilities in science and engineering, including statistical resources on the overall U.S. and international R&D enterprise. The 25-member National Science Board sets the overall policies of the Foundation.

The cornerstone of NSF is the merit-based, competitive process that fosters the highest standards of excellence and accountability—standards that have been emulated at funding agencies around the world.

2011 Budget Request Highlights

At NSF, we understand that new discoveries are a driving force behind societal progress. As the nation’s premier funding agency for basic research, our mission is to advance the frontiers of knowledge, where high-risk, high-reward research can lay the foundation for revolutionary technologies and tackle complex societal problems. The NSF budget for 2011 reflects this vital agenda, and I’m pleased to present it to you today.

Let me begin with the big picture. As noted earlier, the President is requesting \$7.42 billion for the NSF in FY 2011. That’s an increase of almost \$552 million, or eight percent above the current 2010 appropriated amount. While it seems like a large increase, this level is necessary to fulfill the President’s vision for doubling the National Science Foundation’s budget. This increased investment will reinforce NSF’s leadership in basic science and engineering and allow us to preserve America’s preeminence in the global technology economy.

In this year’s proposed budget, funding levels increase for every NSF appropriations account. Research and Related Activities investments increase by 8.2 percent,

¹ <http://www.nsf.gov/statistics/digest10/global.cfm#4>

² Augustine, Norman. *Is America Falling Off the Flat Earth?* National Academies Press

and our Education and Human Resources account is increased by 2.2 percent. We need rapid progress in these areas to stimulate the discoveries in research we need to maintain our standing in the global marketplace, and to keep our students engaged and ready to perform in the global workforce. Our budget includes increases for every Directorate and Office within NSF. But, as with any budget, the FY 2011 Request reflects tough choices and clear priorities. It recognizes NSF's unique national responsibility for supporting basic research, our catalytic role in education, and the ongoing need for investments in stewardship.

Here are highlights of some of the key investments we are emphasizing in our 2011 budget.

NATIONAL INNOVATION STRATEGY

NSF's contribution to the Administration's *A Strategy for American Innovation*, announced by the President in September 2009, stems from its longstanding role in strengthening the building blocks of American innovation. This begins with investing in fundamental research and educating the next generation of scientists and engineers. It also includes more focused research on topics that advance vital capabilities—such as sustainability, secure networks, and leading-edge technologies—and fostering and facilitating partnerships that reach across today's global innovation enterprises.

Maintain American Leadership in Fundamental Research. Since innovation depends on the foundation of earlier investments, NSF's foremost responsibility in innovation is to continue to support fundamental research and education in all fields of science and engineering. The President's Plan for Science and Innovation aims to double the Federal investment in three key basic research agencies over FY 2006 levels. This investment will be vital to the effort to increase national R&D investments to three percent of Gross Domestic Product.

Educate the Next Generation with 21st Century Knowledge and Skills While Creating a World-Class Workforce. Two NSF programs described in this Request support the Strategy's educational goals.

- **The Graduate Research Fellowship (GRF)** program, (16.4 percent increase to \$158.24 million); an Administration priority, supports the development of the Nation's future scientists and engineers. FY 2009 marked the beginning of a growth trajectory to triple the number of new awards made each year to 3,000 by FY 2013.
- **RE-gaining our ENERGY Science and Engineering Edge (RE-ENERGYSE)**, (\$19.37 million) is located at the intersection of energy, environment, and human factors. It is a partnership between the Department of Energy (DOE) and the National Science Foundation that will help the Nation regain its leadership position in science and engineering by attracting and educating future scientists in the clean energy field. By 2015, RE-ENERGYSE would prepare up to 8,500 highly educated young scientists and engineers for clean energy careers and provide training for thousands of skilled clean energy technicians.

Support Research for Next-Generation Information and Communications Technology, and Secure Cyberspace. While nobody can predict which of today's fundamental discoveries will become tomorrow's new products and processes, a number of NSF programs support the Strategy's goal to promote innovation. These include:

- **Science and Engineering Beyond Moore's Law (SEBML)**, (50.3 percent increase to \$70.18 million). In 10 to 20 years, current silicon technology will reach the limits of Moore's Law—the empirical observation that computing power doubles roughly every 18 months. SEBML's transformational activities accelerate innovation and create partnering opportunities with the private sector and national laboratories.
- **Cyber-enabled Discovery and Innovation (CDI)**, (2.8 percent increase to \$105.48 million) CDI supports transformative, multidisciplinary science and engineering research made possible by innovations and advances in computational concepts, methods, models, algorithms, and tools. CDI breakthroughs advance one or more of the three themes: From Data to Knowledge; Understanding Complexity in Natural, Built, and Social Systems; Building Virtual Organizations.
- **Cybersecurity**, (10.6 percent increase to \$144.55 million). NSF's basic research into usability, theoretical foundations, and privacy supports the aims of the Comprehensive National Cybersecurity Initiative.

Encourage High-Growth and Innovation-Based Entrepreneurship, and Create Competitive Communities By Promoting Regional Innovation Clusters

Partnerships for Innovation (PFI), (108.8 percent increase to \$19.19 million). PFI brings together colleges, universities, state and local governments, private sector firms, and nonprofit organizations. Initiated in FY 2000, PFI connects new knowledge created in the discovery process to learning and innovation, while broadening the participation of people and institutions in NSF activities. PFI activities include research, technology transfer, building infrastructure for innovation, and workforce education and training. In FY 2011, \$12.0 million will be invested in a new “NSF Innovation Ecosystem” component, which aims to: increase the engagement of faculty and students across all disciplines in the innovation and entrepreneurship process; increase the impact of the most promising university innovations through commercialization, industry alliances, and start-up formulation; and develop a regional community that supports the “innovation ecosystem” around the university. It will draw on the individual entrepreneurial spirit of university faculty and students, as well as on the proven strengths of established technology centers such as Science and Technology Centers, Engineering Research Centers, Industry University Cooperative Research Centers, and others that link higher education institutions with investment and industry sectors. The Innovation Ecosystem initiative will focus on ways to maximize the innovation potential of scientific and engineering discovery in the university system and accelerate the technological innovation process with robust partnerships with the private sector.

Grant Opportunities for Academic Liaison with Industry (GOALI), (0.4 percent increase to \$18.58 million). GOALI seeks to increase partnerships between the academic and industrial communities and provide opportunities to accelerate innovation by strengthening the discovery knowledge base for a quicker translation of discovery to societal benefit. The program leverages its budget with support from other NSF academic research programs by a factor of four to one.

Centers programs, (8.9 percent increase to \$313.78 million). NSF supports over 100 centers in seven interdisciplinary program areas. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research problem or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers often leverage their activities through partnerships with academic institutions, national laboratories, industrial organizations, and/or other public/private entities, and via international collaborations, as appropriate.

LEARNING AND WORKFORCE DEVELOPMENT

For America to continue to lead the world in science and technology innovation, it must have the most knowledgeable and skilled science, technology, engineering, and mathematics (STEM) workers in the world. The National Innovation Strategy includes programs that support scientists and engineers at the beginning of their careers, prepare the next generation of Americans to understand and meet environmental challenges, and educate the next generation with 21st century knowledge and skills while creating a world-class workforce. This is not just the smart thing to do—it is the right thing to do for our country. By drawing on the spectrum of talents and backgrounds of America’s diverse populace, we can bring new approaches to scientific discovery, new vantage points to engineering design, and new insights to innovation. This is essential as we increasingly find ourselves in competition with scientist and engineers and entrepreneurs from all corners of the globe, and as we strive to remain competitive in the diverse international marketplace.

Administration Priority Programs

The FY 2011 budget maintains strong levels of support for four key Administration priority programs which were strongly supported in the FY 2010 Budget Request. The Graduate Research Fellowship (GRF) Program and the Faculty Early Career Development Program (CAREER) support the most promising students and early-career researchers in order to cultivate the next generation of STEM knowledge workers. Climate Change Education (CCE) targets learning at all levels and is designed to develop the next generation of skilled, educated, and climate-savvy Americans. Advanced Technological Education (ATE) supports new and enhanced two-year college programs that educate technicians for the high-technology workforce.

- **The Graduate Research Fellowship (GRF)** program supports the development of the Nation’s future scientists and engineers. As noted earlier, FY

2009 marked the beginning of a growth trajectory to triple the number of new awards made each year to 3,000 by FY 2013.

- **The Faculty Early Career Development Program (CAREER)** develops the future scientific and technical workforce through support of young faculty who are dedicated to integrating the excitement of research with inspired teaching and enthusiastic learning.
- **Climate Change Education** is designed to develop the next generation of skilled, educated, and climate-savvy Americans. It catalyzes activity at the national level in four strands of STEM education: preparation of a climate science professional workforce; public understanding and engagement; resources for learning; and local and national STEM education policy.
- **Advanced Technological Education (ATE)** supports new and enhanced two-year college programs that educate technicians for the high-technology workforce. It is on a growth trajectory begun in FY 2010 to increase the program's funding to \$100 million by FY 2013.

LEARNING AND BROADENING PARTICIPATION

The integration of research and education has been a hallmark of NSF since its inception. The Foundation's investments do double duty—generating new knowledge and producing the next generation of scientists, technologists, engineers, mathematicians, and educators. Preparing a STEM workforce ready to lead innovation and address national needs requires the involvement of the full range of talent and diversity in the Nation, specifically students from traditionally underrepresented groups. This is not just the right thing to do—it is the smart thing to do for our country. By drawing on the spectrum of talents and backgrounds of America's diverse populace, we can bring new approaches to scientific discovery, new vantage points to engineering design, new insights to innovation. This is essential as we increasingly find ourselves in competition with scientist, engineers, and entrepreneurs from all corners of the globe, and as we strive to remain competitive in the diverse international marketplace.

The FY 2011 Budget maintains strong support for agency-wide efforts to bring a fuller array of perspectives and participants to advancing discovery and innovation. Investments across NSF seek to broaden participation among people, institutions, and geographical regions.

Comprehensive Broadening Participation of Undergraduate Institutions in STEM (CBP-UI), (\$103.10 million). With an FY 2011 investment of \$103.10 million, NSF will implement a new consolidated program, which realigns and builds on existing programs: Historically Black Colleges and Universities Undergraduates program (HBCU-UP), Louis Stokes Alliances for Minority Participation (LSAMP), Tribal colleges and universities (TCUP), and Hispanic-serving institutions. This new program's objective is to help build sustainable partnerships and alliances among institutions with strong track records in producing underrepresented STEM graduates, thereby building capacity for the STEM field across a range of institutions. These comprehensive partnerships will increase the institutions' competitiveness by:

- strengthening STEM curricular offerings, enhancing STEM faculty development, and increasing competencies and competitiveness of students
- Transforming infrastructure, operations, and resources
- Increasing support for and engagement in frontier scientific research and access to advanced research instrumentation, and maximizing undergraduate research opportunities
- Facilitating expanded collaboration between scientists and educators at minority-serving institutions with those at majority institutions
- Stimulating innovation and creativity from the nation's education and research enterprise through support of effective collaborations between minority-serving and majority institutions, especially research-intensive universities with NSF Science and Technology Centers (STC), Materials Research Science and Engineering Centers (MRSEC), and Engineering Research Centers (ERC).

