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OVERSIGHT OF THE NATIONAL SCIENCE FOUNDATION

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

SECOND SESSION

FEBRUARY 26, 2008

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OVERSIGHT OF THE NATIONAL SCIENCE FOUNDATION

TUESDAY, FEBRUARY 26, 2008

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

The Subcommittee met, pursuant to call, at 10:05 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brian Baird [Chairman of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
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SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

Oversight of the National Science Foundation

Tuesday, February 26, 2007
10:00 a.m. - 12:00 p.m.
2318 Rayburn House Office Building

Witnesses

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

Dr. Steven C. Beering
Chairman
National Science Board

HEARING CHARTER

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

Oversight of the National Science Foundation

TUESDAY, FEBRUARY 26, 2008
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Tuesday, February 26, 2008, the Subcommittee on Research and Science Education of the House Committee on Science and Technology will hold a hearing to receive testimony from the Director of the National Science Foundation (NSF) and the Chair of the National Science Board (NSB) regarding NSF's fiscal year (FY) 2009 budget request and related policy issues.

2. Witnesses

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

3. Overarching Questions

- How does the FY 2009 budget request address the NSF programs authorized in the *America COMPETES Act,* including math and science education activities? How is NSF responding to the policy directives in COMPETES, including those regarding mentoring and ethics training for young scientists?
- On what basis should NSF make decisions about how to allocate budgets across education programs, including K–12, undergraduate, and graduate programs? How will NSF's new teacher education initiative balance priorities across the programs that support K–12 education? Is there an appropriate balance among the different modes of support for graduate students (fellowships, traineeships, and research assistantships)?
- The *American Competitiveness Initiative* (ACI) set a 10-year doubling path for the physical sciences, engineering and computer sciences, which had been flat-funded for several years. What is NSF doing to ensure that the social, behavioral, economic and biological sciences are appropriately integrated and sufficiently funded under the often multi-disciplinary research initiatives supported under ACI?

4. Summary of NSF FY 2009 Budget Request

The National Science Foundation is the primary source of federal funding for non-medical basic research conducted at colleges and universities and serves as a catalyst for science, technology, engineering, and mathematics (STEM) education reform at all levels. NSF is one of the research agencies that the President, in his 2006 State of the Union Address, proposed to double over ten years (beginning in FY 2007) as part of the *American Competitive Initiative* (ACI). The *America COMPETES Act* (P.L. 110–69) called for an even more rapid, seven-year doubling path for NSF and responded to a critical shortage of well-trained K–12 STEM teachers by increasing funding for two flagship NSF teacher education programs: The Noyce Teacher Scholarship Program and the Math and Science Partnerships Program (MSP).

Both ACI and COMPETES have yet to be realized. The FY 2007 Appropriations CR resulted in only a 4.2 percent increase for NSF in the first year of ACI—a ten year doubling requires approximately seven percent/year growth. The FY 2008 om-

nibus appropriations bill provides $6.032 billion,[1] a 2.5 percent increase over FY 2007. The Administration's FY 2009 request for NSF is $6.854 billion, $822 million (13.6 percent) above the FY 2008 estimate, reflecting a determination to keep NSF on the 10-year doubling path proposed under ACI. (COMPETES authorized $7.326 billion for FY 2009, $472 million more than the request.) However, the Administration provided only a nominal increase for MSP and reduced the Noyce Program below the FY 2008 omnibus appropriations level.

Research and Related Activities (R&RA)

Scientific research programs and research facilities (which comprise the R&RA account) receive a $773 million (16 percent) increase from FY 2008. In keeping with the Administration's emphasis on the mathematical and physical sciences, engineering and computer sciences under ACI, those directorates, in addition to cyberinfrastructure, each receive an approximately 20 percent increase over FY 2008, while the biological sciences (+10.3 percent) and social, behavioral and economic sciences (+8.5 percent) receive more modest increases. The COMPETES Act specifically called on NSF not to disinvest in the biological and social sciences over the long-term, but did not assume that all fields would receive equal increases each year.

NSF's contribution to the multi-agency National Nanotechnology Initiative (NNI) increases by only $8 million (2.1 percent) to $397 million, $30.6 million of which is directed toward research on the environmental, health and safety aspects of nanotechnology. The Committee will be taking up a reauthorization of the NNI this spring. NSF's contribution to another multi-agency program, the Networking and Information Technology R&D Program (NITRD), increases by $159 million (17 percent) to $1.09 billion. The entire budgets of both the Computer Sciences and Cyberinfrastructure directorates are counted toward the NITRD total.

As part of the FY 2009 request, NSF is launching three new cross-Foundation initiatives: Science and Engineering Beyond Moore's Law ($20 million), Adaptive Systems Technology ($15 million) and Dynamics of Water Processes in the Environment ($10 million). An initiative launched in FY 2008, Cyber-enabled Discovery and Innovation (CDI), will be doubled to $100 million. All of these initiatives repackage existing research under new headings and it is unclear to what extent they create new research directions or provide more money for existing research. CDI and S&E Beyond Moore's Law are both captured within the NITRD portfolio.

The COMPETES Act put special emphasis on increasing support for young investigators, whose funding success rates sit about 10 percent lower than more established investigators. The Administration request includes $182 million (+$14 million) for CAREER grants, less than $2 million below the amount authorized in COMPETES. The Act also created a new Pilot Program for Young Investigators to help provide seed funding to first time principal investigators who, despite being recognized as outstanding, are still disadvantaged by not having a track record of previous funding. Based on staff conversations with NSF officials, NSF is taking this new program seriously and is in the process of deciding how best to implement it.

Since FY 2006, under a Memorandum of Agreement, NSF has been responsible for reimbursing the U.S. Coast Guard for the costs of the icebreakers that support scientific research in the Polar regions. The request for FY 2009 is $54 million, a reduction of $3 million under a recent agreement in which NSF is no longer supporting the Polar Star in caretaker (i.e., mothballed) status. NSF will also continue to purchase back-up ice-breaking services on the open market at a cost of approximately $9 million in FY 2009.

Major Research Equipment and Facilities Construction (MREFC)

The MREFC activity funds the construction of large research facilities, such as telescopes and research ships. Funding for the design, operation and management of these major user facilities is included in the R&RA budget.

The fiscal year 2009 MREFC budget is down by 33 percent to $147 million, in small part because of projects that were completed in FY 2008 and in much larger part because three design-stage projects: The Alaska Region Research Vessel (ARRV), the National Ecological Observatory Network (NEON) and the Ocean Observatories Initiative (OOI) are on hold pending the establishment of rigorous cost and schedule baselines. As recently as last year, NSF put place-holders for these projects in MREFC, but they have since established a "zero-tolerance" policy for

[1] The FY 2008 estimate is $33 million below the appropriated level due to a rescission required by the Appropriators in the FY 2008 omnibus bill.

cost-overruns. The only new project receiving funding in FY 2009 is the Advanced Technology Solar Telescope (ATST), which will receive $2.5 million for late-stage design work. This is the first time that any design funds are requested from the MREFC Account, and NSF is reviewing the policy for funding preconstruction design work in general, as requested in COMPETES. In another break with prior practice, the MREFC budget request does not include out-year funding estimates for ATST and the newly available 2008 Facility Plan[2] does not include any horizon or "readiness stage" projects.

Education and Human Resources (EHR)

EHR funds most of NSF's activities that support K–12 STEM education and the majority of activities that support undergraduate STEM education. EHR also funds most of NSF's graduate fellowship and traineeship programs. The FY 2009 request for EHR is $790.41 million, an increase of $64.81 million (8.9 percent) over FY 2008, but $205 million short of the level authorized in COMPETES. The single biggest increase of $28.6 million (32.5 percent) goes to the Graduate Research Fellowship program. Overall, programs that support K–12 education, including the Noyce Program, MSP, and Discovery Research K–12, increase by only 4.6 percent, half of the total increase for EHR. NSF programs to broaden participation, which includes programs in both R&RA and EHR, increase by only $18.8 million (2.9 percent).

K–16 Programs

The Administration flat-funded or provided only meager increases for a number of K–16 education programs slated for increases in COMPETES, including the Noyce Program, MSP, the Advanced Technological Education Program (ATE), and the STEM Talent Expansion Program. Moreover, the Administration intends to fund the Noyce Program below the appropriated level of $15 million in FY 2008. The rationale given for flat-funding these programs (with the exception of MSP) is that they have not yet undergone the rigorous evaluation required under the Administration's Academic Competitiveness Council (ACC) process. (For background on ACC, see the charter from the June 6, 2007 Research Subcommittee hearing on *Federal STEM Education Programs*.) Discovery Research K–12, which supports applied research aimed at improving STEM education at the K–12 level, fares the best of the three K–12 programs, with an $8.5 million (8.5 percent) increase.

Graduate Research and Education (R&RA and EHR)

The two major NSF programs that support graduate students, the Graduate Research Fellowships Program (GRF) and the Integrative Graduate Education and Research and Training Program (IGERT) take funds from both R&RA and EHR. Both of these programs received special attention in the COMPETES act for their role in nurturing the best and brightest science and engineering students. While GRF is important for the independence it affords graduate students to choose a research advisor who might not otherwise be able to support another student, IGERT is also an extremely well regarded and effective program that by design supports cutting-edge interdisciplinary science through its support for graduate students. In the FY 2009 request, NSF increases GRF by 30 percent to $125 million while flat-funding IGERT at $64 million. The reason for this unbalanced treatment of two equally important and effective graduate student programs is unclear. Another large program that NSF lists under graduate education is the Graduate Teaching Fellows in K–12 Education (GK–12).

Broadening Participation

The single biggest increase for programs to broaden participation goes to the Centers of Research Excellence in Science and Technology Program (+ $5.5 million or 22 percent), which supports research and education infrastructure at minority-serving institutions. Three other programs designed to increase participation by minority students, HBCU–UP, LSAMP and TCUP, will receive a combined $3.5 million increase after having received a $10.5 million increase to $83.4 million in FY 2008. The ADVANCE program, which seeks to increase the numbers of tenure-track women faculty in science and engineering disciplines, will receive a 2.5 percent decrease to $20.8 million after having received a 25 percent increase in FY 2008.

[2] *http://www.nsf.gov/pubs/2008/nsf0824/nsf0824.pdf*

Agency Operations and Award Management

This NSF account funds the internal operations of NSF. The FY 2009 request provides an increase of $23.3 million (8.3 percent) over FY 2008. AOAM was the one account that was nearly fully funded in the FY 2008 omnibus appropriations bill. Dr. Bement made it clear to Congress that AOAM was his number one priority for funding in FY 2008. The NSF workforce has been under increasing pressure as research budgets increased, and the electronic system used to receive and process grant applications is undergoing an upgrade in preparation for implementation across the federal research enterprise.

5. Additional Policy Issues Addressed in COMPETES

The COMPETES Act contained a number of policy directives and report requests not addressed in the FY 2009 budget request:

- Sec. 7007 requires an NSB report, due in August, evaluating the role of NSF in supporting interdisciplinary research. The key issues are whether NSF has a clear policy for the review of unsolicited interdisciplinary proposals, and whether the research community is sufficiently informed about where to submit such proposals.
- Sec. 7008 requires that all NSF grant applications that include funding to support post-doctoral researchers include a description of the mentoring activities that will be provided for such individuals.[3]
- Sec. 7009 requires universities funded by NSF to provide appropriate training and oversight in the responsible and ethical conduct of research to students and trainees at all levels, including post-doctoral researchers. The Manager's Statement accompanying COMPETES directed NSF to provide written guidelines to universities on what constitutes appropriate training.
- Sec. 7010 requires that NSF make summaries of research results publicly available in a timely manner. NSF was already moving in this direction before COMPETES.
- Sec. 7011 requires NSF to enforce its policy regarding the sharing of research results by making any researcher who fails to comply ineligible for future funding.
- Sec. 7013 required NSB to evaluate NSF's policy on cost-sharing. The Board has already responded with a report presented to NSF in February.[4] In short, NSB recommended reinstating cost-sharing by industry for certain Centers programs with significant industry participation, as well as cost-sharing by states under the EPSCoR program. They also issued a series of recommendations regarding management and oversight of cost-shared grants. NSF is currently reviewing NSB's recommendations.
- Sec. 7014 required NSB to review NSF's policies for pre-construction funding and maintenance and operation costs of MREFC projects. The Board also completed this report in February (#NSB–08–15) and it should be online shortly. The gist of the recommendations is that NSB should be more integrated into the large facilities planning process and that MREFC funds should be available for late-stage design activities. NSF is currently reviewing the Board's recommendations.
- Sec. 7018 requires NSF to consider the degree to which grant proposals address critical national science and innovation needs.
- Sec. 7020 requires a plan, due this month, to ensure broadband access for all institutions of higher education participating in NSF programs that require high-speed networking.
- Sec. 7022 requires a report, due in August, on the impact and scope of the "Broader Impacts" grant review criterion used by NSF.
- Sec. 7032 requires a National Academies report, due in August, on barriers to and strategies for greater diversity in STEM fields.
- Sec. 7033 authorizes NSF to establish a Hispanic-Serving Institutions Undergraduate Program similar to a program for Historically Black Colleges and Universities.
- Sec. 7034 authorizes a new Professional Science Masters program at NSF.

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[3] The widespread problem being addressed through this provision is addressed in detail in a 2000 (but still relevant) report from the National Academies: *Enhancing the Post-doctoral Experience for Scientists and Engineers. http://www.nap.edu/catalog.php?record_id=9831*

[4] http://www.nsf.gov/nsb/publications/2008/rprt_*congress_cs_policy.pdf*

6. Questions for Witnesses

Dr. Bement

- How does the FY 2009 budget request address the NSF programs authorized in the *America COMPETES Act,* including math and science education activities?
- How has the planning and budgeting process changed for major research facilities? Why doesn't the FY 2009 MREFC budget request contain any out-year budget requests for the FY 2009 new start, the Advanced Technology Solar Telescope? Furthermore, there are no horizon projects listed in the 2008 Facility Plan. Are there any projects in readiness stage for FY 2010? If not, when can we expect to see a proposal for FY 2010 new-starts?
- Please elaborate on the three new cross-Foundation initiatives for FY 2009: Science and Engineering Beyond Moore's Law, Adaptive Systems Technology, and Dynamics of Water Processes in the Environment. How did these initiatives come about? To what extent do they repackage existing efforts? What new research directions are being funded under these initiatives?
- What is the role of NSF in promoting international science cooperation? To what extent do you coordinate your international efforts with the Department of State or other federal agencies? In particular, what role do you have in promoting scientific exchange with scientists in countries whose research infrastructure lags behind that of United States?

Dr. Beering

- How has the planning and budgeting process changed for major research facilities? How will the role of the Board change in this process?
- What is the appropriate role of NSF in promoting international science cooperation? How should NSF coordinate its international efforts with the Department of State and other federal agencies? In particular, what role does or should NSF have in promoting scientific exchange with scientists in countries whose research infrastructure lags behind that of United States?
- Is the Board satisfied with the current funding level for the Foundation's education programs and with the priorities among categories of programs (K–12, undergraduate, and graduate)? On what basis should NSF make decisions about how to allocate budgets across education programs? In particular:
  - What are the highest priority NSF programs that address K–12 STEM education, and in particular, please comment on whether the Board has a view on the adequacy of the FY09 budget request for the Robert Noyce Teacher Scholarship Program and the Math and Science Partnerships?
  - Does the Board believe there is an appropriate balance among the different modes of support for graduate students (fellowships, traineeships, and research assistantships)?