Experimental Program to Stimulate Competitive Research (EPSCoR), (4.9 percent increase to \$154.36 million) NSF remains a leader in efforts to broaden participation in science and engineering in all states and regions. EPSCoR's goal is to stimulate sustainable improvements in research participation from institutions in geographical areas that are underrepresented in NSF activities. Strategies include supporting research infrastructure improvement, co-funding of disciplinary and

interdisciplinary research, and conducting outreach and workshops. This growth mirrors the overall growth for the R&RA account for FY 2009 through FY 2011.

Government-wide Strategy for STEM Education. In addition to its support for the programs and priorities already mentioned, NSF is actively engaged as a leading participant in the coordinated, government-wide strategy for STEM education. NSF is poised to build on previous and emerging collaborations with the U.S. Department of Education, and to use NSF's unique experience and knowledge base in STEM education to identify research and evaluation priorities and to consider appropriate standards of evidence for various stages of research and development cycles. The agencies are embarking jointly on possible collaborations and complementary initiatives to help states improve K–12 student learning in STEM by building and sharing knowledge of effective curricular and instructional practices, and how they can be implemented at scale.

NSF K–16 Stem Education Priorities

An overarching commitment in all of NSF's K–16 investments is to address current and emerging educational challenges that have bearing on the preparation of a STEM workforce and a STEM-literate society. In particular, NSF K–16 investments are intended to catalyze innovation that improves learning, to validate what we think we already know, to scale what works, and to build a knowledge base through research and evaluation about how to improve STEM learning for all. These investments are made through several core programs that address K–16 education.

NSF has the following four priorities for K–16 education:

- improving K–16 education through increased research and evaluation to allow for more strategic efforts to increase STEM learning, support the creation of effective assessment tools and approaches (including tools for measuring teacher knowledge) that enable teachers and instructors to examine and improve student learning across the K–16 level; and
- supporting topical areas of national importance, namely climate and energy science, into the K–16 educational enterprise;
- preparing the STEM workforce (including teachers) to be the innovators of tomorrow by: improving recruitment, retention, and program completion of undergraduates in two- and four-year institutions; improving undergraduate instruction on the basis of research evidence; and providing scholarships and fellowships. A particular focus here is on specific strategies and programs for increasing the participation of underrepresented minority students in STEM;
- exploring the potential of cyberlearning to enable new avenues of science, technology, engineering, and mathematics (STEM) education and to create new ways of studying the learning process itself.

With the President's clearly stated emphasis on the importance of improving STEM education, NSF will be a willing partner in working with other Federal agencies and departments to more effectively leverage our efforts. This is a great opportunity for us to work together, and to learn from each other in moving toward the goal the President has established—American students moving from the middle to the top of the pack within a decade.

INVESTMENT PORTFOLIOS

A portfolio investment strategy specifically addresses our role in addressing national challenges, such as stimulation of economic growth, promotion of innovative energy technologies which can help mitigate the impact of climate change, training of a world-class STEM workforce, and nurturing a scientifically literate population.

A wide range of ongoing NSF investments contribute directly to energy technologies, understanding and mitigating climate change, and promoting green jobs. The FY 2011 Request presents a new framework for coordinating and enhancing these investments. To leverage NSF's strengths towards addressing the challenges we face, NSF proposes to focus on the full portfolio of activities in two key areas of national importance.

Science, Engineering, and Education for Sustainability (SEES), (16 percent increase to \$765.5 million) will integrate NSF's efforts in climate and energy science and engineering to generate the discoveries and capabilities needed to inform societal actions that lead to environmental and economic sustainability. SEES addresses recommendations from the August 2009 report from the National Science Board, *Building A Sustainable Energy Future*, which emphasized systems approaches to research programs, education and workforce development, public awareness and out-

reach, and the importance of partnerships with other agencies, states, universities, industry, and international organizations.

Cyberlearning Transforming Education (CTE), (63 percent increase to \$41.3 million). This new multidisciplinary research program is intended to fully capture the transformative potential of advanced learning technologies across the education enterprise. CTE will enable wholly new avenues of science, technology, engineering, and mathematics (STEM) learning for students and for workforce development. Collaborating with the Department of Education to bring advances in technology to learners at all educational levels will advance the Nation's ability to study the learning process itself.

INTERAGENCY ACTIVITIES

Networking and Information Technology Research and Development (NITRD), (7 percent increase to \$1.170 billion). NITRD coordinates the unclassified networking and information technology research and development investments across thirteen Federal agencies. These agencies work together to develop a broad spectrum of advanced networking and IT capabilities to power Federal missions, economic competitiveness, and science, engineering, and technology leadership. NSF is a leader in the program and NITRD activities represent 16 percent of NSF's

FY 2011 budget. Funding foci for FY 2011 include large scale networking, cybersecurity and information assurance, high confidence software and systems, human-computer interaction and information management, and software design and productivity.

National Nanotechnology Initiative (NNI), (four percent decrease to \$401.3 million). NSF actively participates in the NNI, which coordinates nanotechnology research and development with 25 departments and agencies across the Federal Government. Nanotechnology encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of 1 to 100 nanometers. NSF's investment in this activity increases in two key areas in FY 2011: nanomanufacturing (44 percent increase to \$32.2 million) and Environmental, Health and Safety (11 percent increase to \$33.0 million).

NSF contributes to the three NNI Signature Initiatives focusing on:

- Nanoelectronics for 2020 and Beyond (in partnership with DOD, NIST, DOE, DNI);
- Sustainable Nanomanufacturing (in partnership with NIST, DOE, EPA, NIH); and
- Nanotechnology Applications for Solar Energy (in partnership with DOE, NIST, DOD, DNI, USDA/NIFA).

Additionally, NSF will further emphasize (beyond current support) the environmental, health and safety implications of nanotechnology, including development of predictive toxicity of nanomaterials, primarily through the support of three dedicated multidisciplinary centers and through support for approximately 60 additional research groups.

The budget request includes, for example, further support for advanced manufacturing with an emphasis on nanomanufacturing, support for Science and Engineering Beyond Moore's Law (an integral aspect of nanoelectronics for 2020 and beyond), and support for new and innovative means for addressing energy challenges (such as solar energy) through the SEES initiative.

STEWARDSHIP INVESTMENTS

Since 2001, the number of proposals submitted to NSF has increased by over 50 percent. In that time, staffing has increased by only 19 percent. To support NSF's excellence in science and engineering research and education, NSF must invest in expanding and developing its workforce and resources to maintain a capable and responsive organization.

The FY 2011 Request includes \$468.8 million (+\$39.1 million) for activities aimed at assuring that NSF will be able to effectively and efficiently manage its operations. Funds will support:

- **Staff**, 40 additional full-time equivalents (for a total of 1,350 FTE) and eleven additional IPAs are requested;
- **IT investments**, such as the expansion of Research.gov, modernization of the NSF financial system, and improvements in the reliability and security of NSF's operational IT systems; and

- **Acquisition**, (\$2.0 million). This increase is part of the government-wide effort to strengthen the acquisition workforce. A key priority for NSF is improving capabilities in the pre-solicitation phase of major acquisitions.

A specific emphasis in FY 2011 is promoting strong, independent evaluation that can inform policy decisions, program management, and performance assessment across NSF. NSF participates in the Administration's government-wide initiative to strengthen program evaluation and performance measurement, and shares its commitment to post the status and findings of this and other important publicly available evaluations online.

- **High-Priority Performance Goal:** NSF's goal for the end of FY 2011 is to develop evaluation and assessment systems for STEM education and workforce programs that can provide findings leading to program re-design or consolidation.
- **Foundation-wide planning, analysis, and evaluation.** \$1.0 million will support additional staff and associated resources for the establishment of a centralized NSF capability for assessment and evaluation. This would bring greater attention and analysis to such areas as comparing different types of programmatic investments and identifying the most effective means for continuous improvement across the NSF portfolio.

Concluding Remarks

Mr. Chairman, I've touched on just a handful of programs found in NSF's diverse and vibrant portfolio. NSF's research and education activities support the nation's innovation enterprise. America's present and future strength, prosperity and global preeminence depend directly on fundamental research. This is not merely rhetoric; the scientific and economic record of the past 30 years is proof that an investment in R&D is an investment in a secure future.

NSF may not be the largest agency that funds science and engineering research, but our size serves to keep us nimble. Our portfolio is continually evolving as we identify and pursue new research at the frontiers of knowledge. An essential part of our mission is to constantly re-think old categories and traditional perspectives. This ability is more important than ever, as conventional boundaries constantly shift and disappear—boundaries between nations, between disciplines, between science and engineering, and between what is basic and what is applied. NSF, with its mandate to support all fields of science and engineering, is uniquely positioned to meet the needs of researchers exploring human knowledge at these interfaces, whether we're organizing interdisciplinary conferences, enabling cyber-sharing of data and information, or encouraging new collaborations and partnerships across disciplinary and national borders. No other government agency comes close to our flexibility in STEM education and basic research.

In today's high-tech economy, the supply of new jobs is inextricably linked to the health of the nation's innovation endeavor. NSF is involved in all aspects of innovation; NSF not only funds the discoveries that directly become the innovations of tomorrow, we also fund discoveries that lead to still more discoveries that lead to the innovations of tomorrow, and, perhaps most critically, we train the technologists who dream up the discoveries that lead to the discoveries and innovations of tomorrow.

Industry continues to rely upon government support for high-risk, high-reward basic research. It is no accident that our country's most productive and competitive industries are those that benefited the most from sustained Federal investments in R&D—including computers and communications, semiconductors, biotechnology, and aerospace.

As we look to the century ahead of us, we face the reality that the other nations in this world are eager to create jobs and robust economies for their citizens. In this context, "globalization" is shorthand for a complex, permanent, and challenging environment that calls for sustainable, long-term responses, not just short-term fixes.

Despite some of the more pessimistic forecasts of some observers, I believe that America can continue to be on the leading edge of ideas and research. Through strong Federal leadership, we can maintain the standing of our businesses and universities. We must not only maintain our position, we must actively seek to increase our strengths: leadership in fundamental discovery, including high-risk, high-reward transformational research, state-of-the-art facilities and infrastructure, and a world-class S&E workforce. With a firm commitment to these fundamental building blocks of our high-tech economy, we can solidify America's role as the world leader in innovation.

Mr. Chairman and members of the Committee, I hope that this brief overview has given you a taste of just how very important the National Science Foundation and its activities are to the future prosperity of the United States. I look forward to working with you in months ahead, and I am happy to answer any questions you may have.

BIOGRAPHY FOR ARDEN L. BEMENT, JR.



Arden L. Bement, Jr., was sworn in as the 12th Director of the National Science Foundation (NSF) on November 24, 2004. He had served as Acting Director since February 22, 2004.

Dr. Bement heads the only Federal agency that funds research and education in all fields of science and engineering. He directs a budget of more than \$6 billion; hundreds of programs that support roughly 200,000 scientists, engineers, educators, and students across the country; and the development of world-class facilities and infrastructure. He oversees a robust international research program in the polar regions and several international partnerships to build sophisticated research and experimental facilities.

Since the White House launch of the American Competitiveness Initiative in 2006, he has overseen numerous initiatives that strengthen the U.S. innovation base and economic position and intensify the training of the U.S. workforce to operate in a high-tech global economy. His top priorities have included increasing the size and duration of NSF funding awards; implementing electronic proposal and grant processing at NSF; developing cyberinfrastructure that advances research and education through expanded capabilities for networking, data processing and storage, modeling, and simulation; and broadening international collaborations to leverage NSF investments. He has expanded NSF's centers of excellence program to encompass dozens of science and engineering disciplines partnering with industries and educators.

He serves as a member of the U.S. National Commission for UNESCO and as the vice-chair of the Commission's Natural Sciences and Engineering Committee. He is a member of the U.S. National Academy of Engineering, a fellow of the American Academy of Arts and Sciences, and a fellow of the American Association for the Advancement of Science.

Dr. Bement is an *ex officio* member of the U.S. National Science Board, which guides NSF activities and serves as a policy advisory body to the President and Congress. He was a member of the NSB from 1989 to 1995.

Prior to his confirmation as NSF director in November 2004, Dr. Bement served as director of the National Institute of Standards and Technology of the Department of Commerce, a position he had held since Dec. 7, 2001. At NIST he oversaw an annual budget of about \$773 million and an on-site research and administrative staff of 3,000 employees, complemented by a NIST-sponsored network of 2,000 locally managed manufacturing and business specialists serving smaller manufacturers across the United States.

He joined NIST from Purdue University, where he was the David A. Ross Distinguished Professor of Nuclear Engineering and head of the School of Nuclear Engineering. He has held appointments at Purdue University in the schools of Nuclear

Engineering, Materials Engineering, and Electrical and Computer Engineering, as well as a courtesy appointment in the Krannert School of Management. He was director of the Midwest Superconductivity Consortium and the Consortium for the Intelligent Management of the Electrical Power Grid.

Dr. Bement joined the Purdue faculty in 1992 after a 39-year career in industry, government and academia. His positions included: vice president of technical resources and of science and technology for TRW Inc. (1980–92); deputy under secretary of defense for research and engineering (1979–80); director, Office of Materials Science, DARPA (1976–79); professor of nuclear materials, MIT (1970–76); manager, Fuels and Materials Department and the Metallurgy Research Department, Battelle Northwest Laboratories (1965–70); and senior research associate, General Electric Co. (1954–65). He has also been a director of Keithley Instruments Inc. and the Lord Corp. and a member of the Science and Technology Advisory Committee for the Howmet Corp., a division of ALCOA.

He has earned numerous awards and served in diverse government advisory roles, including: head of the NIST Visiting Committee on Advanced Technology; head of the advisory committee for NIST's Advanced Technology Program; member of the Board of Overseers for the Malcolm Baldrige National Quality Award; chair of the Commission for Engineering and Technical Studies and the National Materials Advisory Board of the National Research Council; and member of the Space Station Utilization Advisory Subcommittee and the Commercialization and Technology Advisory Committee for NASA. He has consulted for the Department of Energy's Argonne National Laboratory and the Idaho National Engineering and Environmental Laboratory.

Dr. Bement holds an engineer of metallurgy degree from the Colorado School of Mines, a master's degree in metallurgical engineering from the University of Idaho, a doctorate in metallurgical engineering from the University of Michigan, and honorary doctorates from Cleveland State University, Case Western Reserve University, and the Colorado School of Mines, as well as a Chinese Academy of Sciences Graduate School Honorary Professorship. He is a retired Lieutenant Colonel of the U.S. Army Corps of Engineers, and a recipient of the Distinguished Service Medal of the Department of Defense.

Chairman LIPINSKI. Thank you, Dr. Bement. Actually I was sitting here and looking at the two of you and then to my right and my left, and I noticed no one is going to be around. I was getting a little concerned, and Ms. Fudge came in and I felt a little bit better. Hopefully I will be here come next January. I am planning on it.

Dr. Beering, I recognize you.

**STATEMENT OF DR. STEVEN C. BEERING, CHAIRMAN,
NATIONAL SCIENCE BOARD**

Dr. BEERING. Thank you, Chairman Lipinski, Ranking Member Ehlers and Members of the Subcommittee. I appreciate the opportunity to testify. I am Steven Beering, Chairman of the National Science Board and President Emeritus of Purdue University. I am particularly pleased to be here with my valued colleague, Dr. Arden Bement, and I am honored to represent the members of the National Science Board before you today.

Congress established the National Science Board in 1950 and gave it dual responsibilities, first, to establish and oversee the policies for the National Science Foundation, and second, to serve as an advisory body to the President and Congress on national policy issues related to science, engineering research and education. We applaud your continuing support for NSF and your commitment to sustaining U.S. leadership in science and technology.

The United States has long been a leading center of science technology and innovation but we now face challenges to our leadership as a result of growing capacity in science and technology across the globe. Recent data in our biannual statistic report, *Science and En-*

gineering Indicators 2010, convey an important story. Many countries and economies have taken steps to open their markets to trade and foreign investment, develop their S&T [Science and Technology] infrastructures, stimulate industrial R&D, expand their higher education systems and build indigenous R&D capabilities. In short, they are developing strategic plans and policy framework for increasing science and technology capacity and they are investing in the infrastructure and workforce necessary to achieve their objectives. In particular, we are seeing that China and other Asian countries may pose an ever-greater future challenge to U.S. preeminence in terms of overall R&D investment and students and researchers involved in S&T activities. While the number of degrees granted does not provide information on the quality of the students obtaining them, in 2006 China awarded nearly as many doctoral degrees as the United States and may have since surpassed the United States.

Increased global R&D activity should by no means be viewed as negative, however. It leads to a dynamic global system of exchange of scientific knowledge and collaboration among the various researchers and provides opportunities to build shared international programs. However, this also means that the United States must continue to support robust investments in science and technology.

This year's budget request for science and technology agencies acknowledges the critical nature of S&T to America's long-term economic growth. Federal support for research and education across S&E [Science and Engineering] fields is of special importance in tight economic times when private firms are hesitant to invest in R&D projects whose economic benefits may not be immediate. The President's NSF [National Science Foundation] budget request of \$7.4 billion reflects a clear understanding that investments in S&T are not luxuries. Rather, they are critical investments to fund the research and innovation that will build our future.

Funding for NSF's Agency Operations and Award Management, the so-called AOAM account, continues to be a top priority for our Board. This account represents the majority of the funding devoted to agency operations. In fiscal year 2010, the President's request for an AOAM increase of 8.3 percent was reduced to only two percent. Robust human and physical infrastructure and management are critical to support NSF's gold standard merit review process. The Board urges your full support for this year's request for the AOAM account.

The Board has recently identified priorities over the next 12 to 24 months. They are grantee data policies at NSF, mid-scale research efforts, and revisiting the NSF merit review criteria. Each of these studies will examine issues of high importance to NSF, and the Board intends to provide its substantive guidance at the conclusion of each study. Brief summaries of these topics are provided in my written testimony.

In conclusion, the Board urges that the Congress fund in full the President's budget request for the National Science Foundation. As our Nation recovers from economic recession, investment in S&E research and education are ever more critical to laying the long-term foundation for S&T-based innovation that drives the creation

of new jobs and industries. The economic growth and the quality of life that we enjoyed in the 20th century were made possible in large part by scientific discoveries and technologic innovations. Continued economic prosperity and improvements in the American quality of life will require continued and indeed enhanced Federal commitment to investing in S&E research and education.

Mr. Chairman, after nearly eight years on the Board and serving for the last four years as Chairman, my term is about to end in May. On behalf of the National Science Board and the S&E research and education communities, I want to thank you, the Members of the Subcommittee, for your long-term support for the National Science Foundation. Thank you.

[The prepared statement of Dr. Beering follows:]

PREPARED STATEMENT OF STEVEN C. BEERING

Chairman Lipinski, Ranking Member Ehlers, and Members of the Subcommittee, I appreciate the opportunity to testify before you today. I am Steven Beering, Chairman of the National Science Board and President Emeritus of Purdue University.

National Science Board

I am honored to represent the members of the National Science Board before you today. Congress established the National Science Board in 1950 and gave it dual responsibilities:

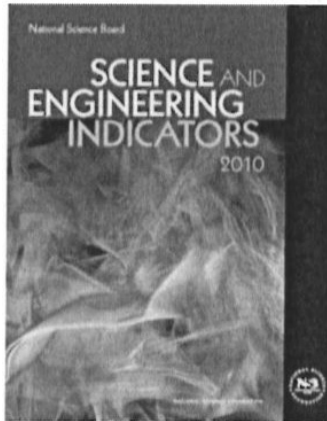
- Oversee the activities of, and establish the policies for, the National Science Foundation (NSF)
- Serve as an advisory body to the President and Congress on national policy issues related to science and engineering (S&E) research and education.

The National Science Foundation is the primary source of funding for academic basic research across non-biomedical science and engineering disciplines. NSF funds cutting-edge research at the frontiers of knowledge, and also supports scientific facilities and activities in science, technology, engineering, mathematics (STEM) education. We applaud your continuing support for NSF and your commitment to sustaining U.S. leadership in science and technology.

Concerns for American Science Leadership from Science and Engineering Indicators 2010

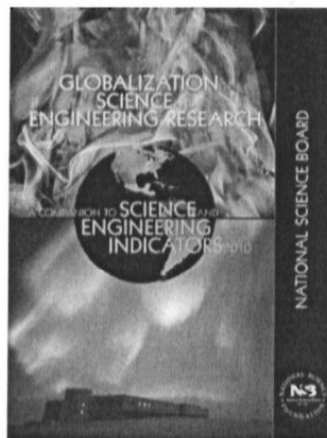
The United States has long been a leading center of science, technology, and innovation, but we now face challenges as a result of growing capacity in science and technology (S&T) across the globe. Economists increasingly emphasize the central role of knowledge, particularly R&D and other activities to promote science and technology, in a country's economic success.¹ But as recent indicators show us, in our biennial statistical report, *Science and Engineering Indicators 2010* (SEI 2010), many countries and economies have taken steps to open their markets to trade and foreign investment, develop or recast their S&T infrastructures, stimulate industrial research and development (R&D), expand their higher education systems, and build indigenous R&D capabilities. In short, they are developing strategic plans and policy frameworks for increasing S&T capacity, and investing in the requisite infrastructure and workforce to achieve their objectives. And while the EU and Japan continue to be major players in S&T, China and other developing nations are rapidly building S&T capacity.