National Science Foundation
FY 2009 Budget Request (dollars in millions)
(Source: Agency Budget Justification)

NSF Program Activity	FY 2007 Actual	FY 2008 Estimate	FY 2009 COMPETES Authorization	FY 2009 Request	Change over FY 2008	
					Amount	% Change
Research and Related Activities (R&RA)	**4758**	**4821**	**5742**	**5594**	**772.5**	**16.0%**
Biological Sciences	609	612		675	63.0	10.3%
Computer and Information Science and Engineering	527	535		639	104.2	19.5%
Engineering	630	637		759	122.5	19.2%
Geosciences	746	753		849	96.0	12.8%
Math & Physical Sciences	1151	1167		1403	235.4	20.2%
Social, Behavioral and Economic Sciences	215	215		233	18.4	8.5%
Cyberinfrastructure	182	185		220	34.8	18.8%
International S&E	40	41		47	6.1	14.8%
Polar Programs	438	443		491	48.4	10.9%
Icebreakers	*53*	*57*		*54*	*-3.0*	*-5.3%*
Integrative Activities	219	232		276	43.7	18.8%
EPSCoR	*102*	*111**	*133*	*114*	*2.4*	*2.2%*
Instrumentation (MRI)	*90*	*94*	*123*	*115*	*21.1*	*22.5%*
US Arctic Research Comm.	1.45	1.47		1.53	0.06	4.1%
CAREER**	187.4	167.8	184	181.9	14.1	8.4%
Graduate Research and Education**	58.6	54.2	63	55.2	0.97	1.8%
Graduate Research Fellowships (GRF)	*8.14*	*8.06*	*10.0*	*8.06*	*0.0*	*0.0%*
IGERT	*42.4*	*37.8*	*53*	*38.8*	*1.0*	*2.6%*
Teaching Fellows (GK-12)	*8.09*	*8.31*		*8.31*	*0.0*	*0.0%*
Research Experiences for Undergraduates (REU)**	63.3	57.7	68	61.6	3.8	6.6%
Education and Human Resources (EHR)	**696**	**726**	**995**	**790**	**64.8**	**8.9%**
Research on Learning	209	214		227	12.5	5.8%
Noyce Scholarships	*10.3*	*10.8**	*115.0*	*11.6*	*0.8*	*7.4%*
Math & Science Partnerships	*46*	*49*	*111*	*51*	*2.5*	*5.2%*
STEM Talent Expansion	*29*	*30*	*50*	*30*	*0.0*	*0.0%*
Advanced Tech Education	*51*	*52*	*58*	*52*	*0.0*	*0.0%*
Grad Research and Educ	156	160	137	191	*30.6*	*19.1%*
GRF	*86*	*88*	*107*	*117*	*28.6*	*32.5%*
IGERT	*25*	*25*	*30*	*25*	*0.0*	*0.0%*
GK-12	*45*	*47*		*49*	*2.0*	*4.3%*
Human Resources Develop.	126	140		153	12.9	9.2%
Major Research Equipment & Facilities Construction (MREFC)	**166**	**221**	**262**	**148**	**-73.2**	**-33.2%**
Agency Operations (AOAM)	**248**	**282**	**310**	**305**	**23.3**	**8.3%**
Inspector General (OIG)	**11.9**	**11.4**	**12.8**	**13.1**	**1.7**	**14.6%**
Nat. Science Board (NSB)	**3.7**	**4.0**	**4.2**	**4.0**	**0.1**	**1.5%**
AGENCY TOTAL	**5884**	**6032**	**7326**	**6854**	**822.0**	**13.6%**

Blank cells: The COMPETES Act was silent on several of the funding lines shown here.
* below the level appropriated in the omnibus ($115m for EPSCoR and $15m for Noyce)
** These programs cut across all of the research directorates.

Chairman BAIRD. Our hearing will come to order now and good morning. Welcome to this Research and Science Education Subcommittee hearing on the National Science Foundation's fiscal year 2009 budget request and related policy issues.

I am happy that despite the disappointment of the fiscal year 2008 Omnibus Appropriations Bill, the Administration remains determined to keep NSF on a doubling path, something this committee has long and strongly advocated for. The strong budget request for basic research at NSF is something that this committee commends and fully supports and will work to advocate with our colleagues.

I am happy to see that the education programs at NSF are getting an increase, however, and this is a sentiment I believe is shared by the overwhelming majority of my Committee colleagues on both sides of the aisle, I am once again dismayed at the treatment of the K through 12 education in the budget request.

The top recommendation of the National Academies of Science's *Gathering Storm* report was to place teachers who have strong content knowledge and effective teaching skills in math and science classrooms across America. The report cited a 10-year old University of Texas UTeach Program as an example of best practices for STEM teacher education.

Based on that success UTeach has already been taken as a model by the State of California, as well as the private sector. The COMPETES Act, passed by this committee and the House last year, used the Academy's recommendations and UTeach as the basis for restructuring NSF's Robert Noyce Teacher Scholarship Program. It set out a funding trajectory that would enable the program to reach the goal of 10,000 new STEM teachers per year.

I am disappointed that the fiscal year 2009 budget request for Noyce not only fails to reach the $103 million authorized in COMPETES Act, but is actually below the fiscal year 2008 appropriations level.

I am also interested in learning more about NSF's decision to apply all of the increases in Graduate Research and Education to the Graduate Research Fellowship Program rather than the Integrative Graduate Education and Research Training Program, since IGERT is also an extremely well-regarded and effective program.

Beyond education, I would like to talk about the proposed changes to the major research equipment and facilities construction budget, as well as some changes proposed with respect to the icebreaker fleet.

Finally, as a social scientist, I also want to say a word about the social and behavioral sciences. While I understand that not all fields will get an equal increase every year, I want to reiterate the importance of social sciences to all of the major challenges our nation is facing, including energy, water, health, national security, and competitiveness. Parenthetically I would mention that Dr. Marburger was here last, two weeks ago, and underscored himself the importance of social science.

I am interested in hearing from you today the justification for the budget request for social, behavioral, and economics directorate and to what extent, if any, the social sciences are integrated into NSF's major research initiatives.

Finally, let me end on a positive note. I was pleased with the request for a significant increase for the Office of International Science and Engineering, and I look forward to Dr. Bement's participation in an upcoming hearing which will explore the role of federal agencies, including NSF, in supporting international science and engineering cooperation.

I thank our outstanding witnesses, first of all, for your great service to the country in the name of science, and also for being here with us today.

And now it is my pleasure to recognize my dear friend and colleague, Dr. Vern Ehlers, for an opening statement. Dr. Ehlers.

[The prepared statement of Chairman Baird follows:]

PREPARED STATEMENT OF CHAIRMAN BRIAN BAIRD

Good morning. Welcome to this Research and Science Education Subcommittee hearing on the National Science Foundation's fiscal year 2009 budget request and related policy issues.

I am happy that, despite the disappointment of the Fiscal Year 2008 omnibus appropriations bill, the Administration remains determined to keep NSF on a doubling-path. The strong budget request for basic research at NSF is something that this committee commends and supports.

And I am happy to see that the education programs at NSF are getting an increase. However—and this is a sentiment shared by the overwhelming majority of my Committee colleagues on both sides of the aisle—I am once again dismayed at the treatment of K–12 education in the budget request.

The top recommendation of the National Academies of Science's *Gathering Storm* report was to place teachers who have strong content knowledge and effective teaching skills in math and science classrooms across America. The report cited the 10-year old University of Texas UTeach program as an example of best practices for STEM teacher education. Based on its success, UTeach has already been taken as a model by the State of California as well as the private sector.

The COMPETES Act used the Academies' recommendations and UTeach as the basis for restructuring NSF's Robert Noyce Teacher Scholarship program. It set out a funding trajectory that would enable to program to reach the goal of 10,000 new STEM teachers per year. I am disappointed that the Fiscal Year 2009 budget request for Noyce not only fails to reach the $103 million authorized in the COMPETES Act, but is also below the Fiscal Year 2008 appropriations level.

I am also interested in learning more about NSF's decision to apply all of the increases in the graduate research and education to the Graduate Research Fellowship Program, rather than the Integrative Graduate Education and Research and Training (IGERT) Program since IGERT is also an extremely well-regarded and effective program.

Beyond education, I would like to talk about the proposed changes to the Major Research Equipment and Facilities Construction budget, as well as some changes proposed with respect to the icebreaker fleet.

Finally, as a social scientist, I also want to say a word about the social and behavioral sciences. While I understand that not all fields will get equal increases every year, I want to reiterate the importance of the social sciences to all of the major challenges our nation is facing, including energy, water, health, national security and competitiveness. I'm interested in hearing from you today the justification for the budget request for the Social, Behavioral and Economics directorate and to what extent, if any, the social sciences are integrated into NSF's major research initiatives.

Finally, let me end on a positive note. I was pleased with the request for a significant increase for the Office of International Science and Engineering and I look forward to Dr. Bement's participation in an upcoming hearing during which we will explore the role of federal agencies, including NSF, in supporting international science and engineering cooperation.

I thank you for being here today and I look forward to your testimony. I now recognize my colleague Dr. Ehlers for an opening statement.

Mr. EHLERS. Thank you, Mr. Chairman. Welcome.

In the fiscal year 2009 budget request, the Administration has requested increases for both the research and educational mission

of the National Science Foundation. However, the proposed increases fall short of the authorizations provided in the COMPETES Act of 2007, which established a seven-year doubling path for the NSF. After a below-inflationary increase provided in fiscal year 2008, due to no fault of the witnesses or of those on the dais here, the NSF has fallen off the doubling path. With a 13 percent increase requested for the agency, coupled with less generous budgets for other agencies, some even within the same funding subcommittee, NSF is going to have to work hard to defend and justify the reasoning behind the substantial increase. In order to return to the doubling path in fiscal year 2009, I believe NSF should be funded at the level authorized by the COMPETES Act.

Unfortunately, we know first hand what shortfalls means for NSF. For the remainder of fiscal year 2008, NSF must defer solicitations and facilities maintenance, will award 1,000 fewer research grants, fund 230 fewer research fellows, and negatively impact more than 3,000 students and teachers. These are just a few of the known impacts of the unanticipated shortfall created by the fiscal year 2008 Omnibus. I am very concerned that federal apathy to NSF is encouraging young scientists to choose another career.

Finally, while I recognize NSF has defended the successes of the Math and Science Partnerships, I am disappointed that only a $2.5 million increase is requested for this program. As reauthorized by the COMPETES Act, the Math and Science Partnership Program has the potential to make a great impact on science, technology, engineering, and math education in this country. This is simply not possible within its current budget.

I look forward to hearing from our witnesses about the new initiatives proposed in the fiscal year 2009 budget, the thriving programs bearing consistent fruit, and how we can work together to implement the COMPETES Act.

Now, let me add a personal note here, and that is I recognize that the objectives of the two witnesses are largely the same as the objectives of those of us sitting up here. We are a victim of forces beyond our immediate control, particularly the passage of the Omnibus Bill last year. And that is an issue that has to be addressed. I am very disappointed with the results of the Omnibus Bill. I vowed to vote against it no matter what was in it because I suspected mischief. This happened a few years ago the last time we passed an Omnibus Bill. NSF was one of the principle victims of that. I do not know what the reasons are for, in the appropriations process or within the committees within the House and the Senate, but I am afraid that NSF appears to be an easy victim to pilferage during an Omnibus appropriations process.

And I will do all I can, and I suspect my colleagues here will join me, in saying we will never, ever support another Omnibus Bill. We will do whatever we can to fight it.

I also have encouraged the White House and various members working in the White House, including the President, to, if another Omnibus is presented, to flatly reject it and tell the Appropriations Committees to go back and do their work the way they are supposed to do it.

It is unconscionable to me that a small group of individuals succeed in destroying an excellent organization such as the National

Science Foundation by arbitrarily cutting the funding without considering all the factors that go into the operation of the organization.

So you have our sympathies. You are here defending the indefensible in the sense that the budget presented is based largely on what was passed last year, and you have our sympathies. We are with you. It is essential for us to work together to make certain that the funding increases and that we do not have another Omnibus Bill disaster this coming year.

Thank you very much.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

In the fiscal year 2009 budget request, the Administration has requested increases for both the research and educational mission of the National Science Foundation. However, the proposed increases fall short of the authorizations provided in the COMPETES Act of 2007, which established a seven-year doubling path for the NSF. After a below-inflationary increase provided in FY08, NSF has fallen off the doubling path. With a 13 percent increase requested for the agency coupled with less-generous budgets for other agencies, some even within the same funding subcommittee, NSF is going to have to work hard to defend and justify the reasoning behind the substantial increase. In order to return to the doubling path in FY09, I believe NSF should be funded at the level authorized by the COMPETES Act.

Unfortunately, we know first-hand what shortfalls mean for NSF. For the remainder of FY08 NSF must defer solicitations and facilities maintenance, will award 1,000 fewer research grants, fund 230 fewer research fellows, and negatively impact more than 3,000 students and teachers. These are just a few of the known impacts of the unanticipated shortfall created by the FY08 omnibus. I am very concerned that federal apathy to NSF is encouraging young scientists is to choose another career.

Finally, while I recognize NSF has defended the successes of the Math and Science Partnerships, I am disappointed that only a $2.5 million increase is requested for this program. As reauthorized by the COMPETES Act, the MSP program has the potential to make a great impact on science, technology, engineering and math (STEM) education in this country. This is simply not possible with its current budget.

I look forward to hearing from our witnesses about the new initiatives proposed in the FY09 budget, the thriving programs bearing consistent fruit, and how we can work together to implement the COMPETES Act.

Chairman BAIRD. Dr. Ehlers, thanks for your comments and your passion in this. I share that, you know. It is—if we look at this budget and it is posing some substantial increases, but as we all know here, the budget that proposes increases without the weight of an Administration fighting to sustain those increases really won't mean anything down the road, and indeed, the result of the appropriations process and the Omnibus, which I also did not support, was because of an Administration mandate to reduce 20 some billion dollars out of that. Much of that cost, unfortunately, fell to NSF and some other agencies.

So it is a nice thing to put forward a budget that calls for increases. It certainly beats the reverse. So we are happy about that, but in and of itself is not enough. And so we share the concern about that and the gentlemen here are not responsible for that. You worked very hard to put forward a sound budget, and we are grateful for that.

I want to acknowledge the presence of Dr. McNerney and Dr. Lipinski. Thank you for joining us, gentlemen. As is the custom of the Committee, if there are any Members who wish to submit opening remarks for the record, we are happy to introduce those.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman. I want to also welcome Drs. Bement and Beering today to testify on the National Science Foundation budget plans for fiscal year 2009 and how those plans will fund programs in the *America COMPETES Act,* as well as current NSF initiatives.

The National Science Foundation is our nation's premier supporter of research and development in the physical sciences. NSF also plays a key role in math and science education programs.

Over the years, NSF has enabled under-represented and minority populations to attain degrees in these fields and to excel. I want to commend the foundation for this work.

When the President signed the *America COMPETES Act* into law and expressed interest in investment into American competitiveness initiative programs, a new era began.

NSF is now tasked with utilizing limited financial resources to support an expanded number and size of programs.

Members of this committee are interested in a dialogue with you on how you will accomplish funding objectives, and we support your efforts.

I would like for you to particularly keep the "Broadening Participation" programs in mind, like the Noyce Teacher Scholarship, and others that I will submit in my written testimony today and as additional budget "Views and Estimates" published by this committee.

Thank you, Mr. Chairman. I yield back the balance of my time.

Supplemental material: key NSF programs that broaden participation by under-represented groups.

- Science, Technology, Engineering and Math Talent Expansion Program (STEP)
- Advanced Technology Education (ATE)
- Experimental Program to Stimulate Competitive Research (EPSCoR)
- Partnerships for Access to Laboratory Science—Sec 7026 of COMPETES Act
- Hispanic-serving Institutions Undergraduate Program—Sec 7033 of COMPETES Act
- Faculty Early Career Development (CAREER) Program
- Informal Science Education (ISE)
- ADVANCE Women's Program
- Broadening Participation in Computing (BPC)
- Graduate Research Fellowships—Women in Engineering and Computer Science
- Opportunities to Enhance Diversity in the Geosciences (OEDG)
- Minority Post-Docs
- Graduate Research Diversity (GRD)—ENG
- Significant Opportunities in Atmospheric Research and Science (SOARS)—GEO

Chairman BAIRD. The Chair will now introduce our witnesses, and if ever there is a case where the introduction I am giving is understated, giving the distinguished careers of these two gentlemen, please forgive us. In the interest of hearing your wisdom we will keep the introductions brief.

But Dr. Arden Bement is the Director of the National Science Foundation. Dr. Steven Beering is the Chairman of the National Science Board. Very brief introductions for some extraordinary careers.

As our witnesses should know well from prior testimony here, spoken testimony is limited to five minutes, but that is really designed to hit the highlights and then we will have a good exchange. And always I want to invite, especially gentlemen such as yourselves, if there are things that we don't cover in our questions but

you feel you want to elaborate on, please, this is a friendly process and feel free to elaborate on that.

We will start our testimony with Dr. Bement. Thank you again.

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

Dr. BEMENT. Yes, Mr. Chairman. If I may before reading my prepared remarks, I want to reflect on your opening remarks.

In spite of the '08 Omnibus Bill I want to express on behalf of the National Science Foundation our deep gratitude for the very strong support this committee gave our entire budget but also the programs within the budget.

I also want to express our appreciation for the confidence you have shown us in increasing the education authorization and the specific programs in the *America COMPETES Act.* I believe that we have outstanding programs, and they are very much in the interest of the Nation, and I appreciate your support.

Going on with my remarks, I am pleased to present the National Science Foundation——

Chairman BAIRD. We won't count that against you. We don't count compliments of the Committee against your time, your five-minute time. Doctor, I should acknowledge, also, the various directorates that are along here with you today. We want to thank them for their work. They probably won't be testifying, but thank you for coming and for your work.

Please proceed, Dr. Bement.

Dr. BEMENT. Thank you. Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee, I am pleased to present the National Science Foundation's budget for the 2009 fiscal year.

NSF proposes an investment of $6.85 billion to advance the frontiers of science and engineering research and education. Our budget request includes an increase of $789 million or 13 percent over fiscal year 2008. This increase is necessary to put NSF back on the course that was chartered by the *America COMPETES Act* and the President's American Competitiveness Initiative.

This budget reflects the Administration's continued resolve to double overall funding for the NSF within 10 years.

I would also like to thank you for recognizing the importance of our Agency Operations and Award Management account in the 2008 Omnibus appropriation. Our stewardship activities allow us to serve award recipients with tools such as the new grants management website, research.gov, and this is a tough account to get strong support.

The timing of this testimony coincides with a period of economic uncertainty in our country. I have come here today to tell you that an investment in the National Science Foundation is an investment in America's economic security. NSF provides two essential ingredients of a healthy, high-tech economy; basic research discoveries and a highly-trained work force.

For over 50 years NSF has been the foundation of innovation, fostering great ideas and the great minds who discover them. NSF discoveries have led to many of the technological innovations you and I take for granted today, and yet for fiscal year 2008 NSF's budget increase fails to keep up with inflation.

By contrast, other nations of the world are steadily increasing their investments in STEM education and basic R&D. I assure you multi-national companies will have no problem relocating their operations to the countries where they can find the best-trained workforce and the latest research ideas.

The world is changing. Lead times for new products are shrinking. Now more than ever basic research discoveries are essential to keeping the wheels of innovation turning in America's high-tech companies. It is not nearly enough to maintain the federal R&D investment status quo. It is our solemn obligation to keep up with corporate America's demand for innovative people and ideas.

At NSF we are responsible to emerging potentially transformative areas of research. I would like to highlight some of our new cross-cutting, multi-disciplinary initiatives. We created these initiatives in response to the input we received from the research communities we serve.

We request $100 million to continue Cyber-enabled Discovery and Innovation, our bold five-year initiative to apply revolutionary computational tools and concepts to all fields of science, engineering, and education.

Our request includes $20 million for Science and Engineering beyond Moore's Law. This initiative aims to position the United States at the forefront of communications and computation, moving us beyond the limitations of current systems.

We are requesting $15 million to fund Adaptive Systems Technology, our new effort aimed at using all aspects of biological science to inspire transformative new technologies.

Our request of $10 million for the Dynamics of Water Processes in the Environment initiative will bring together researchers from various disciplines to enhance our ability to understand the complexities of fresh water systems at regional and local levels.

In addition to our ongoing efforts in transformative research, we believe that a truly competitive workforce is one that reflects the full potential and diversity of the American people themselves. Our efforts to broaden participation in science and technology targets students at all education levels and from all geographic areas. We train the Nation's skilled workforce by providing research opportunities for undergraduates, graduate students, and post docs.

We research and evaluate effective STEM curricula for the Nation's K to 12 classrooms and provide opportunities for teacher education, and we develop innovative programs for informal science and technology learning for students young and old in museums, through the mass media, and through other outreach activities that touch the imaginations of millions of Americans.

Mr. Chairman, time does not permit me to describe the many other numerous activities NSF sponsors to strengthen and support our nation's science and technology research and education. NSF's relatively small size belies its catalytic impact on all sectors of the economy. I am hard pressed to think of another example in which the taxpayers derive such a tremendous return on investment.

Thank you for extending me the invitation to speak with this subcommittee today, and I look forward to answering your questions.

[The prepared statement of Dr. Bement follows:]

PREPARED STATEMENT OF ARDEN L. BEMENT, JR.

Chairman Baird, Ranking Member Ehlers and Members of the Subcommittee, I am pleased to present the National Science Foundation's budget for the 2009 fiscal year.

The National Science Foundation (NSF) proposes a fiscal year 2009 investment of $6.85 billion to advance the frontiers of research and education in science and engineering. Our budget request includes an increase of $789 million—or 13 percent—over the current fiscal year 2008 amount. This increase is necessary to put NSF back on the course that was charted by the President's American Competitiveness Initiative (ACI) and by the *America COMPETES Act*. This year's budget reflects the Administration's continued resolve to double overall funding for the ACI research agencies within 10 years.

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 under-pins 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 leads the world in its level of public and private R&D investment, our counterparts around the globe are well aware of the importance of funding R&D. A string of recent reports have found evidence that China is rapidly accruing global technological standing, including an OECD finding that China was set to become the second-highest investor in R&D among world nations in 2006, behind only the United States.[1,2,3] Over the last two decades, U.S. federal support of research in the physical sciences, mathematics, and engineering has been stagnant when adjusted for inflation. As a percentage of GDP, the U.S. Federal Government has halved its investment in physical science and engineering research since 1970. Conversely, the Chinese government has more than doubled its GDP percentage expenditure in R&D since 1995.[4]

More than a dozen major studies have now concluded that a substantial increase in federal funding for basic scientific research is critical to ensure the preeminence of America's scientific and technological enterprise.

Just 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."[5]

For over fifty 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 a full fifty percent of non-life science basic research at academic institutions. NSF is the research funding lifeline for many fields and emerging interdisciplines at the frontiers of discovery. In fact, NSF is the only federal agency that supports all fields of basic science and engineering research.

NSF relies on a merit-based, competitive process that is critical to fostering the highest standards of excellence and accountability—standards that have been emulated at other funding agencies around the world.

NSF Supports American Innovation

The Foundation of Innovation

NSF often funds a technology in its earliest stages, frequently before other agencies or industries get involved. NSF funding was involved in the developmental phase of the technology used in magnetic resonance imaging (MRI) now ubiquitous in diagnostic medicine, the research that led to the development of silicon-coated

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[1] *http://www.oecd.org/document/26/0,2340,en_2649_201185_37770522_1_1_1_1,00.html*
[2] *http://www.tpac.gatech.edu/hti2007/HTI2007ReportNSF_012208.pdf*
[3] *http://www.nsf.gov/statistics/nsf07319/pdf/nsf07319.pdf*
[4] *Ibid.*
[5] Augustine, Norman. *Is America Falling off the Flat Earth?* National Academies Press.

glass used in flat panel displays, and the early investigations that led to green and blue light-emitting diodes used in cell phone displays and traffic lights. In 1952, Caltech Professor Max Delbruck used one of NSF's first grants to invent molecular biology techniques that enabled one of his students, James Watson, to discover the molecular structure of DNA, and another Nobel laureate, David Baltimore, to unravel some of its mysteries.

In a more recent example, NSF CAREER awardee Jay Keasling, now the head of the NSF-sponsored Synthetic Biology Engineering Research Center at the University of California–Berkeley, and two post-doctoral researchers from his lab founded Amyris, a company that is taking a revolutionary approach to chemical manufacturing by harnessing metabolic processes in microorganisms. Through genetic engineering, the researchers "program" the microbes to churn out useful chemicals, bypassing traditional, more expensive methods. Amyris has engineered a strain of yeast that can produce large quantities of artemisinic acid, a precursor to a compound found naturally in a plant that fights malaria but is currently in short supply. Amyris is also developing a fermentation process to deliver a biofuel gasoline substitute. NSF funding of the early research conducted at Berkeley enabled the discoveries that led to this promising new company, named 2007 "Business Leader of the Year" by *Scientific American* magazine.

NSF as an agency is itself the origin of transformative practices. One new NSF innovation is *Research.gov,* which is fulfilling our vision of a seamless interface between government funding agencies and the investigators we support. *Research.gov* is a one-stop shop, where researchers can go to manage their existing portfolio of grants and explore new opportunities. *Research.gov* is a tool that streamlines the process of applying for federal grants, making it easier and more cost-effective for the Federal Government to serve its customers.

Educating Tomorrow's Workforce

Beyond all of our efforts to advance the frontiers of knowledge and spur innovation, NSF is dedicated to educating and training the Nation's skilled labor force. NSF plays a role in science, technology, engineering, and math (STEM) education at every educational level. Our contribution to education may ultimately be NSF's most profound and meaningful legacy.

The scientists, technologists, engineers, and mathematicians trained through NSF's integration of research and education transfer the latest scientific and engineering concepts from universities directly to the entrepreneurial sector when they enter the workforce.

Our graduate research fellowship (GRF) program has supported several notable technologists and scientists early in their professional training. Prominent economist Steven Levitt, co-author of the popular book *Freakonomics,* was an NSF GRF recipient from 1992 to 1994. Sergey Brin, co-founder of Google, was an NSF graduate research fellow in the mid-1990s when he began thinking about how to create an Internet search engine. NSF's GRF program is as old as the foundation itself, and gives young scientists an early career charge, allowing them to go on to greatness. At least three Physics Nobel Prize winners are former NSF GRF recipients. We are extremely pleased with the proposed $29 million increase in the GRF program's funding for fiscal year 2009 which will enable us to fund an additional 700 promising young American investigators. A recent article from the National Bureau of Economic Research suggests that an increase in the number of GRF awards would help to supply an increased demand for talented individuals in the American science and technology workforce that will result from an increase in R&D spending.[6]

At some point in their careers, nearly 200 Nobel Prize-winning scientists received NSF funding for research in chemistry, physics, medicine, and economics. And scores of NSF-supported scientists shared a measure of the 2007 Nobel Peace Prize as members of the United Nation's Intergovernmental Panel on Climate Change.

To strengthen the educational institutions that benefit from NSF awards, the Directorate for Education and Human Resources (EHR) program, Innovation through Institutional Integration (I3), challenges institutions to think strategically about the creative integration of NSF-funded awards. This provides the opportunity for NSF-grantees at particular institutions to cooperate and share a common vision for improved educational excellence at their institution.

[6] Freeman, Richard. The Market for Scientists and Engineers. *NBER Reporter,* 2007 No. 3, pp. 6–8.

America COMPETES Act Compliance

The *America COMPETES Act* contains several requirements for NSF. We are actively processing those directives and devising plans to implement them in a timely manner. In the FY 2009 request, activities that overlap with the President's American Competitiveness Initiative receive top priority. These priority areas do include strong links to other fields, and our request includes across-the-board increases for all directorates.

We are currently evaluating how to best ramp up the Robert Noyce Teacher Scholarship Program to bring an infusion of talented teachers into the Nation's K–12 education system. To launch such a large-scale program, we will carefully evaluate what we need to do to maximize its societal impact and success. We will apply what we have learned from our other successful scholarship programs to ensure the program is administered in the best possible way.

We are also working how best to evaluate grant applicants' plans for training undergraduates, graduate students, and post-docs in responsible and ethical conduct of research. A number of our programs including our Centers and the Integrative Graduate Education and Research Traineeship (IGERT) program already contain ethics components. We will add a new certification requirement for institutions, which will require the institution to have a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research for all undergraduates, graduate students, and post-docs participating in the NSF-funded research project.

Open access to research results is an essential component of a strong and healthy scientific enterprise. We currently make available the citations of NSF-funded research on both the NSF website and on *Research.gov*. To further the goal of disseminating the results of NSF-funded research, we will develop revised reporting guidelines for NSF principle investigators (PIs). These guidelines will enable the PIs to summarize the key accomplishments of their NSF-funded work, including scientific findings, student training, and professional development activities. This information will be made available on the NSF website.

2009 Budget Request Highlights

At NSF, we understand that new discoveries are the main 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 2009 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 $6.85 billion for the NSF in FY 2009. That's an increase of almost $789 million, or 13 percent above the current 2008 appropriated amount. While it seems like a large increase, this level is necessary to fulfill the President's vision for physical science and basic research set forth in the American Competitiveness Initiative. The FY 2009 request is squarely in line with the goal of doubling of ACI research agency budgets over 10 years. 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 major NSF appropriations account. Research and Related Activities investments increase by 16 percent, and our Education and Human Resources account is increased by 8.9 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.

Here are highlights of some of the key investments we are emphasizing in our 2009 budget.

Cyber-enabled Discovery and Innovation

Cyber-Enabled Discovery and Innovation (CDI) is expected to create revolutionary science and engineering research results using "computational thinking"—thinking that encompasses all possible computational concepts, methods, models, algorithms, and tools. Computational thinking is relevant to all fields of science, engineering and education, and promises to have a profound impact on our nation's ability to generate and apply new knowledge. We expect CDI research to produce paradigm shifts in our understanding of a wide range of science and engineering phenomena, and we anticipate socio-technical innovations to create new wealth and enhance the national quality of life. By investing in CDI, NSF continues its leadership in ena-

bling the United States to preserve its role as the world leader in information technology.

Requested Funding Level: $100 million

Science and Engineering Beyond Moore's Law

"Moore's Law" refers to the empirical observation made in 1965 by Intel co-founder Gordon Moore that the speed of computer processing based on semiconductor integrated circuits doubles about every 18 months. With current silicon technology, we expect to reach the physical and conceptual limits of Moore's Law within 20 years. If we are ever to solve the computational challenges inherent in today's great scientific questions, we must find a way to take computing power and communications beyond Moore's Law. To get there, we'll need entirely new scientific, engineering, and conceptual frameworks. Fundamental research across many disciplines will be called upon to deliver the new hardware, architectures, algorithms, and software of the computers of tomorrow.

Requested Funding Level: $20 million

Adaptive Systems Technology

Recent progress in probing the secrets of biological systems has been explosive. We are only just beginning to see the application of these new and transformational discoveries to the development of engineered systems, especially at the interface between human and machines. We call our new interdisciplinary endeavor—research at the convergence of human and mechanical systems—Adaptive Systems Technology (AST). New applications and technologies resulting from AST have already demonstrated substantial economic potential. Artificial retinas and cochlea, electronic language translators, and smart hand-held electronics are just a handful of the products that have already come to market at the human-machine interface. NSF's broad portfolio encompasses the diverse research areas involved in this new interdisciplinary effort. Biologists uncover nature's progression from simple to complex nervous systems; physicists and chemists explain the fundamental processes underlying complex neural organization and communication pathways; mathematicians, computer scientists and cognitive scientists explore how systems compute; learning and behavioral scientists provide insights into how organisms learn and adapt to their environment; while engineers allow the design, analysis and construction of systems that mimic living nervous system networks. By working together, these scientists and engineers can benefit from the knowledge and experience of experts in other fields, developing new concepts through collaboration and idea-sharing.

Requested Funding Level: $15 million

Dynamics of Water Processes in the Environment

This activity will build upon NSF's considerable track record on fundamental water research, while utilizing our unique ability to cross disciplinary boundaries to bring together the separate communities of researchers working on the varying aspects of water science. Water is fundamental to every economic activity in the country, and yet, we do not have a full understanding of the effects of human interventions and changing environmental conditions on the availability and quality of fresh water. The economic driving forces for understanding water processes are compelling: droughts alone cause average damages of $6 to $8 billion dollars annual in the United States. Understanding water dynamics is also essential to understanding climate and environmental change. NSF's investment in Dynamics of Water Processes in the Environment will enhance our ability to understand complex freshwater systems at regional and local levels, taking advantage of advanced observation networks, cyberinfrastructure, and integrated databases.

Requested Funding Level: $10 million

National Nanotechnology Initiative

NSF leads the U.S. nanotechnology research effort, and we remain strongly committed to supporting this vital emerging industry. Our goal is to support fundamental research and catalyze synergistic science and engineering research and education in emerging areas of nanoscale science and technology. We are also committed to research directed at the environmental, health, and safety impacts of nanotechnology. Novel materials, devices, and systems—with their building blocks designed on the scale of nanometers—open up new directions in science, engineering, and technology with potentially profound implications for society. With the capacity to control and manipulate matter at this scale, science, engineering, and technology are realizing revolutionary advances in areas such as individualized pharma-

ceuticals, new drug delivery systems, more resilient materials and fabrics, catalysts for industry, and order-of-magnitude faster computer chips.