¹National Science Board (NSB). 2010. *Science and Engineering Indicators 2010* (NSB-10-01), p. 6-7.



While the United States continues to be by far the largest R&D-performing country in terms of absolute dollar investment, China and other Asian nations are rapidly increasing their R&D investments. Between 1996 and 2007, China increased its R&D expenditures at a 20 percent annual growth rate from a substantially lower base, while the United States and other mature S&T countries averaged about a 5 to six percent annual growth rate from a higher base. As a result, relative regional investments in R&D changed markedly: the North American region's (United States, Canada, and Mexico) share of estimated world R&D activity decreased from 40 to 35 percent; the European Union's share decreased from 31 to 28 percent. These declines in global R&D share reflect the Asia/Pacific region's increase from 24 to 31 percent, with most of that increase contributed by countries other than Japan.

China and other Asian countries also pose a challenge to U.S. preeminence in terms of students and researchers involved in S&T activities. On both indicators, China's absolute numbers have increased in recent years. As SEI 2010 points out, the number of S&E doctorates awarded in China rose from about 1,900 in 1993 to almost 23,000 in 2006, more than a 12-fold increase. While the number of degrees granted does not provide information on the quality of the students, in 2006 China awarded nearly as many doctoral degrees as the United States, and may have since surpassed the United States.²



²NSB, p. 2-35.

Between 1995 and 2007, the number of researchers in China more than doubled from about 0.5 million to more than 1.4 million, an increase in world percentage from 13 to 25 percent. In comparison, the number of researchers in the United States and the EU grew by an annual rate of about three percent over the same time period. China's publication volume increased by about 14 percent annually over the period 1995 to 2008, moving it into 2nd place behind the United States, up from 14th place in 1995.³

Increased global R&D activity should by no means be viewed as negative. It leads to a dynamic global system of exchange of scientific knowledge and collaboration among diverse researchers, and provides opportunities to build shared international facilities. However, the United States must view increased global capacity in S&T as a call to sustained action to continue robust investments in science and technology.

FY 2011 Budget Request

This year's budget request for science and technology agencies acknowledges the critical nature of science and technology to America's long-term economic growth. Federal support for research and education across science and engineering fields is of special importance in tight economic times, when private firms are hesitant to invest in R&D projects whose economic benefits may not be immediate. Funding the National Science Foundation at the FY 2011 budget request level is essential to our nation's continued prowess in S&T-based innovation, economic prosperity, and high quality of life.

The President's NSF budget request of \$7.4 billion reflects the clear understanding that investments in science and technology are not luxuries but rather critical investments to fund the research and innovation that will build America's future. If approved, this 6.9 percent increase in real terms, 8.0 percent in current dollars, above the 2010 funding level, would put NSF on track to double its budget in ten years, as part of the President's Plan for Science and Innovation and roughly consistent with the *America COMPETES Act*.

The request for the National Science Board is \$4.84 million, an increase of \$300,000, or 6.6 percent, over the FY 2010 budget of \$4.54 million. This increase will allow the Board to continue to strengthen its role in policy for NSF and in advising the President and Congress on significant national policy issues in science and engineering and education in science and engineering.

Funding for NSF's Agency Operations and Award Management (AOAM) account continues to be a top priority for the Board. This account represents the majority of the funding devoted to agency operations. In FY 2010, the President's budget request for NSF for an ADAM increase of 8.3% was reduced to only 2%. For NSF to continue to serve our nation, we must have adequate human and physical infrastructure and management. The quality of the merit review process greatly depends upon NSF having staff with the necessary expertise, within and across disciplines, to select and recruit superior reviewers and panelists. To sustain excellence in merit review, the Board urges full support of the request for the ADAM account.

Now, I wish to address several topics raised by Chairman Lipinski.

National Science Board Priorities

The Board has recently identified priority areas to explore over the next 12 to 24 months: grantee data policies at NSF, multi-investigator and multi-scale research efforts supported by NSF, and revisiting the NSF merit review criteria. Each of these studies will examine issues of high importance to NSF, and the Board intends to provide substantive guidance to the agency at the conclusion of each study. Below are brief summaries of the topics.

1. Data Policies

Increasing ease of gathering massive amounts of data and of use of large-scale collaborative projects has made it a priority to consider NSF data policies. The Board will examine how NSF data policies govern how data collected in NSF-supported projects should be managed and shared, to ensure broad, timely, and long-term data availability and accessibility. The Board's study will build upon its 2005 report, *Long-Lived Digital Data Collections: Enabling Research and Education in the 21st Century* (NSB-05-40). Although the initial focus of the study will be NSF's data policies, the Board hopes to use this study to engender a discussion of the topic in a broader Federal context.

³NSB, p. 5-5.

Several policy questions will be considered, including:

- How can NSF most effectively develop cyberinfrastructure that supports the data acquisition, accessibility, manipulation, and storage needs of the broad scientific community, particularly at NSF funded large facilities and distributed networks that generate extremely large amounts of raw data?
- Is there a way to capitalize on cyberinfrastructure investments made and lessons learned among multiple NSF facilities facing similar data issues?
- What role, if any, should NSF play in managing and ensuring the long-term availability and accessibility of data—particularly digital data?
- How should data collected with NSF funding be managed and shared to ensure openness?

2. Multi-Investigator and Mid-Scale Research

NSF utilizes a variety of mechanisms to facilitate research at the frontiers of knowledge (e.g. cooperative agreements, centers, programs linking industry and academia, and MREFC projects). In light of the ever-increasing size and complexity of research projects, the Board plans to examine the adequacy of its support frameworks for mid-scale, multi-investigator research. Research projects that cost approximately \$10 to \$100 million (larger than average awards, but smaller than MREFC projects), and are conducted by multiple investigators and sometimes encompass multiple disciplines, are the subject of this study.

In broad terms, the Board plans to examine NSF's current efforts in supporting mid-scale research activities, and explore the best means for doing so in the future.

3. Merit Review Criteria

All NSF proposals are evaluated with respect to two equally important merit review criteria—intellectual merit and broader impacts. These merit review criteria were established in 1997 to replace a four-criteria system, in which reviewers evaluated researcher performance competence, intrinsic merit of the research, utility or relevance of the research, and effect on the infrastructure of science and engineering.

The Board last reviewed the NSF merit review in the mid-2000s, at the request of Congress. The Board issued a report in September 2005, concluding that the NSF merit review process is fair and effective, and “remains an international ‘gold standard’ for review of science and engineering research proposals.”

The Board intends to reevaluate the two current merit review criteria and decide whether to retain the current criteria or to consider some degree of enhancement. As part of this reevaluation, the Board intends to examine, among other issues, whether enhancements could be made to clarify the meaning and appropriate responses concerning “transformative research” for the first criterion, and “broadening participation” for the second criterion.

NSF Investment in Research Infrastructure

In addition to its examination of NSF multi-investigator and mid-scale research, the Board has created a new subcommittee to focus on facilities. Recognizing the need to address the issue of strategic facility planning across NSF, the Board last year established the Subcommittee on Facilities (SCF) under its Committee on Strategy and Budget (CSB), with responsibility for providing guidance on strategic planning for the entire NSF research equipment and facilities portfolio. SCF activities include undertaking an annual review of the portfolio of all NSF-funded research facilities (including facilities funded under Research and Related Activities account). This annual review will allow SCF to provide to CSB and the Board a clear assessment of the impact that specific projects and the overall facilities portfolio will have on long-term budget planning at NSF, and recommend to CSB and the Board guidance to be provided to NSF management on the prioritization of all projects that have completed a Conceptual Design Review (CDR) and are being considered for further funding to develop Preliminary Designs. This committee is established under the auspices of CSB to allow for full discussion of NSF's research infrastructure investments relative to the agency's other types of research investments. Its intent is to maintain Board focus on all phases of facilities—design, development, construction, operations, and decommissioning.

The MREFC account supports the acquisition, construction, and commissioning of major research facilities to provide unique capabilities at the forefront of science and engineering research. There are several distinct phases in the NSF process for conceptualizing, planning, and constructing MREFCs: conceptual design stage, prelimi-

nary design (Readiness) stage, and final design stage. The Board is involved in the process at two key critical design points—following preliminary design review (PDR) and final design review. The Board is exploring with NSF how the Board may best be involved in selecting projects that advance towards the Readiness stage.

During the Readiness stage, a Preliminary Design is developed and vetted through a formal PDR by the MREFC panel (composed of all NSF Assistant Directors, Office Heads, and the Deputy Director) and outside experts. The Preliminary Design is generally used as the baseline project definition when requesting Congressional appropriation of construction funds. If the PDR judges the preliminary design to be of high scientific merit and construction readiness, the MREFC panel recommends to the Director that the Board consider advancing the project to the Proposed New Starts category of facilities for inclusion in a future President's budget request. The Board votes up-down to advance the project to the Final Design Stage.

During the Final Design Stage, the project continues its pre-construction planning, and NSF conducts annual cost review updates, with results reported to the Board. A Final Design Review (FDR) is conducted to ensure that the project is aligned with the appropriated budget, if such budget is successfully attained through the Congressional appropriation process. The FDR also considers whether the underlying assumptions about the project continue to be valid, and whether the project is fully ready to undertake construction activity. Following the FDR, the Board is asked to approve the obligation of MREFC funds (if Congress has appropriated funding for the project) to begin construction.

Facility operating costs are considered in the context of deciding whether to undertake construction of a new facility under the MREFC account. Projects are repeatedly assessed throughout the planning and construction period to ensure accurate awareness of projected operating costs. Beginning with the NSF FY 2009 budget request, the NSF Director instituted a no cost overrun policy requiring that the project cost estimate at PDR include adequate contingency to cover all foreseeable risks, and that any cost increases not covered by contingency be accommodated by scope reduction. Since implementing the policy for new facilities, NSF has been successful at staying within cost and schedule plans.

Reauthorization of America COMPETES Act

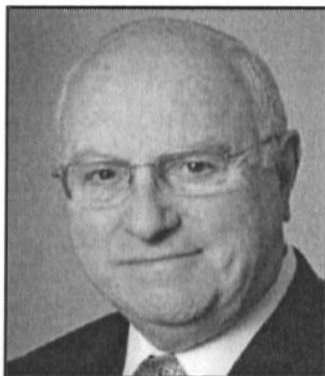
The Board has several operational issues related to staffing, ensuring timely information for S&E Indicators, and in defining a quorum for gatherings outside of plenary sessions. Ongoing discussions with Subcommittee staff should help resolve these important issues.