Requested Funding Level: $397 million

Climate Change Science Program

Scientists predict that the climate of the Earth is changing rapidly, and we have much to learn about how climate affects human activities, how human activities affect climate, and what we can do to protect human life and health in the face of disruptive climate events. The Climate Change Science Program (CCSP) was established in 2002 in response to the challenge of understanding climate and climate variability. Science-based knowledge is absolutely essential to our ability to predict the changes that are likely to take place, and devise informed plans to mitigate the negative impacts of climate change on humanity. The CCSP engages thirteen U.S. agencies in a concerted interagency program of basic research, comprehensive observations, integrative modeling, and development of products for decision-makers. Consistent with the FY 2009 Interagency Implementation Priorities memo, NSF provides support for the broad range of fundamental research activities that form a sound basis for other mission-oriented agencies in the CCSP, and the Nation at large.

Building on our agency's particular strengths, NSF encourages interdisciplinary activities and focuses particularly on Earth system processes and the consequences of change. Our priorities include the management of enormous amount of data necessary for accurate global change modeling and research, the refinement and improvement of computational models, and the development of new, innovative Earth observing instruments and platforms.

Requested Funding Level: $221 million

International Science and Engineering

International collaboration is essential to the health of the Nation's research enterprise. The importance of international partnership continues to increase as globalization "shrinks" our world. Consequently, our funding request for the Office of International Science and Engineering is increased by nearly 15 percent to $47.4 million. A major focus in our budget is the Partnerships for International Research and Education (PIRE) program, which increases by $3.0 million to $15.0 million. This program funds innovative, international collaborative research projects that link U.S. institutions and researchers at all career levels with premier international collaborators to work at the most promising frontiers of new knowledge.

Broadening Participation

NSF remains a leader in efforts to broaden participation in science and engineering, so that America's science and engineering enterprise is as diverse as the Nation from which it draws its workforce. Our 2009 request for the Experimental Program to Stimulate Competitive Research (EPSCoR) program increases to $113.5 million. We are also increasing our request for several programs designed to reach out to under-represented groups, including Alliances for Graduate Education and Professoriate (AGEP), the Historically Black Colleges and Universities–Undergraduate Program (HBCU–UP), the Louis Stokes Alliances for Minority Participation (LSAMP), and Centers of Research Excellence in Science and Technology (CREST).

Enhancing Opportunities for Beginning Researchers (CAREER)

The 2009 request provides an increase of approximately $14 million for funding of the CAREER program. This increase will allow us to award some 34 more CAREER awards than in FY 2008. CAREER awards support exceptionally promising college and university junior faculty who are committed to the integration of research and education. Our experience with previous CAREER awardees has proven that these faculty become the research leaders of their respective fields, and this program is vital to fostering the success of emerging science and technology leaders.

Requested Funding Level: $182 million

Stewardship

NSF's Stewardship goal, to support excellence in science and engineering research and education through a capable and responsive organization, remains a priority in the 2009 budget, with a 13 percent increase to $404.3 million. Our request increases the NSF workforce by 50 staff to enable us to manage our growing and increasingly complex workload. Investments in information technology (IT) increase by 32 percent to $82.0 million, with an emphasis on increasing the efficiency, productivity, and transparency of NSF's business processes. In this request, NSF's IT portfolio

is realigned to tie funding for mission-related activities more directly to NSF's programs.

Requested Funding Level: $404 million

Major Research Equipment and Facilities Construction (MREFC) account

NSF will continue to support a portfolio of ongoing projects in the Major Research Equipment and Facilities Construction account (MREFC), including the Atacama Large Millimeter Array, Ice Cube, and Advanced LIGO.

The Foundation continues to be committed to the Alaska Regional Research Vessel (ARRV), the National Ecological Observatory Network (NEON), and the Ocean Observatories Initiative (OOI). However, in keeping with new NSF policies, Administration and Congressional mandates, and guidance from the National Science Board, NSF has adopted more stringent budget and schedule controls to improve our stewardship of taxpayer dollars. We are postponing requests for additional funding for those projects until they have undergone a final design review, completed a risk management plan, and developed a rigorous baseline budget, including carefully considered contingencies.

NSF's MREFC portfolio includes late-stage design-phase funding for the proposed Advanced Technology Solar Telescope (ATST), which if carried into the construction phase would be the first large U.S. solar telescope built in the past 30 years. ATST would reveal critical information needed to explore crucial mysteries such as: What are the mechanisms responsible for solar flares, coronal mass ejections and space weather, with their associated impact on satellites, communications networks, and power grids? What are the processes that cause solar variability and its impact on the Earth's climate and evolution? The ATST project is managed by the National Solar Observatory, which administers the world's leading collection of solar telescopes.

Requested Funding Level: $2.5 million

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 rethink 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 increasingly relies on government support for high-risk, high-reward basic research. If we fail to provide adequate support of the technological sector now, we may well reduce our own economic security. 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. Regardless of our action or inaction as a nation, the world is full of highly motivated

and increasingly skilled workers who are working hard to improve their economic standing and well-being. We can either innovate, and keep our economic prosperity, or stagnate, and suffer the consequences of inaction.

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., became Director of the National Science Foundation on November 24, 2004. He had been Acting Director since February 22, 2004.

He joined NSF from the National Institute of Standards and Technology, where he had been Director since Dec. 7, 2001. As head of NIST, he oversaw an agency with an annual budget of about $773 million and an on-site research and administrative staff of about 3,000, complemented by a NIST-sponsored network of 2,000 locally managed manufacturing and business specialists serving smaller manufacturers across the United States. Prior to his appointment as NIST Director, Bement served as the David A. Ross Distinguished Professor of Nuclear Engineering and head of the School of Nuclear Engineering at Purdue University. 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.

Bement came to the position as NIST Director having previously served as head of that agency's Visiting Committee on Advanced Technology, the agency's primary private-sector policy adviser; as head of the advisory committee for NIST's Advanced Technology Program; and on the Board of Overseers for the Malcolm Baldrige National Quality Award.

Along with his NIST advisory roles, Bement served as a member of the U.S. National Science Board from 1989 to 1995. The board guides NSF activities and also serves as a policy advisory body to the President and Congress. As NSF Director, Bement now serves as an ex officio member of the NSB.

He currently serves as a member of the U.S. National Commission for UNESCO and serves as the Vice-Chair of the Commission's Natural Sciences and Engineering Committee.

Bement joined the Purdue faculty in 1992 after a 39-year career in industry, government, and academia. These positions included: Vice President of Technical Resources and of Science and Technology for TRW Inc. (1980–1992); Deputy Under Secretary of Defense for Research and Engineering (1979–1980); Director, Office of Materials Science, DARPA (1976–1979); Professor of Nuclear Materials, MIT (1970–1976); Manager, Fuels and Materials Department and the Metallurgy Research Department, Battelle Northwest Laboratories (1965–1970); and Senior Research Associate, General Electric Co. (1954–1965).

He has been a Director of Keithley Instruments Inc. and the Lord Corp. and was a member of the Science and Technology Advisory Committee for the Howmet Corp. (a division of ALCOA).

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 degree in metallurgical engineering from the University of Michigan, an honorary doctorate degree in engineering from Cleveland State University, an honorary doctorate degree in science from Case Western Reserve University, an honorary doctorate degree in engineering from the Colorado School of Mines, and a Chinese Academy of Sciences Graduate School Honorary Professorship. He is a member of the U.S. National Academy of Engineering and a fellow of the American Academy of Arts and Sciences.

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

Dr. BEERING. Good morning, Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee. I very much appreciate the opportunity to address you today. My name is Steven Beering, and I am the Chairman of the National Science Board. I am honored to represent the 24 members of this Board before you today.

Let me first thank the Members of the Subcommittee for your long-term commitment and support of the National Science Foundation and its investments in a broad portfolio of research and education. We also applaud your strong bipartisan support for legislation over the past year that will bolster U.S. leadership in science and technology, including the passage of H.R. 2272, the *America COMPETES Act.*

The National Science Board and the broader science and engineering community were surprised and disappointed by the actual appropriations in the fiscal year 2008 Omnibus Bill, which erased most of the anticipated increases in support for research. In such an uncertain funding climate we are concerned with the signal this sends to our potential partners in international science projects, but also the message we send to international and American students who may be deterred from pursuing science and engineering careers in this country.

As many other countries invest heavily in science and engineering research, graduate a record number of scientists and engineers, and increase incentives to attract outstanding international students and scholars, it is a dangerous time for the U.S. to neglect our science and engineering enterprise.

The National Science Board is committed to helping this country maintain our leadership in science and technology. In addition to its policy and oversight role at NSF, the Board has also addressed a number of significant policy issues for U.S. science and engineering. The Board is working, for example, with NSF to implement recommendations in several recent education reports, including a *"National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering and Mathematics Education System," "Moving Forward to Improve Engineering Education,"* the *"Hurricane Warning, the Critical Need for a National Hurricane Research Initiative," "Enhancing Support of Transformative Research at the National Science Foundation,"* and the *"Science and Engineering Indicators 2008,"* which includes the *"Digest of Key Science and Engineering Indicators"* and the companion piece policy statement entitled, *"Research and Development: Essential Foundation for U.S. Competitiveness in a Global Economy."*

We will be introducing an additional report next month on *"International Science and Engineering Partnerships, A Priority for U.S. Foreign Policy and Our Nation's Innovation Enterprise."*

In response to the *America COMPETES Act,* the Board has undertaken a number of actions. We recently sent reports to Congress to make recommendations on NSF policies regarding cost sharing and on pre-construction and management and operations cost coverage under the Major Research Equipment and Facilities Construction Account and will be preparing a final report for Congress on this subject this year.

The Board is also reviewing the impacts of NSF policies on interdisciplinary research and on limiting the number of proposals per institution of higher education for some awards. The Board will report back to Congress on both of these issues by August of this year. Finally, the Board will evaluate a pilot program of grants for new investigators at NSF and report the findings to Congress by August of 2010.

For fiscal year 2009, the request for the National Science Board is $4.03 million, an increase of 1.5 percent over fiscal year 2008. Next year's budget will allow the Board to strengthen its oversight in policy duties for NSF and provide independent scientific advice for the President and Congress.

In addition, the Board will continue to increase communication and outreach with all of our stakeholders. For example, we continue to engage with numerous stakeholders to implement recommendations from our STEM Education Action Plan.

The National Science Board supports the fiscal year 2009 budget for NSF and for basic science research in other agencies at the President's request, so that we can begin to make up for the opportunities that we will miss this year under the fiscal year 2008 Omnibus Appropriations Bill.

You have my pledge on behalf of the Board that we will continue to work closely with the NSF Director to insure that funding decisions continue to provide maximum returns on the taxpayers' investment and our nation's future.

Thank you very much.

[The prepared statement of Dr. Beering follows:]

PREPARED STATEMENT OF STEVEN C. BEERING

Chairman Baird, Ranking Member Ehlers and Members of the Committee, I appreciate the opportunity to address you today. My name is Steven Beering, and I am the Chairman of the National Science Board. I am honored to represent the twenty-four members of the National Science Board before you today.

On behalf of the entire National Science Board,[1] I would like to thank the Members of this Subcommittee for your long-term commitment in support of the National Science Foundation and its investments in a broad portfolio of research and education in science, technology, engineering, and mathematics. We also applaud your strong bipartisan support for legislation over the past year that will bolster U.S. leadership in science and technology, including the passage of H.R. 2272, the *America COMPETES Act,* last August. The science and engineering communities were also encouraged to see that this committee recommended increases in funding for basic scientific research in the *Commerce, Justice, Science, and Related Agencies Appropriations Act* last year. With the President and Congress in agreement about the importance of science and engineering research and education for U.S. innovation and competitiveness, the stakeholders in science and engineering research and education looked forward to advances in discovery and innovation that would be enabled by the promised budget increases.

The National Science Board and the broader science and engineering community were surprised and disappointed by the actual appropriations in the fiscal year 2008 omnibus bill, which erased most of the anticipated increases in support for research. Now, instead of expanding research activities as planned, we are confronted with the possibility of layoffs for outstanding researchers in our National Laboratories and the frustrating reality that our federal research funding programs will be forced

[1] The National Science Board was established by Congress in the National Science Foundation Act of 1950 to oversee the activities of the National Science Foundation and to serve as an independent advisory body to the President and Congress on national policy issues related to science and engineering research and education. The twenty-four members of the Board are national leaders in diverse areas of science and engineering research and education from around the country, who are nominated by the President and confirmed by the Senate to serve six-year terms. The NSF Director also serves as an ex-officio member of the Board.

to turn away many innovative ideas that would have received awards if funding had been in keeping with the objective of doubling over 10 years for NSF, National Institute of Science and Technology in Department of Commerce, and the Office of Science at the Department of Energy.

The 2008 omnibus bill has significantly impacted the National Science Foundation's mission to support basic research in the United States. The 1.3 percent increase in the research and related activities budget is below the rate of inflation, and thus represents a decline in support for these activities. If the FY 2008 omnibus were in line with the budget doubling that was supported by the President's American Competitiveness Initiative and the *America COMPETES Act,* NSF estimates that they would have been able to award 1,000 more grants and 230 more graduate research fellowships this year. NSF has also shelved several program solicitations that were planned for 2008, including a new program in Computer and Information Science and Engineering for the development of a competitive workforce and the Office of Polar Programs' program on Climate Change and Changing Seasonality in the Arctic program.

In such an uncertain funding climate, we are concerned with the signal this sends to our potential partners in international science projects but also the signal sent to international and American students who may be deterred from pursuing science and engineering careers in this country. As many other countries invest heavily in science and engineering research, graduate a record number of scientists and engineers, and increase incentives to attract outstanding international students and scholars, it is a dangerous time for the U.S. to neglect our science and engineering enterprise.

Although the United States is still the world leader in science, technology, and engineering, the findings of the National Science Board and of many other eminent bodies representing a wide range of perspectives, from think tanks, industry, academia, and government, indicate that urgent and sustained action is required to maintain our leadership. During these difficult economic times, when industry may be forced to cut back basic research investments for short-term survival, it is particularly critical for the Federal Government to ensure our innovative capacity through basic research and workforce training in science and engineering. The American public agrees: the National Science Board's *Science and Engineering Indicators 2008* reports that according to the most recent NSF survey, in 2006, public support for federal investments in basic scientific research is at its highest level since inception of the survey in 1979.

Overview of National Science Board Activities in FY 2007–2008

The National Science Board is committed to helping this country maintain our leadership in science and technology. Over the past year, in its oversight role for NSF, it has reviewed and endorsed the Office of Inspector General's Semi-annual Reports to Congress and approved the NSF management response; we approved the Foundation's Budget Submission for transmittal to OMB; reviewed the Foundation's annual Merit Review Report; and provided review and decisions on major awards or proposal funding requests for 13 awards, with a total approved funding of over $1.08 billion.

The Board also addressed a number of significant policy issues for U.S. science and engineering, in accord with our statutory mission—far more than I will have time or space to describe here. I would like to briefly outline the Board's conclusions from a number of reports it has issued, and also to present our priorities for the upcoming year.

First, I will highlight some of our major accomplishments, including those activities that specifically address Congressional concerns.

NSF Oversight and Policy Directions

Science, Technology, Engineering and Mathematics (STEM) Education—The Board is working with NSF to implement recommendations in several recent education reports. In October, the Board released *A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System* in response to a request from Congress. The report outlines a number of actions that local, State, and federal stakeholders can take to improve the Nation's STEM education system. In that report, the Board first recommends greater coherence in the STEM education system, vertically across grade levels and horizontally across States. The second priority recommendation is to ensure that students are taught by well-prepared and highly effective teachers. A number of NSF programs are identified specifically as contributing to the development of human capital in the science and engineering workforce, including STEM teachers. These include Louis Stokes Alliance for Minority Participation (LSAMP),

Research Experiences for Undergraduates (REU), the Robert Noyce Scholarship program, and the Math and Science Partnerships program as examples of NSF programs that prepare effective teachers. We are pleased to see that the budget provides additional funds for MSP, the Noyce Scholarship and other programs that contribute to the Board's objectives for the STEM teaching workforce.

Another report, *Moving Forward to Improve Engineering Education,* recommended a number of actions for NSF to build upon its innovative programs in engineering education to attract, retain, and train American engineers from diverse backgrounds to meet domestic needs and growing international competition.

Transformative Research—Occasionally in the course of scientific research endeavors, a new finding revolutionizes a field or creates new sub-fields of discovery. The willingness of review panels to take risks on potentially transformative proposals is an area of continual attention at the National Science Foundation in keeping with its mission to support discovery through funding basic research. We recognize that risk aversion in recommendations for funding by review panels is likely to increase as funding becomes increasingly competitive. However, we also recognize that our nation cannot afford to miss out on revolutionary ideas. Therefore, the Board formed a task force on transformative research, which issued a report last May entitled *Enhancing Support of Transformative Research at the National Science Foundation.* In the report, the Board recommends that NSF implement a Transformative Research Initiative, and is currently working with the NSF to implement this recommendation.

Implementation of the America COMPETES Act—In response to the *America COMPETES Act,* the Board has undertaken a number of actions. The Board recently sent reports to Congress to make recommendations on NSF policies regarding cost-sharing and on pre-construction and management and operations cost coverage under the Major Research Equipment and Facilities Construction (MREFC) account, and will be preparing a final report for Congress on this subject this year. To briefly summarize the findings of these reports:

- The National Science Board has statutory responsibility for the oversight of activities funded from the MREFC account. It is a substantial challenge to prioritize and manage MREFCs, and the Board is exploring the best solution for ensuring solid analyses of science needs, construction costs, and operations and maintenance (O&M) costs in the "MREFC process" and to define how the Board can contribute in the oversight process. In particular, the Board recommends that better estimates of lifetime costs be obtained in the pre-construction planning phase of a project.
- A 2004 NSB policy eliminated the cost-sharing requirement for research grants and cooperative agreements. The Board recommends changes in the 2004 cost-sharing policy, including reinstatement of mandatory cost-sharing for certain programs.

I would be happy to meet with you at a later date to elaborate on the Board's policy activities or respond to any questions concerning any or all of these important policy concerns.

The Board is also reviewing the impacts of NSF policies on interdisciplinary research and on limiting the number of proposals per institution of higher education for some awards. The Board will report back to Congress on both of these issues by August 2008. Finally, the Board will evaluate a pilot program of grants for new investigators at NSF and report the findings to Congress by August, 2010.

Advice to the President and Congress

Science & Engineering Indicators—One of the highlights of the year was the recent release of *Science and Engineering Indicators 2008,* which the Board transmits to the President and Congress every even numbered year. It is the most comprehensive series of indicators on the state of the U.S. science and engineering enterprise in a global context. The 2008 *Indicators* tell a mixed story. A sample of findings include:

- The U.S. is the largest, single, R&D-performing nation in the world supplying an estimated $340 billion for R&D in 2006, a record high. However, federal obligations for all academic research (basic and applied) declined in real terms between 2004 and 2005 and are expected to drop further in 2006 and 2007. This would be the first multi-year decline for federal support for academic research since 1982.

- Basic research accounted for 18 percent of total R&D, or $62 billion. The Federal Government supplied about 60 percent of all basic research funds, industry about 17 percent, with private foundations, academic institutions and other governmental entities supplying the rest.
- U.S. grade school students continue to lag behind other developed countries in science and math, although fourth and eighth grade U.S. students showed steady gains in math since 1990. Only fourth graders showed gains in science compared to 1996.
- The U.S. sustained a relative economic advantage over other developed and developing economies. The U.S. is a leading producer in high-tech manufacturing and knowledge-intensive services, but several Asian countries, led by China, have rapidly increased their global market share. The U.S. comparative advantage in exports of high-technology products has eroded: the U.S. trade balance in advanced technology products shifted from surplus to deficit starting in 2002. Information and communications products geographically concentrated in Asia—particularly China and Malaysia—account for this deficit.
- U.S. public support for government funding of scientific research is strong and growing. In a 2006 survey, 87 percent of Americans supported government funding for basic research, up from 80 percent in past surveys dating back to 1979. Also, Americans who said the government spends too little on scientific research grew from 34 percent to 41 percent between 2002 and 2006.
- Diversity has increased in the academic science and engineering labor force. From 1973 to 2006, in the academic, doctoral labor force the share of women increased from nine percent to 33 percent, of under-represented minorities (African-Americans, Hispanics, and American Indians/Alaska Natives) from two percent to eight percent, and of Asian/Pacific Islanders from four percent to 14 percent.

Along with *Science and Engineering Indicators 2008,* the Board has prepared two additional reports: *Digest of Key Science and Engineering Indicators 2008* and a Companion Piece policy statement: *Research and Development: Essential Foundation for U.S. Competitiveness in a Global Economy.* The first report was developed to encourage broad use of *Indicators* data. It includes a set of 20 important indicators, and is structured for ease of understanding and to provide linkages to more extensive discussions and data in the main *Indicators* volumes that are related to the selected indicators. The second, Companion Piece, report expresses Board concerns with industry and federal investment in U.S. R&D, especially basic research and academic research, and offers recommendations on improving our understanding of global trends in industrial science and technology and implications for the U.S. economy and jobs.

International Partnerships

The Board's Task Force on International Science conducted a series of roundtable discussions and meetings to examine the role of the U.S. Government in international S&E partnerships. The task force prepared a report on their findings, which was approved at the December 2007 meeting and will be released in March 2008. The report, *International Science and Engineering Partnerships: A Priority for U.S. Foreign Policy and Our Nation's Innovation Enterprise* (NSB–08–4), recommends that the U.S. strengthen S&E partnerships with other countries.

The NSF Office of International Science and Engineering should be more active in encouraging international partnerships between NSF funded Principal Investigators and scientists and engineers in other countries, especially developing countries. In a global world, such partnerships enable us to leverage growing basic research investments in other countries. For example, partnerships would help to share costs of research on common global challenges such as sustainable energy, climate change, natural disasters, disease pandemics, and the fight against terrorism. In addition, the Board believes that S&E partnerships could be utilized more broadly for diplomacy. We also would like to see more formal, high level cooperation in S&E among federal agencies through NSTC. Opinion polls show that countries with very unfavorable views of the U.S. in general still overwhelmingly admire U.S. science and technology. For example, scientific collaborations with Russia improved goodwill between the countries after the Cold War and helped to ensure that nuclear technology was adequately protected; collaborations with countries such as Iran could serve a similar purpose today.

Hurricane Research—Hurricanes account for over half of total weather-related damage in the U.S. Stimulated by the devastation after Hurricane Katrina, the National Science Board convened a Task Force on Hurricane Science and Engineering. In January of 2007, it unveiled the National Hurricane Research Initiative (NHRI) in the report, *Hurricane Warning: The Critical Need for a National Hurricane Research Initiative.* The proposed NHRI would establish highly focused priorities that involve industry, academia, and government in addressing research gaps and in applying research findings to operations that could help us to mitigate the destructive impacts of future hurricanes.

FY 2009 Budget Request

National Science Foundation

The National Science Board reviewed and approved the FY 2009 budget request that was submitted to the Office of Management and Budget. The Board supports the President's budget request. The $6.85 billion request represents an increase of nearly $789 million, or 13 percent, above FY 2008 levels. The request is the first step toward doubling the budgets of several agencies including NSF, the National Institute of Science and Technology, Department of Commerce, and the Office of Science, Department of Energy, over 10 years and is critical for realizing the goals of the bipartisan competitiveness agenda that will help to maintain U.S. leadership in scientific and engineering research and education.

The NSF already receives many more outstanding research proposals that we can fund, so I assure you that the budget increase will be put to good use. The proposed 13 percent budget increase will provide funding for 1,370 more outstanding research proposals and 3,075 more Graduate Research Fellowships to support our most promising young American scientists—tomorrow's innovators. Support for graduate education is one of NSF's fundamental responsibilities. The Board continues to examine the best ways to financially support the future generation of scientists and engineers during graduate education. Although it is clear that financial support in any form—whether scholarship, assistantship, or traineeship—is important for success in graduate school, the Board continues to consider how the mechanisms for support contribute to the achievement of a range of objectives for graduate education, including adaptations to ensure American scientists and engineers can compete with scientists and engineers from around the world.

National Science Board

For FY 2009, the request for the National Science Board is $4.03 million, an increase of $61,000, or 1.5 percent, over the FY 2008 estimate of $3.97 million. The FY 2009 budget will allow the Board to strengthen its oversight and policy duties for NSF and to provide independent scientific advice for the President and Congress. In addition, the Board will continue to increase communication and outreach with universities, industry, the science and engineering research community, Congress, federal science and technology agencies, and the public. For example, we continue to engage with numerous stakeholders to implement recommendations from our STEM education action plan.

This year, the Board will continue to expand our role in approving MREFC projects, address the topic of sustainable energy through a series of roundtables, review the NSF cost-sharing policy, review the impact of multiple proposals on institutions, and analyze support for interdisciplinary research. In addition, by August 2010, the Board will submit to Congress a report of findings and recommendations on the NSF pilot program of grants for new investigators that was established by the *America COMPETES Act.*

The Board also has been re-examining the policy for recompetition and renewal of awards at NSF. In 1997, the Board approved a statement on competition, recompetition, and renewal of NSF awards. The Board assessed the implementation of the statement, and issued a statement to reaffirm the 1997 statement at their last meeting. The Board endorses strongly the principle that all expiring awards, including major facility awards, are to be recompeted, and believes that peer-reviewed competition and recompetition is the process most likely to assure the best use of NSF funds for supporting research and education.

One of the most significant activities over the next two years is to plan content for *Science and Engineering Indicators 2010* and to consider whether we should prepare a second round of the *Digest of Key Science and Engineering Indicators* (that was pilot tested with *Indicators* 2008) for the 2010 volume of *Indicators.* The Board is already soliciting input on the 2008 *Indicators* and *Digest* to determine how we can improve the 2010 version to address the concerns of the various communities who rely on this comprehensive and objective set of data to craft policies that foster

discovery and innovation through science and engineering. We will also be presenting the findings of our policy Companion Piece to *Indicators* to a range of stakeholder audiences to discuss possible responses to our recommendations. To this point we have held two roll-out events for *Indicators* 2008, on Capitol Hill and at the Chamber of Commerce. We have held additional discussions with spokespersons from the Department of Commerce and with the members of the Government-University-Industry Research Roundtable at the National Academies on data issues and policy concerns highlighted in our Companion Piece, *Research and Development: Essential Foundation for U.S. Competitiveness in a Global Economy.*

A priority for the Board during the upcoming year is sustainable energy. In October 2007, the Board established the Task force on Sustainable Energy to address the science and engineering challenges related to sustainable energy. The Task Force held the first of a series of roundtable discussions earlier this month on the role of the Federal Government, businesses, non-profits, and other U.S. stakeholders in addressing the S&E challenges of sustainable energy. The Task Force will continue to meet with stakeholders in order to inform a forthcoming report that will contain recommendations for implementing a nationally coordinated initiative in S&E research and education for sustainable energy.

Closing Remarks

The Board strongly recommends that Congress fund in full the President's budget request for the National Science Foundation and for basic scientific research at other agencies. Amidst the great economic and political uncertainty of the moment, the importance of research and development for innovation and economic growth is undeniable. NSF-funded research and education provides the foundation for American scientific and technological greatness. The economic growth and the quality of life that we enjoyed in the 20th century were made possible in large part by technological discoveries and innovations. In addition, we need science and engineering advances more than ever to tackle some of the greatest challenges that we have ever faced, including climate change, national security, and sustainable energy production.

I understand that investments in science and technology compete with a host of other funding priorities. Though it might be tempting to forego the long-term investments in the face of short-term challenges, neglecting scientific research and education now will have serious consequences for the future of our country. We must bear in mind that investments in our scientific and technological workforce, infrastructure, and basic research are not luxuries—they are critical for long-term prosperity and security. As other countries now actively seek to emulate our success by building their own innovation infrastructures, we must be ever vigilant to enhance our own innovative capacity.

Based on the President's budget request and the appropriations bill from this committee last year, it appears that both parties of Congress and the White House appreciate the importance of scientific research and education for our country. The FY 2009 budget for NSF and for basic science research in other agencies at the level of the President's request can begin to make up for the opportunities that we will miss this year under the FY 2008 omnibus appropriations bill. You have my pledge on behalf of the Board that we will continue to work closely with the NSF Director to ensure that funding decisions continue to provide maximum returns on the taxpayers' investment in our nation's future.

Cited Board Documents

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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, CID Corporation, 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.

DISCUSSION

Chairman BAIRD. Thank you both. We have been joined by Eddie Bernice Johnson from Texas. Ms. Johnson, thank you for joining us, who has been a champion of women and minority issues in science and actually that is a nice segue to one of the questions I wanted to ask.

We had a very informative hearing awhile back on issues pertaining particularly to women's role in science. Donna Shalala was here, Dr. Olsen as well, testified, and I noted with some concern I think as I read the budget, a proposal to reduce funding for ADVANCE, and ADVANCE was one of the programs that had been cited that if used well, particularly effective in changing, making the kind of institutional-wide cultural changes that lead to retention. One of the issues that came up clearly in our hearing was that we have a fair number of women in the science pipeline coming out of high schools, fair number entering college, but at the upper levels we have a dramatic drop off, and ADVANCE seems to do some of the cultural things to change that.

Could you comment a little bit about that, if you would, and what else is being done as manifested in the budget to address women and the minority role in science?

Dr. BEMENT. Yes. Thank you, Mr. Chairman.

ADVANCE is a program that is jointly funded by our Research and Related Activities Account and also our EHR account. We do plan a solicitation in '08, in spite of the reduced funding in '08. We have some funding flexibility in '09, that if we have meritorious awards that we would like to fund, we will try and find additional funding to do that.

Chairman BAIRD. So it sounds like you feel fairly committed to the program as well still.

Dr. BEMENT. Yes, we are very committed to the program.

Chairman BAIRD. Talk to us a little bit, if you would, about the role of international science. One of the things this committee, I mentioned earlier, is going to focus a great deal on is scientific diplomacy and international scientific collaboration. If you could address some of those programs as reflected in this budget and in your perspective on their role in the mission. Dr. Beering and Dr. Bement. Either.

Dr. BEERING. Thank you. As I mentioned, we are going to have a full report forthcoming very shortly, we hope by the 28th of March. Our first priority in the International Science Taskforce has been to generate a clear, coherent, and integrated National strategy. Our second priority is to balance U.S. foreign policy with the R&D policy, and the third priority is to enhance global mobility of scientists and engineers.

When our taskforce met in Brussels on the occasion of the 50th anniversary of the European Union, and I must admit I hadn't realized they had been at it for 50 years, we were thrilled by their openness and their willingness to share scientific knowledge across national boundaries. Science is an international language, and knowledge has no boundaries. And it wasn't a question of financial support. It was a question of willingness to share and to work together.

And so we would like to see that our international science efforts can be coordinated to become a true instrument of international policy.

Dr. BEMENT. Yes. Thank you. The international activities of the National Science Foundation are not only very broad but also very appreciated throughout the world. And it is very difficult to summarize briefly the full scope of activities in our international programs, so with your permission I would like to submit for the record a summary report on those activities. [*Please refer to NSF's response to questions for the record submitted by Subcommittee Chairman Baird. For reference, the specific question is:* Please provide a summary of all international science and engineering cooperation activities at NSF, including the relevant budget allocations.]

But they include a broad range of research collaborations, not only with the developed economies but also with the developing economies throughout the world. It includes institutional interactions. I should also say up front that we only fund the U.S. part of those interactions on a true partnership basis. We engage in exchanges of undergraduate, graduate, and post-doc students to give them a research experience in different parts of the world. We engage in international organizations such as UNESCO and OECD

and the World Bank to help promote capacity building in the developing world.

And we are also a principle player on most of the bilateral exchanges that are coordinated by the State Department. In fact, in just the last three or four weeks I have spoken to the science counselors of all the major embassies here in Washington, and I have had two luncheons with key ambassadors, especially in Europe, hosted by Under Secretary Dobriansky.

So a good bit of my time and my Deputy's time and also our Assistant Director's time is spent engaged in these types of international activities.