Closing Remarks

The Board urges that Congress fund in full the President's budget request for the National Science Foundation. As our nation recovers from economic recession, investments in science and engineering research and education are ever more critical to laying the long-term foundation for S&T-based innovation that drives the creation of new jobs and industries. The economic growth and the quality of life that we enjoyed in the 20th century were made possible in large part by scientific discoveries and technological innovations. Continued economic prosperity and improvements in the American quality of life will require a continued, and indeed enhanced, Federal commitment to investing in science and engineering research and education.

Mr. Chairman, after seven years on the Board and serving for the last four years as Chairman, my term is about to end in May. On behalf of the National Science Board and the S&E research and education communities, I would like to thank the Members of the Subcommittee for your long-term recognition of and commitment to support for the National Science foundation.

BIOGRAPHY FOR STEVEN C. BEERING



Steven C. Beering received B.S. and M.D. degrees and an honorary Doctor of Science degree from the University of Pittsburgh. Before becoming President of Purdue in 1983, he served for a decade as Dean of Medicine and Director of the Indiana University Medical Center. He holds appointments as professor of medicine at Indiana University and professor of pharmacology at Purdue University. He retired from the Purdue presidency in 2000.

He served on active duty with the USAF Medical Corps from May 1957 to June 1969, achieving the rank of lieutenant colonel.

Beering has held numerous national offices, including the chairmanship of the Association of American Medical Colleges and the Association of American Universities. He is a former regent of the National Library of Medicine.

He is also a Fellow of the American College of Physicians and the Royal Society of Medicine, a member of Phi Beta Kappa, the Institute of Medicine of the National Academy of Sciences, and the Indiana Academy.

He serves on a number of national and corporate boards, including NiSource Inc., Central Indiana Corporate Partnership, Inc., Community Foundation of Northern Indiana, and Marquis Who's Who. He is a Trustee of the University of Pittsburgh, and the Universities Research Association, and is Director Emeritus of the Purdue Research Foundation.

Beering was appointed to the National Science Board in 2002, reappointed in 2004, and elected Chairman in 2006.

Chairman LIPINSKI. Thank you, Dr. Beering, and at this point we are going to begin our first round of questions, and the Chair will begin by recognizing Dr. Baird.

Mr. BAIRD. Thank you, Mr. Chairman. I want to echo the sentiments of the Chairman in thanking both of these distinguished public servants for their many years of service in their prior positions and their extensive contributions to science. We are grateful, and you have made a real difference, and personally speaking, it has been a real privilege to get to know you and to work with you, and for that matter, with the entire board and the staff of NSF. One of the difficult things, I am sure, for Dr. Ehlers and me as we contemplate our own departure from this institution, is leaving this committee that we are so passionate about, and we will look forward to working with you in some capacity in the future.

Dr. BEMENT. Thank you very much.

Mr. BAIRD. I will make a commercial announcement to my colleagues. Last night I had the privilege of going to the 3D Hubble film, the world premiere of this at the Air and Space Museum, and if you have not seen this, because it just premiered last night,

make it a point to do this. If you want to feel great about American science and technology and engineering and just can-do spirit, that film is a must-see. And I commend both of you and the Administration for recognizing through this budget the importance of funding our scientific endeavors adequately.

I want to ask a little bit about your thoughts on—as you know, I was very active and continue to be so on the issue of global science, and talk to us a little bit about how you see this budget and various programs within it fitting into efforts for science diplomacy. Dr. Beering, you mentioned a little bit about the importance of international exchange of ideas. Share with us how this budget and your plans for the future for the agency reflect science diplomacy issues.

Dr. BEMENT. Yes. Thank you, Mr. Baird. The intention in bringing the Office of International Science and Engineering up to the Director's office was to make it more strategic in position for budget growth. I am proud to say that over the six years I have been in the Foundation, the budget has grown quite substantially compared with the average growth of the agency as a whole. We have introduced new programs. The PIRE program, which goes beyond the investigator-to-investigator collaboration to institution-to-institution collaboration, that has been a huge success. Our success rate is still too low so we need to bring up the funding over time. Nevertheless, the transformative research that is being done under these international collaborations is critically important, and it keeps us abreast of not only where scientists abroad see the frontier, but also in developing new synergies to do not only interdisciplinary research but also research that can really make a major difference.

The other initiative that—a couple other initiatives. One is, we have developed a relationship with USAID [U.S. Agency for International Development]. As you know, we are a domestic agency so we don't fund research projects abroad, but in the developing world, there is a need to provide some assistance so that their research can match our research as we fund our part of the research initiative. We are working closely with USAID. We have found some projects that fit their interest that will allow us to move forward. We hope that the numbers will continue to increase over time. In the President's Muslim Majority Initiative, we have allocated \$2.5 million to provide support for summer institutes, for exchanges of post-docs, graduate students and so forth in order to improve the engagement in those countries around the world.

So those are some new steps that we are taking, and as I look forward to the future, I see that NSF's leadership and international engagement will only increase.

Mr. BAIRD. Dr. Beering, did you wish to comment on that at all?

Dr. BEERING. Some while ago, I had a chance to be in Europe and attend an anniversary celebration of the European Union, and the Secretary General wanted to reassure me that he was not interested in our dollars, but what he was interested in, they were all sharing in that sentiment as I discovered over the ensuing days, was a partnership of ideas and a partnership of effort, and I believe they are quite sincere in that and I believe that our new project emphasis is going to help that.

Mr. BAIRD. Dr. Bement, thank you. Did you want to—

Dr. BEMENT. I can add a footnote. We have also sought cooperation and partnerships with private funding agencies—not agencies but organizations like the Gates organization, and we have together with the Gates Foundation, the Bill and Melinda Gates Foundation, established a new initiative called the BREAD initiative [Basic Research to Enable Agricultural Development], which is basic research in agriculture in the developing world, primarily to focus on small holder agriculture to make it economically viable in those parts of the world. This is the kind of relationship, similar to USAID, where the National Science Foundation will pay for the U.S. scientists and the Bill and Melinda Gates Foundation will pay for the in-country scientists to enable the collaborative work to proceed.

Mr. BAIRD. That is a great partnership. Thank you very much. Thanks, Mr. Chairman.

Chairman LIPINSKI. The Chair will now recognize Dr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman, and I join in expressing my appreciation to both of you for your long and good service for the Federal Government, and I never realized before how making boiler-makers could develop such wide-ranging skills.

Dr. BEMENT. It is more of a drink than a skill.

Mr. EHLERS. Well, I wouldn't know anything about that. My only vice is tea.

Just following up on the comments made by Dr. Baird, a quick question. When I came here a long time ago, I was surprised at the lack of scientific interest in the Department of State and the lack of scientific aides there, and managed to correct that through the *Unlocking the Future Report* so we have had some good people there since. On the international issues and the diplomatic part, do you think that the Department of State at this point is fulfilling what should be done, or should they increase their staff or their funding for their effort to take your ideas, the NSF ideas and make things run more smoothly?

Dr. BEMENT. First of all, I think that State has done a very good job in trying to become better connected with the scientific community at large, and also to employ scientists in their programs in science diplomacy. The first step was establishing a Science Advisor to the Secretary. That has been a very powerful position, not only in developing a network to the scientific community, but also in establishing programs like the Jefferson Fellows that bring top talent from U.S. universities to work in the State Department in very important roles all around the world. Those scholars are very well regarded and they do very important work, and we see some of that work through our own offices in Beijing, Tokyo and Paris, and we have been able to establish a relationship to that network. I think it is also represented in the quality of some of the people they are bringing in to key posts, some political positions that have scientific backgrounds. So I think over time it is going to be an increasing recognition of the importance of science diplomacy, not science directed by diplomacy but diplomacy opportunities resulting from science.

Mr. EHLERS. Thank you. I am glad to hear that optimistic report.

Getting back to the point I made during my opening comments about the Administration's \$3.7 billion dollar historic commitment,

as the President labeled it, in K–12 STEM education, I certainly welcome this effort but my concern is, what role will NSF be playing in this? Were you contacted? Were you in discussions with the Office of Management and Budget on this and on the allocation? What have you done up to this point and what has Secretary Duncan done up to this point to develop a good working relationship to try to make sure that we have two departments—I am sorry, an agency and a department working in complete concert to achieve their goals?

Dr. BEMENT. Well, I would like to say to start with that I think we have gotten rid of all the old tapes. I just hope that that will be better recognized. Having top officials from the Chicago School District that has so well represented NSF programs in their transformation gives us an opportunity to talk real terms about the role of research and the NSF program as we seek continued partnership with the Department of Education so that Secretary Duncan, Administrator Easton and others are very close partners with the NSF at the present time and we are seeking new ways to collaborate. We have new programs, for example, IES, the Institute of Education Sciences, and are carrying out joint assessments of teacher proficiency, and teacher proficiency in math, and also teacher proficiency in STEM across the board including science. There are other initiatives that we are thinking about doing jointly including continuing the close working relationship we have had with the MSP [Math and Science Partnership] program, or in the case of education, Department of Education, their new program based on the Math and Science Partnership program.

There are three priorities that the Administration has delineated for the National Science Foundation. One is to prepare the STEM workforce, which is very broad. That includes broadening participation. The second is increasing the number of graduate fellows to triple the number of new fellowships by 2013. And the third is to expand evaluation activities to build capacity tools and methods. So in the 2011 budget, the two programs that we especially wanted to pay attention to are the ones that are research-intensive, namely the Math and Science Partnership program and also the Discovery Research K–12 program. Now, you will recognize that in the Recovery Act bill, there was \$85 million that was allocated for the Noyce program and the Math and Science Partnership program. If you take into account that the base for K–12 investment through the Foundation which includes both the EHR component and the R&RA component, I think conservatively would be about \$250 million across the board. Even though we only report about \$57 million, it is considerably greater. If you take the \$85 million invested through the Recovery Act, most of which are in—all of which are in standard grants and will spend out over the next three to five years, against that \$250 million base, that represents a 35 percent increase. If you take the average of four years, that would represent about an 8.5 percent increase per year in K–12 education across the board. We felt it was prudent, recognizing that we also have to plan for renewals, that in 2011 we would have to hold back a little bit or pause a little bit, and then prepare to grow in the outyears. So we feel that K–12 education is robust. We are putting much more focus on research. That will be through program re-

alignment. It will also be through staffing. We feel that that is not only the long suit of the National Science Foundation but the most important role that we can play in trying to upgrade K-12 education both in math and in science.