Chairman BAIRD. We applaud that, and we look forward to the hearing.

Two other quick comments and then I will recognize my friend, Mr. Ehlers. You mentioned, Dr. Beering, hurricane warning process and clearly we need to make improvements in that area and improve our accuracy and location, magnitude, et cetera.

But this is chance for me to also raise a question I asked earlier about the social sciences as well. I have spoken to some hurricane forecasters, and actually, if you look at Katrina, we were pretty good. They were pretty good, not we, but they were pretty good in terms of saying where it was going to hit, what its magnitude was, what the potential impacts were, et cetera. The challenge was not so much the accuracy of the prediction of timing, location, and magnitude, it was partly getting people to pay attention. And that seems to me to be a social science issue.

And I note that the budget for social science research is actually a good bit less in terms of its increase than is the budget for other areas of the overall budget proposal. If you, either of you would care to talk about that, I would appreciate that.

Dr. BEMENT. Yes. Thank you. Social science at the National Science Foundation is integrated throughout the Foundation. It threads through the Foundation. And it is especially important in areas of national need. You mentioned disruptive storm events like hurricanes, but it also plays a critical role in terrorism, homeland security, and most of our cross-foundation initiatives. You will find it in environmental health and safety with regard to nanotechnology.

And you are correct that it is important to understand how decisions are made because Katrina, after all, was not just a natural disaster. It was a human disaster as well, and it fell far short of adequate performance among the key decision-makers.

So we very much support social science. With regard to the allocation of resources, social science in terms of dollar amount has in the '09 budget one of the largest incremental increases in years. Biosciences has the largest increase in about eight years. We not only had to pay attention to their role throughout all of our programs in the Foundation, but alignment of our overall program to the goals of the American Competitiveness Initiative and the *America COMPETES Act.*

So the main objective is to be sure we have healthy increases in all the programs but also to pay attention to the alignment.

Chairman BAIRD. I respect and understand that. I will just underscore that the *America COMPETES Act* was explicit that social

sciences should share in the increase. It has to a degree, but I have concerns.

Dr. BEMENT. I agree.

Chairman BAIRD. I will recognize my distinguished colleague, Dr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman.

First of all, I do want to comment the majority for the beautiful redecoration of this room. It looks very nice. I assume we will soon return the portraits and perhaps disturb the décor.

Chairman BAIRD. We are looking for an alternative to Tennyson by the way if anyone wants to offer that.

Mr. EHLERS. Just don't try changing the Bible quote.

Anyway, I think it would be nice, however, if you could turn the heat back on.

Chairman BAIRD. We are lowering our carbon footprints.

Mr. EHLERS. Anyway, Dr. Bement, an essential element in this submission is support for science and engineering education from pre-K through grad school and beyond. I would appreciate if you could explain why your new budget, fiscal year 2009 budget, does not include funding for many of the NSF STEM education activities authorized in the COMPETES Act?

And I know you are short of money, but I would just like to know the rationale.

Dr. BEMENT. Yes. We are short on money. First of all, let me take the Math and Science Partnership Program. I think the increase there was about two and one-half million, which in some of these terms, doesn't look like a lot, but it is a turnaround from where we were two or three years ago, where we were declining at the rate of our mortgage payments with very little flexibility for new starts.

Now, the budget in '09 will allow us to not only cover our continuing grants but to invest $15 million in new starts. So we expect to have about 15 to 17 new awards. Now, that is a big change, and most of that change came about as a result of our assessments over the last two years that demonstrated very clearly that we are making tremendous headway in our math and science partnership school districts and schools in improving math education and also science education at almost all levels. The only problem is at the middle school level for science, but in all other categories there is very positive improvement.

In some of the other programs the assessments either haven't been completed, or they are still in progress, and under the *Deficit Reduction Act of 2005,* and the establishment of the Academic Competitiveness Council, the philosophy is "show me." Show me that these programs are effective through rigorous third-party assessments before the funding increases.

And so that is the environment under which we are currently operating. I am very optimistic, however, that our programs are strong and the assessments that are currently underway will be positive, and we will be able to grow those budgets and get them closer to the authorization levels.

Mr. EHLERS. Thank you. And Dr. Beering, you have put a lot of work into developing the National Action Plan for STEM Education, and I am curious what feedback the National Science Board

has received on that report and to what extent the Board is still involved with implementing some of its recommendations. In particular, how the fiscal year 2009 budget reflects any role that NSF might have in that.

Dr. BEERING. Thank you. First of all, we get personal support and encouragement. I think by and large there has been a National consensus that we need to have a change in attitude and commitment and to bring education, particularly science education, into the curriculum very early on.

The big problem is the logistics of 95,000 different school board members, and that is where the pushback has also come. We had a hearing in this very room here a few months ago where that came out, as you recall, and nonetheless, I feel that there is broad-based support for the major recommendations of having horizontal and vertical alignment and having the teachers better prepared than they are now.

There is concern that teachers don't stay in the profession long enough. There is concern that they are not paid at the level of their counterparts in business and industry with similar preparation, and I have had a lot of reactions from business and industry that is in agreement with that perception and that hopes to be helpful to us.

So the early results of that have been very pleasing to us, and I think we will continue to make progress.

Mr. EHLERS. Let me ask you, though, vertical and horizontal alignment of standards. That brings forward another issue that I have been preaching about for several years, and in fact, Senator Dodd and I have introduced a bill trying to develop voluntary National standards for the sciences.

I think we have tremendous problems in this country because of the diversity of governments of the schools with the local school boards, the state boards of education, and so forth. But then in addition beyond that, because we are such an incredibly mobile society, a student can take classes in one school building, move 10 miles, and find the sequence of subjects is different.

Do you think the vertical and horizontal alignment will take care of that, or do you think we should develop these voluntary standards, which I would hope would at least take care of the sequencing and the major components. These would not be mandatory but at least would be good suggestions.

I would appreciate your comments on that.

Dr. BEERING. I think, again, there is agreement that voluntary standards would be quite helpful. There is a concern that any proposed legislation would mandate a federal coordinating council rather than a voluntary coordinating organization as we have proposed, and I think that is the single issue that I have had the most comment on from people, wondering are we really serious about having a non-federal coordinating council, and if so, that would be alright, and that would be helpful.

Mr. EHLERS. Yeah, and I think there would be general agreement in the Congress that that would be good as well, as long as it is established well, and it has the ability to operate in a way that will produce results.

I see my time is expired. I yield back.

Chairman BAIRD. Thank you, Dr. Ehlers.

Dr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman. Dr. Beering, in your written testimony you indicate that there is a growing public support for increasing federal funding for research, for scientific research. Do you attribute that to awareness of the link between that kind of expenditure and our national economic well-being? And if so, and even if not so, what do you propose or what do you recommend in terms of keeping that enthusiasm alive and growing for public support?

Dr. BEERING. I think people are increasingly aware of the scientific advances that are being publicized through the media, and they are hopeful that this will produce Nirvana and long life and health and happiness, and it is more a hope than a reality in many instances.

But I am happy that there is this positive support rather than the opposite.

Mr. MCNERNEY. There are no recommendations how to continue to grow that public support?

Dr. BEERING. I don't have any special ones. No.

Mr. MCNERNEY. Well, okay. Dr. Bement.

Dr. BEMENT. Yes.

Mr. MCNERNEY. Thank you for coming here today, and I, certainly you will find fewer people, you will find nobody that is more sympathetic toward funding for science education than myself and members of this committee here.

You indicated that since 1970, the federal investment in physical sciences has been halved as a percentage of GDP. At the same time we know that our competitors like India and China are increasing their support. And in fact, an often repeated phrase, the Chinese are putting out more English-speaking engineers per year than the Americans are now.

So do you believe there is a direct correlation between federal funding and the number of engineers and scientists that we are turning out?

Dr. BEMENT. Absolutely. I should point out that almost all the funding provided to the National Science Foundation supports our innovation system one way or the other. For example, our research grants are actually used to train and educate graduate students who go right into the innovation system. Our graduate fellowships and traineeships have very much the same purpose.

The problem is that the growth in demand for scientists and engineers is increasing at about five percent per year, but the growth in degrees is only increasing at about one and one-half percent per year.

Furthermore, we are reaching a period where baby boomers are retiring at an ever-increasing rate, so that many of our federal labs, whether they are defense or non-defense are going to start hollowing out before too long.

Mr. MCNERNEY. So by supplying the men, then you would expect there to be increasing salary offers for these types of trained people.

Dr. BEMENT. I think over a career you would find that these are very lucrative career paths. China and India have gotten the mes-

sage that what is driving the economy in a knowledge environment is education and investment in research. So both India and China are investing quite substantial sums in improving the quality of their education, especially at the graduate levels, masters and Ph.D. programs.

And the equation there is very simple. If you produce the high-level talent, industry will find their way to your doorstop. And if you look at the writings of Craig Barrett, Norm Augustine, they are the Cassandras that see the future quite clearly because they are in the process of seeing this migration begin to take place.

And I believe we only have a reasonable period of time before we address this question. That is why our budget for '09, is highly skewed to train the graduate students and to provide the fellowships and traineeships that will begin to address this in the near-term rather than the longer-term.

Mr. MCNERNEY. Well, that sort of segues into my next question was that the COMPETES Act does authorize a new pilot program for young investigators that don't have the reputation to get the big grants. Do we expect to see that program implemented in some form in the coming fiscal year?

Dr. BEMENT. We currently have working groups working on all the sections of the *America COMPETES Act* to figure out, first of all, how to come into compliance with all the requirements in the Act, and we are making good progress on that. Also to begin designing the new programs that are called for in the Act. Some of those I think we can start in '08, but we need the flexibility in '09 to really bring them up to a decent level.

With regard to young investigators, if you look at the distribution curve of funding and numbers of grants, as a function of years from last degree, namely the Ph.D. degree for most, what you will find is distribution that is skewed very strongly towards younger investigators. In fact, the peak of the curve is at about six to seven years after the Ph.D., and then it trails off over time. And what we are discovering is that about 30 percent of all new investigator grants go to young investigators that are about five years from their Ph.D. And that comes as a result of our paying attention to young investigators through our CAREER grants, through many other grants, that favor young investigators.

But I think more than anything else is the fact that we reserve a healthy fraction of our core program to fund unsolicited grants, and young investigators would normally apply for unsolicited grants in order to support their particular interests.

Mr. MCNERNEY. So you are talking about numbers of grants or numbers of dollars when you say that the, when you talked about the skew?

Dr. BEMENT. Both. We thought of it both ways.

Chairman BAIRD. Mr. Bilbray from California.

Thank you, Mr. Bilbray.

Dr. Lipinski.

Mr. LIPINSKI. Thank you, Mr. Chairman. I want to thank Dr. Bement and Dr. Beering for their testimony and for all the work that they do. This is one of the most critical areas for our country and doesn't really get the attention I think that it deserves.

I have some, probably some further questions. I am, as you know, a political scientist and have some further questions on that in writing, but I want to, a couple other things I want to ask you here.

First of all, when the Administration, it used the Academic Competitiveness Council's assessment of the effectiveness of federal STEM ed programs as part of its justification for its budget decisions for NSF's Education and Human Resources Directorate. The Academic Competitiveness Council, ACC, was carried by Education Secretary Spellings, and the ACC found that a number of NSF programs did not have adequate evaluations.

So I want to ask Dr. Bement, would you agree with the report's conclusions that NSF's education programs are not properly evaluated?

Dr. BEMENT. No. I disagree and disagree quite strongly. Evaluation is a very critical part of all of our education programs in EHR, our Education Human Resources Directorate. And starting in 1997, we required assessments and evaluations on every one of our programs, and even now with all incoming grants, we require an assessment plan as part of the grant. And that is considered in awarding a grant.

Now, there is quite a difference of opinion on whether random control testing is the gold standard. I think you would recognize that in the Noyce Program where you particularly select people for scholarships, that is not necessarily a random process. So you violate external measures as well as internal measures statistically in that kind of an evaluation.

Furthermore, to do a random control test you have to have sufficient numbers that are statistically significant, and if you are doing research, it depends on the stage of the research. If you are doing implementation, it depends on the stage of implementation. Now, we work pretty much at the project and the program level, so that in many cases a well-regulated comparison group study is a better means of evaluation in the earlier stages of the program where changes are occurring dramatically rather than just taking a snapshot through a random control test to see what the status is near the stage of scale-up.

So I think we are using the proper instruments. I think we are getting the results that we need in order to establish that our programs are effective, and we work very closely with the Department of Education in scaling up our programs so that eventually they will be proven effective through random control testing as well.

Mr. LIPINSKI. There is just basically a disagreement over the, what good testing, what good evaluation is. I am concerned that there is a—certainly a battle going on in terms of who is going to do our STEM education. Is it the Department of Education——

Dr. BEMENT. Yeah.

Mr. LIPINSKI.—or the NSF. I certainly believe that the NSF has shown, at least to me, that NSF has done a very good job of doing this over the years.

Dr. BEMENT. I want to make one point clear, and that is that, first of all, even though Secretary Spelling's chaired the Academic Competitiveness Council, I was a very vocal member on that council as are a number of other agency heads. Furthermore, in the

working groups that established the report that was presented at Congress last May, those working groups were either chaired or co-chaired by NSF staff. So we stand behind the recommendations in that report, and you will note that the recommendations do provide a flexibility for how to evaluate different types of programs. And, again, I would assert that we are in full conformance with the recommendations of the report.

Mr. LIPINSKI. One other thing I wanted to raise. The National Nanotechnology Initiative only gets a two percent increase, which is actually below the inflation rate. Why is the NNI getting such a low increase, actually a decrease considering inflation?

Dr. BEMENT. Well, we have a way of determining whether a program has begun to reach the flat part of a learning curve, and that is based on the quality of proposals that we receive in the program. And when the number of potentially transformative ideas or the number of excellent proposals begin to taper off, that is the time to start moderating the funding.

Now, most of the priority in the NNI Program, in this budget is an increase in environmental health and safety research. And the reason for that is pretty obvious, and that is that in any new technology one has to be aware of health and safety considerations. NSF has been a leader in this program, in this regard for, since the beginning of the program. We have always held apart something of the order of seven percent of our total budget in order to look at EHS issues. And I feel the time has come to increase that because we are seeing a lot of variability in the research results and the test results on the effective engineered nano-particles on human cells and other factors.

And a lot of that variability is just lack of rigorous characterization of the particles. And so we have to develop better instrumentation, better protocols, and better means and better standards. Incidentally, we are working with NIST in trying to back up some of the standards to reduce that variability so that we can have confidence in the results.

Mr. LIPINSKI. Thank you. I see my time is up.

Chairman BAIRD. Thanks, Dr. Lipinski.

Dr. Bement, I applaud your defense of methodologies, and I will recognize Ms. Johnson in one second. I would just, as someone who used to teach statistics, to try to get folks to understand that the very premise of a test of statistical significance assumes random assignment and you are comparing the actual observed difference in your two subject groups with what might occur through random assignment, if you don't have random assignments, the premise of a test of statistical significance is really called into doubt. And there is a rather slavish dependence on this I think by the Department of Education, which in itself maybe symptomatic of some of the problems in our education system.

Ms. Johnson.

Ms. JOHNSON. I have always had great admiration for the National Science Foundation and felt that it was one of the most accountable agencies that we had and I think at this point one of the most important since we need this *America COMPETES Act* implemented. As I think about the future of the space program, of our

high tech, all of the things that, even our air controllers, we need so many more people than what we are training, involved.

Would you give me an idea of how much implementation you can do with the current budget that you are defending?

Dr. BEMENT. Yes. Thank you. Our concern about this issue is more than just the level of funding and the number of programs but how those programs align themselves and provide synergy among the different programs.

For example, in education in order to reduce wastes and leakage in the pipeline, we feel that a two plus two plus two approach is necessary, and this is recognized in our Innovation of Institutional Integration program, which is a way of aligning different programs by focusing on a particular strategy.

The strategy here is to focus on the last two years of high school, the first two years of undergraduate training, and the second two years of undergraduate training. That is the two plus two. And of course, the first two years of undergraduate training also brings in the community colleges as well, and what we want to do is look at the critical junctures between those programs and get those programs aligned so that we can have greater success in retention but also pre-college or preparation at the secondary school level.

So that is going to be a hallmark of our '09 initiatives in the budget, and we feel that this can be very effective.