Mr. EHLERS. Well, I hope our successors can continue that string. I just want to make sure that the money is allocated fairly, in this case \$1 billion for STEM education. I want to make sure it is allocated properly between the NSF and the Department of Education.

Dr. BEMENT. I appreciate that very much.

Mr. EHLERS. Thank you. Yield back.

Chairman LIPINSKI. Thank you, Dr. Ehlers.

The Chair now recognizes Ms. Fudge.

Ms. FUDGE. Thank you, Mr. Chairman.

I thank both of you for your service and thank you for being here today. I have really two questions.

The first one, Dr. Bement, how do you reconcile the Administration's commitment to improving STEM education when the majority of programs in the Education and Human Resources directorate will be flat funded or even decreased and the directorate overall will receive only a 2.2 percent increase in fiscal year 2011? Of particular interest to this committee, which you have just briefly touched on, the Noyce teacher scholarship program and the Math and Science Partnerships program that we expanded in the 2007 COMPETES Act. Both of these programs have demonstrated success. Shouldn't we be pouring as much money as we can into sure bets such as these two programs?

Dr. BEMENT. Well, again, I refer back to the impact that the Recovery Act has had on that program, both the Noyce and the Math and Science Partnership program. There was an enrichment or an infusion of significant funding to really increase the number of awards in those two programs, and we will continue to use that as the flagship to grow those programs as the NSF budget continues to increase. So I think we are very well positioned in both Math and Science Partnership and the Noyce program looking out over the next two or three years. We have got any number of awards already in place as a result of the Recovery Act that will boost the outcomes from those investments.

Ms. FUDGE. Okay, but we know the Recovery Act is only going to last so long, so—

Dr. BEMENT. Well, as I say, we made standard grants that will spend out over three to five years, so it is not just a short-term investment, it is a long-term investment. So as we continue to grow our budget overall, we will continue to boost those programs, but for one or two years we are sort of holding back a little bit so that we can meet the renewal commitments and obligations of the awards we have already made.

Ms. FUDGE. Thank you. My next question: the Department of Education's Office of Educational Technology recently released the report "*Transforming American Education: Learning Powered by Technology*." In the report released on Friday, the National Educational Technology Plan Working Group draws guidance from a 2008 report from NSF's Task Force on Cyberlearning and makes several policy recommendations for the Department of Education, some of which include collaboration with the National Science

Foundation. I see that NSF is proposing to establish the Cyberlearning Transforming Education [CTE] program, funded at \$41 million. How do you see this program cooperating with and supporting efforts at the Department of Education and who will be responsible for the assessments and/or evaluation of these programs?

Dr. BEMENT. First of all, Cyberlearning Transforming Education is highly responsive to the report you made reference to and it is an exciting area that we feel has a lot of opportunity in upgrading education. But it is a multi-level investment. It is not just K-12, it is also undergraduate education, graduate education and even post-doc education. With regard to K-12 and undergraduate education, we have already a close working relationship with the Department of Education, and as I indicated, through the Institute of Education Sciences, we have joint initiatives underway to do assessments of teacher proficiency both in math and science, and included in that, when the CTE program comes into effect, will be the evaluation of the effectiveness of that education as well. One thing that we feel has to be paid attention to is not just the research but the scaling of the outcomes of the research. In other words, how do you build a brushfire? How do you take the results from a few districts and extend them throughout the country? We can only do the scaling and the transferring of those best practices through close cooperation with the Department of Education and states, because of the 15,000 school districts in the country, we can touch about 250. And we can develop the best practices and do the research but we have to reach the other 15,000 school districts, and that is where partnerships with both the Department of Education and the state departments of education are vitally important.

Ms. FUDGE. Thank you, Mr. Chairman.

Chairman LIPINSKI. Thank you, Ms. Fudge.

The Chair now recognizes Mr. Inglis.

Mr. INGLIS. Thank you, Mr. Chairman, and Dr. Bement, thank you for your work at NSF. We are grateful for the years of service you have had there, and I understand this is perhaps your last hearing with us so we are—

Dr. BEMENT. I fear that may be the case. I don't hope that that is the case.

Mr. INGLIS. Well, we very much appreciate your work, and perhaps on the way out you can give us some advice. You know, at NSF, it is scientific endeavors that you are all about there, ongoing and constant. In politics, things come and go, you know, and we were all jazzed up about gas at \$4 a gallon. Now you can't find a story about gas at \$4 a gallon. But I think it is pretty clear that as soon as the recovery takes off, given the inelastic supply curve, we are going to jump on the price again as the demand rises and we will be squawking once again about energy prices.

Do you have any suggestions for us about how to maintain a steady and persistent drive to energy independence and how it would be that we should be funding scientific endeavors in that way?

Dr. BEMENT. Well, I would like to comment on your point, and that is, the reality that we have to cope with in society is variability around the mean, and it is a question of what the periodicity

is of that variability, whether it is in terms of a couple years or whether it is a decade or whether it is longer than a decade, and energy, carbon-based fuel availability, whether it is natural gas, oil, depends on the finding rate as well as the consumption rate and there will be variability around the mean. Same thing in climate change. We had a cold winter so everyone feels that climate change has gone away. Well, they don't remember that about four years ago in Europe they had a heat spell that killed about 2,000 people. So, you know, those are variable.

But you have to pay attention to the mean. The only way you can really address that is to understand it better and develop new knowledge about what is really driving change, what the forcing functions are, so to speak. It also is important that you develop new options, because if you are limited in the number of options, then you are going to have to pay the consequence of having to live with change as it occurs. Now, that is one of the roles that the National Science Foundation can play through our SEES [Science, Engineering and Education for Sustainability] initiative and other initiatives that we are working on to work at a higher level of complexity, higher level of modeling, and rather than looking at change in a century, trying to understand change over a decade. But rather than looking at change on a global basis, look at change on a regional basis. That will take more computation. It will take more research. It will take better understanding of complexity. It will have to require the understanding of all the interrelationships involved, and they are very complex interrelationships. But the greatest benefit, I think, to society is, again, to offer up more technological options that one can choose from, from a public policy point of view.

Mr. INGLIS. And sort of related to that, science has taken a big hit recently on the pages of a lot of newspapers with the "Climategate" e-mails. Any comments about how to restore the credibility of science and to help people understand that, suppose there are quacks, for example, in the cancer field but if you get diagnosed today with cancer, perhaps you want to go see somebody in the field. You don't want to abandon the field. How do we persuade people that, really, scientific processes still work and that we have integrity there?

Dr. BEMENT. I think with the issues that we are talking about which are highly complex, there is still not yet complete science convergence or consensus on some of the aspects of that change. So we have almost too much ambiguity or perhaps too much objectivity, if you will, in the data that currently exist. I think in that kind of scenario, where you are dealing with very complex issues, for scientists to take an advocacy position and take a piece of the science in order to support their advocacy position does not do service to not only the community of science but the public at large. I think being an honest broker and looking at all the options and objectively presenting the options is a much better course of action, and I think we have seen some of the consequences of being an advocate for a particular scientific position.

Mr. INGLIS. Thank you, Dr. Bement, and thank you for your service. We really are very appreciative.

Dr. BEMENT. Thank you, Representative Inglis. It has been fun working with you.

Mr. INGLIS. Thanks.

Chairman LIPINSKI. Thank you, Mr. Inglis.

The Chair now recognizes Mr. Carnahan.

Mr. CARNAHAN. Thank you, Mr. Chairman, and welcome to you both. I appreciate your service. I appreciate what you have done to promote science in this country and appreciate also the work that Chairman Baird has done on a group looking at ways how we can improve what we do with science diplomacy. I think it is very important for us moving forward in terms of building our international relations.

But the question I wanted to ask you today had to do with the proposed consolidation plans for broadening participation in terms of the consolidated approach versus the portfolio approach, in terms of reaching out to different undergraduate groups of the individual programs that have been out there for Historically Black Colleges, the Stokes Minority Participation program, tribal colleges, Hispanic-Serving Institutions. Can you describe in more detail how you believe consolidating those under a program is going to help build capacity and add value, because, absolutely, I believe it is critical that we build that capacity.

Dr. BEMENT. Yes. Thank you, Mr. Carnahan. The goal of the program is really twofold. One is to capitalize on what has been learned from the currently targeted programs in broadening participation, but also to position the program for growth, and the reason that is so critical is that time is not favorable. By 2020, minorities will represent 39 percent of the population so they will represent a very large base for developing STEM talent for the Nation, which by 2050 will be a majority of minorities. So we have to find ways to accelerate. Linear growth is no longer acceptable. We have to have positive feedback and we have got to go into geometric growth. There has got to be acceleration.

So what prompted our movement to this approach is what we have learned over the last two years in having listening sessions with the Hispanic community, and what we discovered that was uppermost on their mind was, first of all, they needed more faculty development. They needed more support for students. They especially needed summer academies for students to ease the transition from high school to college, especially in math proficiency. As we listened to these challenges, what we discovered is, they are very much the same challenges that are being faced by Historically Black Colleges and Universities and also Tribal Colleges and Universities. So there was an opportunity to rethink how we approach this problem and to ask the question, are there advantages to be gained rather than looking at these, as you say, as a portfolio of institutions. And looking at it from the standpoint of, first of all, how you can share knowledge, how you can network knowledge, how you can develop the different kind of alliances, and also how you can leverage the program, both financially, intellectually and geographically.

The opportunities for financial leveraging within the Foundation are quite substantial. In EHR [Education and Human Resources] alone, only 29 percent of the active awards to these three types of

institutions come from the HBCU [Historically Black Colleges and Universities] and LSAMP [Louis Stokes Alliances for Minority Participation] programs. The majority of the awards come from a broad array of EHR programs. Also, if you look across the Foundation, the percentage of funding that goes to minority institutions from these programs is only 36 percent of the total. The other 64¹ percent comes from other parts of the Foundation, including elsewhere within EHR as well as within the R&RA [Research & Related Activities] account. But then if you had a consolidated program, one would have to look at the leveraging opportunities with other agencies, with the private sector, with private foundations, with national laboratories, with other entities who would see this in a much more holistic light and would see the advantages of participating and supporting the program. So in positioning the program for growth, future growth and also with regard to getting the benefits of leveraging, we felt that a consolidated approach is far better than a fragmented approach. One could go on and talk about administrative costs, administration cost and efficiency of operation, but that is not the primary driving force.