Ms. JOHNSON. In other words what you are saying is you are adequately funded for the beginning of the implementation.

Dr. BEMENT. I think in the '09 budget we are happy with the way we have aligned the budget to meet those objectives. Yes. It will give us a good start.

Ms. JOHNSON. Thank you very much.

Chairman BAIRD. Just a couple of further questions if I might.

My understanding is that there was a significant increase in the administration, administrative budget of NSF, and that that was very much needed to keep up with increasing demand and though it came under some assault in the appropriations process, I would urge my colleagues on this committee to not fall victim to that no matter how seductive the offset may seem to be, because if we are going to process these programs, we need people in the administrative offices. And I think NSF keeps its overhead relatively low.

Would either of you like to talk about the current status and some of the changes that have been made in that area?

Dr. BEMENT. Thank you. Well, as a result of the good action we had in the '08 budget, we are going to be able to start immediately in addressing some of the very critical staff shortages that we currently have, especially among program officers who are under tremendous pressure.

But the Agency Operations and Award Management budget is more than just people and space. It deals with our pre-award activities as well as our post-award accountability for how programs are actually carried out. And it also includes adequate travel so that program officers can do post-award management.

In addition to that it also supports security and all of our information technology programs that deal with E-government, that deal with the essential application programs that we use to operate, namely our FastLane process, the new website, *grants.gov,* and

also to try to automate the internal operations within the foundation in order to continually improve our productivity. And as the productivity increases, it has been so dramatic over the years, our proposal volume has gone up by almost a factor of three or so and yet our staff costs have been held at only a slight increase.

Those are very worthwhile investments, and we get a lot of return on those investments, and we are still able to keep our overhead costs to within about five percent.

Chairman BAIRD. Given the complexity of the issues that your folks have to deal with, the level of technical demand, the complexity of the programs that are put forward, the diversity of issues that NSF deals with, I think the, that you should be acknowledged and the appreciation extended from this committee.

And as I say, we will do whatever we can to try to make sure the Administration, administrative budget stays——

Dr. BEMENT. It is very much appreciated. Thank you.

Chairman BAIRD. I want to also compliment you. I am pleased to see the water initiative. It just shocks me how little we know about water. We are made of water, the planet is largely made of water, at least the part we live near, and I believe water will become a signature issue of this century. And the amount of fresh drinking water available on this planet is very small, and it is diminishing through pollution, et cetera, and so I applaud NSF's directive in that area.

I want to raise one question, and I don't really expect an answer here. I just want to, just for the record. First by way of compliment, we had the great privilege of going down to Antarctica and golly, the American people should see what a remarkable achievement has happened down there, the science is world class. The conditions under which it occurs is, are extraordinarily difficult, and your people are to be absolutely commended for the work, and I congratulate you on the opening of the new South Pole Center. It is quite an accomplishment, and we are proud of what our country can do in that area.

A slight negative note or question I guess it is better put. I noticed in the budget report I don't know how much money was spent, but some art project that consisted of putting spheres out on the ice somewhere to simulate the heavens, I am probably one of the few or last people in this Congress to demagogue against humanities and art spending, but I have a sense now having been there of the logistics of getting equipment and people down to that part of the world. And I just would query for future budgetary needs whether or not such expenditures are maybe better left to the National Endowment of the Humanities or maybe better left to people who want to appreciate the heavens will look at the sky at night, Rocky Mountains or something, and you will get a sense of how they fairly much supercede the experience of a few spherical objects placed on the ice.

So in future budgets you might want to have a look at what——

Dr. BEMENT. Chairman Baird, you raise an issue I should be concerned about, so with your permission I would like to look into it and report back to you in writing.

[The information follows:]

INFORMATION FOR THE RECORD

Dr. Bement's response to an inquiry by Chairman Baird regarding the Antarctic Artists and Writers Program (AA&W):

NATIONAL SCIENCE FOUNDATION

ANTARCTIC ARTISTS AND WRITERS PROGRAM (AA&W)

The National Science Foundation has been responsible for managing the United States Antarctic Program (USAP) on behalf of the Nation for many decades now, pursuant to Presidential Memorandum 6646. As such, NSF supports research projects supported by NSF and other federal agencies in the field, coordinates the logistics support activities of DOD and several other agencies, and also maintains a modest, merit-reviewed Antarctic Artists and Writers (AA&W) Program. The goals of the USAP are to expand fundamental knowledge of the region, to foster research on global and regional problems of current scientific importance, and to use the region as a platform from which to support research and education. The AA&W Program was established in 1980 in furtherance of these goals. It seeks to bring information about the USAP to the American public through the published work of artists and writers and therefore to complement the publication of scientific papers that speak primarily to the research community.

Like all NSF programs, the AA&W Program subjects proposals to external review by peers—in this case established writers or artists. The review process informs NSF's decision concerning the merits of each proposal. Unlike NSF's regular programs, the AA&W Program does not provide funding for projects, but rather only access to our stations, field camps, and scientists in Antarctica.

The project you asked about has resulted in a number of shows at art galleries and has been the subject of a number of public presentations at other forums, bringing a perspective on Antarctica to the public that is somewhat unique. The more typical result of an AA&W award has been the publication of books and articles in widely read journals.

Chairman BAIRD. We are very proud and happy on this committee, Dr. Ehlers and myself, to steadfastly defend scientific projects in peer review on the Floor of the House. It would be more difficult for me to defend that particular project perhaps.

One question I have as we looked at the increase in funding, one of the challenges NSF has faced and was acknowledged in the *Rising Above the Gathering Storm* is the growing disparity between availability of grants that actually get funded to researchers and applications. And I hear this from researchers in all branches of science. When they apply to federal grants, their probability of success is going down.

Now, as we see an increase in funding, what happens, because we are also seeing an increase in demand. Are we still losing ground but losing ground at a slower rate than we used to lose it, or are we keeping pace now with, if we were to enact the proposed '09 budget?

Dr. BEMENT. Well, if we enact the '09 budget, that will increase our success rate by about two percentage points, so it is not a one-budget cycle issue. On the other hand, that would greatly reduce the amount of churn in the system and churn is a very big issue, not only for the investigators but also the people that devote time for merit review. When they start seeing the same proposal over and over again, they wonder whether their time is being well spent.

There are provisions in the *America COMPETES Act* that will help us in this matter, and we are also studying other ways in which we can, near the end of a fiscal year, hold proposals that are fundable over for funding in the succeeding fiscal year. And any-

thing we can do to reduce the amount of churn would, of course, be in the right direction.

Chairman BAIRD. I think that is so important for Members of this committee but for the entire Congress to understand is that, is the impact of worthwhile projects competing against other worthwhile projects, and when they don't get funded, especially early career investigators, really start, they actually give up at some point. And very promising lines of research and promising investigators may go in other directions that are probably damaging to our overall competitiveness.

Dr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman. Just a few additional questions.

Dr. Bement, during your testimony you mentioned several new key investments. The Science and Engineering Beyond Moore's Law, Adaptive Systems Technology, and the Dynamics of Water Processes, which we just discussed a moment ago. Could you give us more details on how, what the projects are and how the money is——

Dr. BEMENT. Yes.

Mr. EHLERS.—going to be spent?

Dr. BEMENT. The Science and Engineering Beyond Moore's Law recognizes that we are about to reach an endpoint because we are reaching quantum limits in silicon technology. And our estimate is that we will probably reach the end of Moore's Law in about 20 years, maybe sooner.

So this is the time now that we should begin to look at alternate technologies in order to get on a new law. And there are promising technologies that will use, molecular electronics, for example, carbon nano-tube technology, quantum dot technology, even quantum computing.

And so what we would like to do is increase our investment in these alternate technologies so that when the time comes, we will be prepared to keep going, and not only to make information systems more compact, but even more ubiquitous than they are today.

And the second initiative, Adaptive Systems Technology. The human body can do things better than electrical and mechanical systems with regard to interpreting sensor signals, nerve and motor control, and also in terms of analytical thinking, which enables a human being to both anticipate and adapt to change.

As we learn more about the brain, the nervous system, and the sensory systems, we feel that we can take that knowledge and, if you will, reverse engineer it, although that is a crude term. But, nevertheless, to embed some means of adaptation and anticipation in engineered systems.

Let me just give you a couple of examples. We feel by using smart agents we can develop a much more robust electric power grid where it would be possible to anticipate upset conditions in time to actually take corrective action, either by load shedding or bringing on new capacity.

In our computing systems and also in our networks we could use these adaptive technologies or anticipatory technologies to identify intruders in the systems and to encounter intruders in a much more natural and much more effective way.

In human prostheses we have already begun seeing development of artificial retinas that will enable the blind to see and also artificial cochleas that will enable the deaf to hear. We already have amazing developments in connecting the brain to the nervous system in order to restore muscular activity and also nervous activity, to restore sensory activity.

Now, we feel that these are emerging technologies that are not only being paid attention to in Europe and also Asia where the investments are going up, but I think we in this country have an opportunity to establish leadership and maintain leadership in these areas, and because of the broad range of scientific and engineering disciplines that NSF supports through interdisciplinary research, I think we can really make good progress in this area.

In the case of the waters initiative, there are changing patterns in our hydrological systems caused by ecological changes, climate changes, and so forth. But also there are major changes in water usage. For example, we aspire to produce ethanol fuels from biomass. That requires an enormous amount of water, not only for growing the crops but also for processing the ethanol. Now, the question is over time is that sustainable? Will the water be where the biomass is, because the processing plants have to be reasonably close to the source in order to make it economically feasible.

That is just one example, but there are many others. As we look ahead on a National basis there is a great possibility that there would be growing drought conditions in the central part of the country. There will be more violent storms and more water deposited in the coastal regions where it runs off and flows into the ocean. We don't have effective catchment to hold onto that water.

So being able to do long-term forecasting, both on a regional basis and also on a local basis of what these changes may amount to, is critically important. Just another example would be the increasing flow of fresh water into the Atlantic Ocean from the Arctic Ocean and the seas around the Arctic Ocean just due to the melting of ice. That could lead to disruptive climate change.

So the purpose of this initiative is to begin to put the computational tools in place to model these interactive events of the changes in the ecology and climate with the changes in the hydrological systems in order to inform other federal agencies that are engaged in this area as well, what changes are likely to come about and what meaningful strategies there may be for adaptation and mitigation in some of these changes.

Mr. EHLERS. Is this new money or are you repackaging existing programs to try to achieve this?

Dr. BEMENT. There are ongoing efforts in each of the directorates. This new money will link these together and form a more interdisciplinary approach to the problem.

Mr. EHLERS. Okay. And so——

Dr. BEMENT. So it is not just reshuffling the cards. It is adding another component to the overall program.

Mr. EHLERS. I will be very interested in seeing the details on that. And I do have to add as a resident of the Great Lakes region, that no matter what you do with water, don't take a drop out of the Great Lakes. They have a militia prepared to deal with that.

Dr. BEMENT. Maybe Michigan will be a biomass state of the future.

Mr. EHLERS. Probably.

Mr. BILBRAY. Don't worry, Congressman. We will only take the Canadian water. How about that?

Chairman BAIRD. Mr. McNerney. Dr. McNerney.

Mr. MCNERNEY. Thank you. Speaking of climate change, one of the objectives of the National Science Foundation in climate change is to provide products for decision-makers. Could you describe what products are available that have already been produced, what validation there is of those products, and——

Dr. BEMENT. Uh-huh.

Mr. MCNERNEY.—what sort of products you see coming up in the future?

Dr. BEMENT. Yes. One of the most important products that we support is the development of sophisticated climate models that are used to measure not only the rate of climate change but also the cause, the forcing functions that lead to climate change. A good bit of that work is done at the National Center for Atmospheric Research, NCAR, but it is supported at other centers as well, at the universities. And incidentally, that work feeds into the International Panel for Climate Change that got the Nobel Peace Prize. So we feel that we have a piece of that prize. I think it is the first peace prize that the National Science Foundation has supported.

But beyond that, the work that we do in the polar regions, which was touched on in terms of looking at climate change over time, looking back over the previous glacier cycles to understand what regularity there may be in some of these changes is critically important. So we are investing in ice core drilling and also drilling in sediment beds and at the ANDRILL Project, which was done jointly with Germany and New Zealand, where we are drilling back five million years. That is important. We are now joining with the Russians to do similar drilling in El'gygytgyn Lake near Chokotka, on order to also go back to that period of time.

But, you know, that just touches on a few areas of work and climate change. Our oceanography program is also engaged. Our neon community is looking forward to developing a national system to sense climate change through the National Ecological Observatory Network.

And so it is not just the competition of models. It is the tools. It is the Arctic Observing Network that we hope to put in place in concert with a number of other nations to measure changes, not only in the climate but also in ocean circulation that affects the climate. And try and understand why in Greenland, for example, the center of the ice shield is growing because of more precipitation, whereas it is eroding in the costal margins just due to warming effects. And we find those effects throughout the Arctic Ocean as well as in Antarctica. So that is pretty much just a snapshot of some of the things that we are doing in this area.

Mr. MCNERNEY. That was my only question.

Chairman BAIRD. Dr. McNerney. Mr. Bilbray.

Mr. BILBRAY. Thank you, Mr. Chairman. I was glad you brought up the artificial retina. Extraordinary breakthrough. And you think about Star Trek and they, I forget the name of the character who

had the special glasses, and I actually had the privilege of breaking bread with a young man who actually has that, those glasses and that artificial retina, and I just hope we don't become so jaded that we start not being in awe of these breakthroughs.

But the Chairman talked about the water, and one thing we have learned in southern California that water itself is not an answer. You have got to have clean, cheap electricity to either transport the water or to purify it like we are doing with reverse osmosis.

Dr. Beering, you mentioned in your testimony a taskforce on sustainable energy and about the meetings earlier this month and with the various stakeholders here. I wonder if you could bring us up to steam about if there is any preliminary statements or information with the forthcoming report, and give us an update on what the task force is sort of hitting on.

Dr. BEERING. Well, the taskforce has had its first meeting, and we are trying to find the dates where the group can get together for another meeting. We heard testimony from a variety of subject matter experts, and I am encouraged that there really is a great deal of activity, both by the public and the private sector, that is focusing on this entire set of issues. It isn't just the popular notions but some very scientific and fundamental things that are going on.

But it would be too early for me to give you any specific answers.

Mr. BILBRAY. I just had a meeting with Mary Nichols. It is kind of funny we have switched roles. She was at EPA here, and I was at the Air Resources Board in California. Now she is Chairwoman at Resources and now I am over here. And one of the big—there are some big concerns we have raised, and I don't know if the Committee is looking at it or reviewing it, because we talk so much about the challenges from a science and engineering point of view, but is the Committee also looking at the challenges of the regulatory barriers to sustainable energy sources?

One of the biggest concerns we have in California is the fact that we may have, as Californians tend to do, actually outlawed the process that could be addressing our problems. Is that even being discussed at all in this——

Dr. BEERING. I am glad you brought that to my attention. We have not discussed that yet.

Mr. BILBRAY. Well, I would say sincerely that is a real challenge.

Mr. Chairman, when I hear people talk about the concept of sequestering carbon, I will tell you, as somebody who served on regulatory agencies, the concept of permitting a site two miles down under three states, I just, it boggles my mind that people really think that is doable under the existing process. And needing to understand that some of the challenges we are going to have with the science is just getting government the hell out of the way and allowing people to accomplish their goals. And excuse the terminologies but that is going to be the challenge.

And the other challenge that I hope you guys are looking at is the political agenda getting in the way of scientific agendas, and you are going to hear me screaming bloody murder about this hell-bent run to go to corn ethanol as somehow it is sustainable, when, in fact, I think everybody is shaking their heads and just saying, well, everybody is jumping, so we might as well jump. And so I

hope that the Committee, again, looks at a lot of these things and brings back a degree of sanity from the scientific point of view for us who are forced to have to at least consider the political game.

Dr. BEERING. Thank you very much.

Mr. BILBRAY. Thank you.

Chairman BAIRD. Are you suggesting that the NSF change the Presidential caucus locations?

Mr. BILBRAY. Yeah. How about if we just change the primary agenda or calendar so that certain parts of the country don't dictate agendas for the rest of the Nation.

Chairman BAIRD. Your points are well taken about the merits and the issues of regulatory concerns.

I just have one final question. I have got to leave shortly, and I think others do as well.