We would like to propose, and this is in our planning at the present time—and since this is our development year, I am only supposed to talk conceptually. I can't really get into a large amount of detail at this point. But broadly speaking, we see four tracks in this program going forward. The first track we would call the Louis Stokes Model Alliances track, which is patterned after the LSAMP program. It would include intramural networks in collaborations for information-sharing, program assessment, and development of instructional materials and curricula involving community colleges, tribal colleges, early-stage STEM programs that could benefit from institutions that have well-developed STEM programs, including majority institutions that also graduate substantial numbers of minority students in STEM. We envisage here that both MSIs and majority institutions could be the lead institution but we would use a collaborative grant approach so that we could put more money in the hands of the minority-serving institutions. In other words, grants would go to all institutions in the alliance, which is a departure from the way the programs work today. So in the case of MSIs, we would encourage MSIs to serve as lead institutions, but in the case of a non-MSI in a leadership position, we would require that at least two partners be MSIs as part of the alliance.

The second track is transformational initiatives. This is focused primarily on capacity building to integrate education with research and other forms of activity-based learning in order to stimulate recruitment, retention, graduation success and to lower barriers at the various transition points. This would be also research-intensive. We would again expect that MSIs would be in a leadership position, or if not MSIs, institutions again with a proven track record of improving underrepresented minorities in STEM participation.

The third track recognizes that there are cultural and contextual differences among different kinds of institutions, not only in terms of minority populations but also in terms of the type of institution,

¹Originally stated incorrectly by Dr. Bement as 77 percent.

whether it is research or whether it is education only or whether it is a two-year university or whether it is a university that is incorporating indigenous knowledge with education, which is the case for many institutions. This track would focus on targeted initiatives in order to focus on those differences and also as a result develop strategies for continuous improvement for early-stage STEM program development and also growth at minority-serving two-year and four-year undergraduate colleges.

The fourth track would be research. That would complement as well as supplement the other three tracks and it would focus in on overcoming specific barriers, such as math preparation or other areas that again are at the transition points, but it would also deal with grand challenges in broadening participation itself. In other words, what more can be done in order to leverage geographically and so forth. For example, the EPSCoR states have a significant number of minority-serving institutions. Are there strategic ways in which we could partner with the EPSCoR program in order to get further leverage in those states for building capacity and also providing connectivity of broadband and other needs that are necessary and essentially essential for education these days.

So the only final points I would like to make is, first of all, we do understand in this program that there is a wide span of institutional types and we have to accommodate all these institutional types. We recognize that we need more development before this program can be launched, and we want to do this in a very transparent way, because we are seeking further suggestions and ideas from the communities at large. Furthermore, during the transition, recognizing that we have existing grants and some of those may be renewed, we see transitioning this program over a period of three to five years, so it is not a 'step' function, it is a 'ramp' function.

And finally, we recognize that there are cultural and contextual differences that will have to be explored in the program, and in some cases, use them as opportunities. It is a two-way street. Many majority institutions can benefit from the mentoring experiences and the counseling experiences and the student support experiences that occur at Hispanic-Serving Institutions and Historically Black universities and colleges, and we want to be able to share that. So that is basically the outline of what we have in mind.

Mr. CARNAHAN. Thank you, and Mr. Chairman, if I could just ask unanimous consent to ask him a 30-second question? I know that was a long answer, but just one point that—

Chairman LIPINSKI. Go ahead.

Mr. CARNAHAN. Thank you.

Just real quickly, what about steps to help these colleges get the commercialization of their research? Are there are opportunities to help encourage and growth that capacity?

Dr. BEMENT. Well, yes. Certainly at the two-year community colleges where a lot of training is done to prepare skilled technical personnel for industry, we would see opportunities for partnerships. As far as technology transfer, that is something we encourage in almost all of our programs, and again, by leveraging with other programs, we can add that component, especially our Partnerships for Innovation, which broadly addresses not only the fun-

damental issue of transferring technology but especially focused on broadening participation.

Mr. CARNAHAN. Thank you very much.

Thank you, Mr. Chairman.

Chairman LIPINSKI. Thank you.

Dr. BEMENT. Oh, I might also add, the I-cubed program, or Innovation for Institutional Integration, there are tracks in that program that would also be valuable to leverage.

Chairman LIPINSKI. Thank you, Mr. Carnahan.

The Chair now recognizes Ms. Johnson.

Ms. JOHNSON. Thank you very much, Mr. Chairman, and let me apologize to both witnesses for being a little late getting here. We have a great ability to schedule most things at the same time.

Dr. Beering, as you know, the National Science Foundation maintains dozens of programs which ultimately fulfill the mandate of the National Science Foundation, to support all fields of science and engineering, and all of these programs serve different purposes yet share one goal of enhancing American science. My question specifically is, what mechanisms are in place at the National Science Foundation to measure the individual effectiveness of these programs? Or perhaps Dr. Bement.

Dr. BEERING. I will ask Dr. Bement to enlarge upon that.

Ms. JOHNSON. Sure.

Dr. BEMENT. We have a number of mechanisms for continuous improvement and also for oversight, primarily being the National Science Board itself, but also within the Foundation we employ Committees of Visitors to evaluate each and every program at least every three years. We have Advisory Committees that give us a link to the community so that we can be connected with what their interests are, and also to advise the Foundation on new opportunities as well as some issues. We have committees that report to the Director, like CEOSE [Committee On Equal Opportunities in Science and Engineering], for example, and like GPRA [Government Performance and Results Act] committees, GPRA committee especially in looking at outcomes from our programs and determining whether the programs are viable.

But in addition to that, we have working groups across the Foundation that represent the various directorates and offices that probe in depth issues and policies within the Foundation as well as oversight, and they provide continuing review of the effectiveness of these policies. And then finally, at the direction of the current Administration, we are establishing at the Foundation level an office of assessment and evaluation, program assessment and evaluation, and we are planning on linking that with our strategic planning as well as evaluating our progress against our goals and our plans. That is in the formative stage at the present time. It is still being conceptualized as well as being developed. But we have envisioned that that will be another tool that the senior management of the Foundation can draw on in order to assist not only in their program plans but also in their budget planning.

Ms. JOHNSON. Thank you. As a follow-up, as you are aware, there are currently over 200 Hispanic-Serving Institutions and this number obviously is growing very fast and seemingly will continue. Combining the three existing broadening participation programs

into a consolidated program along with an additional fourth that invites proposals from these institutions calls for increased funding. How do you propose that a \$13 million or a 14 percent increase of the overall funding for broadening participation programs really increased funding for every single one of these programs, each of which serves unique individual purposes?

Dr. BEMENT. Well, thank you for that question. First of all, if I take the sum total, and here I am going back to fiscal 2009 data because those are the best data that we have, the total funding of HBCUs, HSIs, TCUs came to about \$113.1 million. That was from EHR² sources. If we just take these focused programs that we are talking about under broadening participation, it totaled \$87 million in 2009. That investment was highly leveraged across the Foundation, if you include Recovery Act funding in 2009 to a total of \$312 million, so that is a substantial amount. Now, what we are proposing in this budget is \$103 million, of which a small fraction will be used for administrative costs and those will be for networking, for developing a network, developing a database and developing services for the community. So you can compare that \$103 million, which is not yet fully leveraged, with the \$87 million that was provided in 2009. Now, the program will be competitive. It will be openly competitive so that, you know, every institution will have an opportunity to compete. So the opportunity budget for everyone is \$103 million. Now, there is no segmentation or limitation. There is no artificial barrier so that this is what makes it a much more holistic approach in what will we think encourage alliances and partnerships, which is what we are really trying to achieve.

Ms. JOHNSON. Thank you very much, Mr. Chairman.

Chairman LIPINSKI. Thank you, Ms. Johnson.

The Chair will now recognize himself for five minutes. and I am going to begin with a question for Dr. Bement but also if Dr. Beering has any comments on this, I would appreciate those also. Two weeks ago in this Subcommittee, we held a hearing on research infrastructure at American universities. During that hearing, witnesses testified about the billions of dollars in deferred maintenance and stalled plans for new research buildings. The NSF had a study that came out in 2007 from a 2005 survey that said there is \$3.6 billion in deferred maintenance for their research buildings. Now, I have concerns; how we can continue to compete with countries like China, who are pouring billions of their own into brand-new high-tech research facilities, when we are having trouble here with ours at worst crumbling, at best just falling behind? AAU [Association of American Universities] and APLU [Association of Public and Land-grant Universities] are now on record in favor of sustaining the Academic Research Infrastructure program, the ARI program, that received \$200 million in the Recovery Act after not being funded for more than a decade. Now, NSF was not represented at this previous witness panel so I want to give you men a chance to respond now to calls to reauthorize the ARI program at NSF, and if not ARI, what else could be done to address this potentially serious concern that could impact America's standing in research into the future.

²Originally stated incorrectly by Dr. Bement as being from "all sources".

Dr. BEMENT. Well, first of all, I understand the concern, and I have visited research facilities both here and abroad. I do that as a regular part of my work. And it is true that the rest of the world is catching up. The rest of the world is investing in infrastructure as well as research instrumentation, so it is much more competitive. My judgment is that we are in pretty good shape but we probably aren't as dominant as we have been in the past, and we do have an aging infrastructure, and the universities are stressed at the present time for resources because state funding has decreased, especially with the economic downturn, so I am very sympathetic with the issue.

On the other hand, there are priorities within the Foundation that we haven't met that I believe are more important than being the funding source of last resort for bricks and mortar, and that is medium-scale instrumentation and equipment. It is improving our success rate, continuing to push our success rates up, especially in some programs where they are still quite low. It is increasing the grant size. Our grant sizes are no longer adequate to support research groups as they had been in the past. And also in some of our fellowships and traineeships, our costs of education allowances for universities are so far out of date that universities will no longer submit proposals for fellowships or traineeships or scholarships because they can't afford it. So those are still burning issues. I would say that ARI, although it does have some merit, comes under the category of choice, how you keep a program balanced, and my preference is to keep the research strong and allow the universities or expect the universities to find the resources necessary to make the usual improvements, not only in the existing infrastructure but also to operate and maintain—I should say resources for new infrastructure, but also to operate and maintain the existing infrastructure. That is my position.

Chairman LIPINSKI. Is there any—you had brought this up. I sort of want to follow up with this. Is there any new thinking by either the Board or the Foundation of how to approach the gap in funding between very small and very large instruments and facilities?

Dr. BEMENT. Well, I will defer to the Chairman because the answer is yes, but I want him to explain it.

Dr. BEERING. We have just created a new subcommittee which is going to evaluate that very closely, and as Dr. Bement said, we are not in dire straits yet. In fact, the infrastructure funding over the last seven years has been close to 30 percent, and I am very pleased that the universities have been helped by foundations and private donors and by businesses and industries in terms of partnering with NSF and other Federal agencies to keep is pointed in the right direction.

Chairman LIPINSKI. The number that you had cited, the 30 percent, my understanding is it was closer to 24 percent for infrastructure. Is it—

Dr. BEMENT. Actually the real number in between. It is around 28 percent.

Dr. BEERING. 28 to 29.

Chairman LIPINSKI. We will have to look more into that because the numbers that I have seen are not that high. It would be good if it is up there.

I also wanted to follow up in terms of the survey. Since 1986, NSF has been required by law to conduct a survey of the state of our science and engineering research facilities every two years and submit a report to Congress. As far as I know, the last report was published in 2007, based on the fiscal year 2005 survey. I am told the survey was conducted last year as well, although I am not sure. I don't believe there was a survey conducted in 2007. But when do you expect the results of the 2009 survey to become available?

Dr. BEMENT. Well, I have to refer to my experts. We will provide that for the record.³

Chairman LIPINSKI. Okay, and it does concern me because as I said, the last report was based on the 2005 survey and it said \$3.6 billion in deferred maintenance, and since we don't have another—don't have reports since then and we should have had at least one more report based on 2007 and we are still looking for the report, you will get me the information on the 2009 survey. It concerns me that we are not getting the best bang for our buck out of our research funding without having the best infrastructure that we could have there, but we can follow up more on that later.

With that, I have other questions but I will finish the first round here and I will yield to Dr. Ehlert for five minutes.

Mr. EHLERS. Thank you, Mr. Chairman. I just have two fairly short questions, which probably require only short answers.

But on the whole issue of the minority education, what you have outlined makes sense to me. Of course, I haven't seen all the details but I think it is a good approach. But the concern I have is you are going to have a 14 percent increase in the funding for these programs. How will that affect the other work of the division of Human Resource Development, the opportunities for women and persons with disabilities, which has a five percent decrease. How would you see that balancing out?

Dr. BEMENT. That is a question, the detail of which I am not prepared to go into. Some of these small changes in budget depend pretty much on what the renewal is for a given year, how many awards have to be renewed and what the opportunity is for funding new awards. Perhaps I can get a better answer. No, I guess we will provide that also for the record.⁴

Mr. EHLERS. All right. Thank you, and I hope we can continue those programs to the extent that they are needed and they are certainly needed.

No NSF budget hearing would be complete without a question about icebreakers and it has no connection with the boilermakers

³Follow up from the National Science Foundation: NSF conducts the Survey of Science and Engineering Research Facilities on a biennial basis. The FY 2007 survey data will be available upon the release of an InfoBrief by late-summer 2010. The FY 2009 survey data are expected to be released by early summer 2011.

⁴Follow up from the National Science Foundation: The proposed new comprehensive broadening participation effort at the Foundation will include attention to issues of women and persons with disabilities in STEM. The five percent (or \$1 million) decrease below the FY 2010 Estimate in the current programs for research on women and persons with disabilities will allow for a basic research focus in those programs. Other aspects of those programs that have now reached critical mass (e.g., diffusion and extension service activities) will be one focus of planned program evaluation, so additional support through evaluation will be directed toward the programs. In the FY 2010 Estimate, 57 percent of the Research on Gender in Science and Engineering (GSE) Program budget will be available to fund new awards and 34 percent of the Research in Disabilities Education (RDE) program budget will be available to fund new awards, with the amounts remaining in both programs funding to sustain existing awards.

you mentioned earlier. Is everything copasetic now? Is the Coast Guard happy? Are you happy?

Dr. BEMENT. Well, as far as our working relationship, I think we have a good relationship. We are still operating under a memorandum of understanding that we have negotiated. The problem is that we were mandated, and so was the Coast Guard, for that matter, to shift the funding from the National Science Foundation to the Department of Homeland Security for the operation and maintenance of the icebreakers, where the Foundation would then pay incremental costs for icebreaking services. Now, that didn't happen. Those funds were not in the budget for the Coast Guard in the 2011 budget, so in order to sustain our mission, we have had to again provide operations and maintenance costs out of the NSF budget. That is a default position which we regret but it is important.

Mr. EHLERS. And how much money does that involve?

Dr. BEMENT. It is about \$52 million—\$54 million.

Mr. EHLERS. Well, that is considerably less than Homeland Security is going to spend for the new screening methodology, so there should be a little money there somewhere. I hope we can find that through the budget process.

Thank you, and I yield back.

Chairman LIPINSKI. Thank you, Dr. Ehlers.

First one follow-up along the lines of the last questioning. When do you expect that the grants will be made for ARI under the Recovery Act program? Because I keep hearing that they are expected in the near future, and as far as I know, no grants have been made in that.

Dr. BEMENT. I think all the proposals have been evaluated. I think the grants are imminent, probably this month. April through July.

Chairman LIPINSKI. All right. Thank you.

I wanted to move on to talking about high-risk, high-reward research. In 2007, at the same time this committee was developing the *America COMPETES Act*, the National Science Board released a report calling for NSF to establish a transformative research initiative. There are a few details in that report and in the Gathering Storm recommendations but there is an eight percent set-aside at each agency. Since then, the *ARISE [Advancing Research in Science and Engineering]* report has spelled out more detailed recommendations and NSF has experimented with different approaches to meeting this need. So first, Dr. Bement, can you elaborate on some of those approaches and give us an idea of what percentage of your total research budget is, and ideally, should be, dedicated to this effort on transformative research?

Dr. BEMENT. This is a philosophical point because the focus on the Foundation has been that we pay much more attention to the frontiers of science and that we try to push the community closer to that frontier so that basically all the grants that we fund would be potentially transformative. It is very difficult to know at the onset whether it will actually be transformative until the research is carried out. But in terms of higher risk, higher risk was a priority in the use of our Recovery Act funds. We funded a number of programs that I have reviewed that are very exciting, are poten-

tially transformative. But to get to your question, in the 2010 budget we have allocated \$92 million across the Foundation, \$2 million per division, and we are using this year as a development year to experiment on different approaches for supporting transformative research. In fact, my hope is that those in the community that feel that they can submit a proposal and reduce the risk in the proposal in order to get it past a review committee may get their proposal denied on the basis that it doesn't have enough risk. So this is the games that we play back and forth with the community with regard to risk.

But there are three categories of innovations that we are currently looking at. One has to do with the review process itself, the merit review process, and the training we give not only to our program officers but also the reviewers, and what our expectation is, what our definition of transformative research is, which was developed by the Board. Now, the second has to do with incentivizing transformative research through venture funding, through other mechanisms to incentivize program officers to pick out those programs that are perhaps a little below the line but nevertheless are very exciting and very transformative and be able to fund them. The third has to do with other methodologies or modalities for not only the way we phrase our solicitations, but also how we do our workshops in order to identify areas that would be potentially transformative. So there are a number of different methodologies that are being explored by the various divisions at this point.

So this is the activity that is currently going on. The question is or what is before us is actually putting in place a program evaluation of all these different approaches to see what their effectiveness is and what we can pull out as a best practice. And the best practices that are effective will be the ones that will be propagated across the Foundation in future years.

Chairman LIPINSKI. As a result of the fiscal year 2006 appropriations bill, the NSF engaged the National Academy of Sciences to study innovation inducement prizes. That NAS report recommended that NSF embrace the challenge and stated that innovation inducement prize contests will be a sound investment in strengthening the infrastructure for U.S. innovation. I agree with the NAS on this and I think that innovation inducement prizes not only support transformative research in a way that complements traditional NSF grant making, but they can increase public recognition of scientific and research accomplishments. Do either of you have any recommendations concerning a potential prize program?

Dr. BEMENT. Obviously this has been on our plate for a long time. There are prizes that do make sense and prizes that don't make sense for the Foundation. The ones that do make sense are the ones that fit in with our mission and our purpose. We don't do systems engineering, we don't develop prototypes like a DARPA [Defense Advanced Research Projects Agency], for example. So there are some types of inducement prizes that deal with whole systems, like developing a single launch to space or developing a new solar car or something of that type, which doesn't really fit the NSF mission. On the other hand, there are a couple of ideas that we have been exploring that I think do make sense. Oh, by the

way, we also have prizes in the Foundation. We have the Waterman prize, for example. We give Presidential medals, or we manage the Presidential medal program for science and for teachers and for mentors. But in terms of inducement, we have two criteria for our merit review process. One is scientific merit and the other is broadening participation. We argue that these criteria have equal weight, but on the one hand, we recognize achievement on the scientific merit side but we don't recognize achievement in broadening participation. I am sorry, and other impacts, broader impacts, the importance of that is, we need to recognize citizen scientists who make a contribution to society and are connected with society and the world, the so-called citizen scientists rather than just the scientists in the ivory tower. So a prize that would incentivize attention to broadening participation and give recognition for outstanding achievements in what is being done already in that category, I think would be very important. It would stimulate the community. It would also give tangible evidence that we do pay attention to broader impacts.

The second area would be in innovation. It is very important that new concepts, and new knowledge transfer into the community broadly for economic development where possible and find their way into the marketplace. That is very much in our mission space. It is recognized in a number of programs that we support to not only exploit new concepts but also to provide talent, educated talent, through our graduate programs by integrating research with education. They eventually will go into the private sector and become the innovators and the entrepreneurs in our society.

It occurs to me that if we had an innovation prize at the national level that would be based on competitions that are held internally with universities to pick the best concept where it is not just based on the scientific merit of the concept but would also have to identify how that concept would be transferred, how it would be launched and how it would be accelerated. So this is a prize that could also require matching funds from the private sector—at least those who would benefit from the transfer activity—or it could even be state loans or other forms of support so it would be a matched prize, and this could be a competition, for example, that would be adjudicated by the National Academy of Engineering. We would have to support that. In order for the universities to be interested in entering into this prize program, there would have to be a reward for the winning university that puts forward the concept. So the prize would not only—there would not only be a part of the prize that would go to the university, but there would be a major prize that would go to the entrepreneur or the innovator at the university that would be matched by private sector funding. That is the concept.

Chairman LIPINSKI. Thank you, Dr. Bement.

Anything else, Dr. Beering, on that or following up?

Dr. BEERING. Some years ago, I was privileged to chair the series of seminars and hearings around the Nation on K-12 education, and out of that came our acquaintance with Secretary Chu now, who helped us with our energy symposium, and the education secretary, who was remarkable in our seminar in Chicago, and I think what it all comes down to is, we need to invest in people with ideas

who have a passion for science and education and who are broadly engaged in their views, who have vision and who have the steadfastness to pursue that vision, and I am just delighted with the way we are doing right now. Things are really moving in a very productive direction and I am strengthened in that belief because of the marvelous staff that we have at NSF and the very imaginative work that is going on throughout the enterprise. I am very optimistic about the future, and I think we are going to continue to do well. Thank you very much for hearing us.

Chairman LIPINSKI. That is an excellent way to conclude the hearing today, and I thank both of you again for your testimony and for your service to our country and to science.

So with that, the record will remain open for two weeks for additional statements from Members and for answers to any follow-up questions the Committee may ask of the witnesses.

With that, the witnesses are excused and the hearing is now adjourned.

[Whereupon, at 11:37 a.m., the Subcommittee was adjourned.]