Regarding the Major Research Equipment and Facilities Construction lines in the budget, and you don't necessarily have to answer this here, but we observe that there is, as far as we can tell, no horizon projects listed in that section of the budget, and my understanding is typically one would look ahead and say, okay. So what big things are down the road that we might want to look toward? Is there a reason for that and——

Dr. BEMENT. Yes.

Chairman BAIRD.—if there are some projects you are looking at, when might the Committee and the Congress have a sense of what you see as on the, the next big thing so to speak?

Dr. BEMENT. Thank you, Mr. Chairman. We will be glad to share that with you. There are horizon projects. Those are actively supported in our directorates, and they are actively discussed with the members of the Board. We made a conscious decision not to publish horizon projects in our facilities plan, primarily because it sets expectations that just because we are considering them that they are going to be supported until they are actually constructed.

Now, some of these projects the Board may choose to accelerate, along with the Foundation. Some of them they may choose to bury in a shallow grave for awhile. Some they may decide to terminate. We need to retain that flexibility in turning over opportunities for major facilities until such time that we are ready to go through conceptual design review, preliminary design review, and final design review, and readying these projects for submission to the Congress for funding.

Chairman BAIRD. I certainly respect the need for that flexibility. I just would make sure that there is an effort to give Congress as much heads up as——

Dr. BEMENT. Yes.

Chairman BAIRD.—especially on the budgetary front as we look ahead to what, you know, you look at Hadron, and that is not a cheap operation, and if we have some of those down the road, we got to have a look at that.

Dr. BEMENT. Obviously it is in our best interest to do so, and we will.

Mr. EHLERS. Just a quick one. I hate to harp on the temperature of the room, but it did remind me of the ice breaker question. What is the situation with the Coast Guard, and has all that been worked out or not?

Dr. BEMENT. We still have a good working relationship with the Coast Guard. We give them a forecast of our needs. They give us their plan. We enter into negotiations on how we actually implement the plan. That is the ongoing process, and we will continue to use that process.

Chairman BAIRD. Dr. Ehlers, I should interject. It is my hope that we can have a discussion with Ice Serve also and the Coast Guard Committee, and we could, we have sort of two main issues met by the Ice Breakers as you know; the Scientific Mission but also the National Security Mission and particularly with changes in the polar regions, especially the North Pole. We plan to have some meetings, probably informal meetings initially with the Coast Guard, NSF, and see how we can work this out because I am not the funding scheme makes a whole lot of sense.

Dr. BEMENT. Well, we will certainly contribute to the science part of that discussion.

Chairman BAIRD. Committee Members if they had additional information they would like to submit or our panelists, witnesses, and with that the hearing stands adjourned with the gratitude of the Committee. Thank you very much for your work.

Dr. BEMENT. Thank you.

Dr. BEERING. Thank you.

[Whereupon, at 11:27 a.m., the Subcommittee was adjourned.]

Appendix:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Arden L. Bement, Jr., Director, National Science Foundation

Questions submitted by Chairman Brian Baird

Q1. For the Graduate Fellowship Program, for the most recent year for which data are available and for the two preceding years, what percentage of total applications received were from women and from under-represented minorities, and what percentage of the awards were made to each of those groups?

A1. The requested details follow:

Fiscal Year	Total Eligible Applications	Total Female	% Female	Total Under-represented Minority	% Under-represented Minority	Total Awards	Total Female	% Female	Total Under-represented Minority	% Under-represented Minority
2005	8,471	3,892	**45.94%**	875	**10.33%**	1,020	550	**53.92%**	119	**11.67%**
2006	7,512	3,449	**45.91%**	803	**10.69%**	906	502	**55.41%**	132	**14.57%**
2007	7,776	3,530	**45.40%**	858	**11.03%**	920	508	**55.22%**	139	**15.11%**
2008	8,146	3,687	**45.26%**	912	**11.20%**	913	490	**53.67%**	133	**14.57%**

Eligible applicants meet all three eligible criteria: 1) US citizenship or Permanent Residency status, b) NSF-supported field of study, and c) academic levels.

Q2. Please provide a listing of the current staffing for the assistant director, division director and deputy division director positions at NSF showing whether the incumbent is a permanent federal employee or a rotator.

A2. For the assistant director/office head positions, nine are permanent federal employees and seven are IPAs. All 13 deputy director/executive officer positions are held by permanent federal employees. For Division Director positions, 22 are permanent federal employees, 11 are IPAs, and there are currently six vacancies. All 17 of the deputy division director/executive officer positions are held by permanent federal employees. There are four vacancies in this category.

NSF Senior Leadership Staff Positions

	Assistant Director/ Office Head	Deputy AD/ Exec Officer	Division Director	Dept Division Director/ Exec Officer
BIOLOGICAL SCIENCES	IPA	Career SES		
Division of Biological Infrastructure			LTD Term SES	Vacant
Division of Environmental Biology			IPA	Career SES
Division of Integrative Organismal Systems			Vacant	Career SES
Molecular & Cellular Biosciences			Vacant	
COMP & INFO SCIENCE & ENG	IPA	Career SES		
Computer & Networks Systems			IPA	
Computing & Communication Foundation			Vacant	
Information & Intelligent Systems			IPA	
EDUCATION & HUMAN RESOURCES	IPA	Career SES		
Division of Graduate Education			Vacant	Vacant
Human Resource Development			Vacant	Career SES
Research on Learning			IPA	Career SES
Division of Undergraduate Education			LTD Term SES	LTD Term SES
ENGINEERING	IPA	Career SES		
Engineering Education & Centers			IPA	Career SES
Chemical, Bioengineering Environmental, & Transport Systems			IPA	Career SES
Civil, Mechanical & Manufacturing Innovation			IPA	Career SES
Electrical, Communication & Cyber Systems			LTD Term SES	
Industrial Innovation & Partnerships			Career SES	
GEOSCIENCES	Career SES	Career SES		
Atmospheric Sciences			Career SES	
Earth Sciences			Vacant	
Ocean Sciences			IPA	
MATHEMATICAL & PHYS SCIENCES	IPA	Career SES		
Astronomical Sciences			Career SES	Career SES
Division of Chemistry			IPA	Career SES
Division of Materials Research			LTD Term SES	Vacant
Mathematical Sciences			IPA	Career SES
Division of Physics			Career SES	Career SES
SOCIAL, BEHAV & ECON SCIENCES	IPA	Career SES		
Behavioral & Cognitive Sciences			LTD Term SES	
Resources Statistics			Career SES	Career SES
Social & Economic Sciences			IPA	
CYBERINFRASTRUCTURE	IPA	Career SES		
GENERAL COUNSEL	Career SES	Career SES		
INTEGRATIVE ACTIVITIES	Career SES			
EPSCoR	Career SES			
INTERNATIONAL SCIENCE & ENGINEERING	Career SES	Career SES		
LEGISLATIVE & PUBLIC AFFAIRS	Career SES			
POLAR PROGRAMS	Career SES	Career SES		
Antarctic Infrastructure & Logistics			Career SES	
Antarctic Sciences			Career SES	
Arctic Sciences			LTD Term SES	
Polar Environment, Health & Safety Office			Career SES	
BUDGET, FINANCE, AND AWARD MGMT	Career SES			
Deputy Director/Planning, Coordination & Analysis		Career SES		
Deputy Director/Large Facilities		Career SES		
Acquisition and Cooperative Support			Career SES	
Budget Division			Career SES	Career SES
Financial Management			Career SES	Career SES
Grants and Agreements			Career SES	
Institution and Award Support			Career SES	
INFORMATION AND RESOURCE MGMT	Career SES			
Administrative Services			Career SES	Vacant
Human Resource Management			Career SES	Career SES
Information Systems			Career SES	Career SES

Q3. Please provide an explanation of how the Research at Undergraduate Institutions (RUI) program is managed at NSF. How is the RUI program budget goal determined for a particular fiscal year and is there an individual that is responsible for ensuring that the budget target is achieved? How much flexibility do individual program officers have in encouraging and funding RUI grants? Is the program administered differently by the different directorates? What is the variation in number and amount of funding for RUI awards across the directorates?

A3. RUI is fully integrated into NSF's research programs. RUI proposals are evaluated and considered for funding in competition with all other proposals submitted in the same areas of research, using the program's usual merit review process.

RUI is not a stand-alone program. NSF senior management will issue guidance in the budget process to highlight RUI and related activities. The FY 2009 Budget Request includes $35.23 for RUI. NSF program officers have flexibility in determining the portfolio mix of RUI awards and research grants in their programs. An NSF-wide coordinating committee ensures that program officers throughout all of the directorates understand the RUI guidelines and program goals.

In addition to supporting research activities that include undergraduates, the RUI program allows researchers at predominantly undergraduate institutions to access state-of-the-art facilities that might otherwise limit their success in NSF competitions. Funding is provided for (1) individual and collaborative research projects, (2) the purchase of shared-use research instrumentation, and (3) work with NSF-supported investigators at other institutions—these are Research Opportunity Awards (ROA) supplements.

All of NSF's research directorates provide researchers at predominantly undergraduate institutions with the opportunity to compete for RUI awards. Approximately 125–150 new RUI research project awards and about 20–40 new RUI equipment awards have been made each year over the past few years. BIO and MPS provide support for the majority of these awards. The majority of the approximately 100 ROA supplements made each year are supported by BIO. Over the past several years, RUI funding has been approximately $35 million each year.

Q4. Please provide a summary of all international science and engineering cooperation activities at NSF, including the relevant budget allocations.

A4. International S&E research and education activities are funded by all NSF directorates and research offices. International implications are found throughout all of NSF's activities, from individual research awards and fellowships for students to study abroad, to centers, collaborations, joint projects, and shared networks that demonstrate the value of partnering with the United States.

NSF's approach to international S&E is distributed and flexible, accommodating differences across the spectrum of NSF-funded disciplines, the diverse needs of specific communities within the United States and with colleagues around the world. A common element, however, is partnership with NSF's research and education constituency. Areas and opportunities are identified through consultation and through the proposal and merit review process. Proposals with international activities may be submitted to any NSF research or education program and to the special programs of NSF's Office of International Science and Engineering (OISE).

As a result of its international portfolio encompassing projects in all S&E disciplines, NSF effectively partners with almost every country in the world. In fiscal year 2007, more than 4,200 NSF awards had an international component and these awards involved cooperative activities with 145 countries.

Whereas it is not feasible to summarize all NSF-funded projects that have an international component in this response, NSF's international S&E cooperative activities generally fall into three broad categories:

Global research and education opportunities for U.S. students and early career scientists and engineers to gain professional experience in international teams

- For example, the Research Experiences for Undergraduates program, an NSF-wide activity, gives undergraduate students the opportunity to engage in high-quality research, often at important international sites. One of these sites is CERN, the European Laboratory for Particle Physics in Switzerland, and one of the world's premier international laboratories. Undergraduate students work with faculty mentors and research groups at CERN, where they have access to facilities unavailable anywhere else in the world.

Global-scale research alliances, partnerships and S&E networks focused on a complex problems or individual disciplines

- For example, NSF's Division of Materials Research within the Directorate for Mathematical and Physical Science supports the Materials World Network (MWN), a global collaborative aimed at fostering partnerships between materials science and engineering researchers at institutions around the globe, including institutions in Africa, Europe, Asia, and Australia. Through MWN, NSF and international partner agencies jointly solicit proposals for collaborative projects. Research is targeted at improving medical diagnosis, developing stronger materials for the housing and transportation industries, and more.

Support for large or distributed research facilities and infrastructure serving numerous scientists and engineers

- For example, at the ends of the world, NSF coordinates nearly all of the U.S. scientific research in the Arctic and Antarctica through its Office of Polar Programs. In fact, NSF was designated as the lead federal agency for the International Polar Year (IPY) 2007–2008. During this campaign, more than 100 countries undertook projects involving scientists, students, teachers, and the public to increase understanding of the polar region.
- Additionally, in today's highly sophisticated, technology-driven science, many international partnerships center around major, high-budget research facilities made possible only by combining the resources of more than one nation. Such international infrastructure projects play a key role in advancing S&E capacity worldwide. NSF leadership and proactive involvement in large international research projects helps ensure that U.S. S&E stays at the frontier. For example, NSF's facilities budget includes construction funds for the following:
    - The IceCube Neutrino Observatory—the world's first high-energy neutrino observatory—offers a powerful example of an international, interagency research platform. Agencies in Belgium, Germany, and Sweden have joined NSF and Department of Energy (DOE) in providing support for IceCube, which will search for neutrinos from deep within the ice cap under the South Pole in Antarctica. Neutrinos are hard-to-detect astronomical messengers that carry information from cosmological events.
    - The Atacama Large Millimeter Array, currently under construction near San Pedro de Atacama, Chile, will be the world's most sensitive, highest resolution, millimeter wavelength telescope. The array will make it possible to search for planets around hundreds of nearby stars and will provide a testing ground for theories of star birth, galaxy formation, and the evolution of the universe. ALMA has been made possible via an international partnership among North America, Europe, and East Asia, in cooperation with the Republic of Chile. NSF is the U.S. lead on this ground-breaking astronomical facility.
    - As part of the aforementioned IPY activities, NSF serves as lead contributing agency for the Arctic Observing Network (AON)—an effort to significantly advance our observational capability in the Arctic. AON will help us document the state of the present climate system, and the nature and extent of climate changes occurring in the Arctic regions. The network, organized under the direction of the U.S. Interagency Arctic Research Policy Committee, involves partnerships with the National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration, Department of Interior, Department of Defense, Smithsonian Institution, National Institutes of Health, DOE, and USDA. NSF coordinates AON activities across the U.S. government, as well as with international collaborators, including Canada, Norway, Sweden, Germany, and Russia.

Lastly, the Office of International Science and Engineering—the centerpiece of NSF's international activities—integrates Foundation-wide activities and manages a broad range of programs that support U.S. scientists and engineers engaged in international research and education. In FY 2009, NSF proposes a budget of $47.44 million for OISE.

NSF's international office has implemented specific programs to stimulate innovative international partnerships. The East Asia and Pacific Summer Graduate Research Institutes (EAPSI), International Research Fellowship, and Partnerships for International Research and Education (PIRE) Programs are examples of three OISE-supported programs that facilitate partnership across institutions and countries.

The *East Asia and Pacific Summer Graduate Research Institutes (EAPSI) Program* enables U.S. graduate students to build collaborations with scientists and engineers working in the top research facilities in East Asia and the Pacific region. The eight-week institute programs are held at top research institutions in Japan, Korea, Taiwan, China, Australia, New Zealand, and Singapore. Over 1,600 U.S. graduate students have participated in the program since its inception in 1990. The program fosters a U.S. S&E workforce capable of operating in a global marketplace increasingly impacted by scientific developments in Asia and the Pacific Region.

The *International Research Fellowship Program* supports approximately three dozen U.S. postdoctoral fellows for nine to 24 months at foreign host institutions annually. The program's objective is to introduce U.S. scientists and engineers to cutting-edge international research opportunities in the early stages of their careers. Fellows' research projects involve international collaboration, the use of overseas instrumentation, and access to unique research environments in a wide range of

fields, including biology, physics, engineering, geosciences, computer sciences, and social and behavioral sciences.

In FY 2007, 39 fellowship recipients from 21 states were selected to conduct research in 21 foreign countries. After completion of the fellowship, the researchers return to jobs in academia and industry in the United States. Past fellows have reported that their experiences positioned them to build new collaborations with colleagues in their host country. These collaborations have led to foreign hosts of NSF International Research Fellows joining U.S. research teams.

The *Partnerships for International Research and Education (PIRE) Program* is an example of a larger collaborative research activity supported by OISE. PIRE enables U.S. institutions to establish collaborative relationships with international groups or institutions to conduct research dependent upon international collaboration. The program catalyzes a cultural exchange in U.S. institutions by establishing innovative models for international collaborative research and education. PIRE also readies U.S. students to participate in international research collaborations.

To date, the PIRE program has supported the work of 32 institutions in 23 states. Research collaborations with more than 40 countries have resulted. The U.S.–China PIRE project on electron chemistry and catalysis was listed in the Chinese media as one of the top ten S&T developments in China for 2006. The PIRE program supports research projects that nurture U.S. relationships with international counterparts.

The progress of humankind will depend increasingly on the new knowledge of science and technology. The collaborative pursuit of new knowledge is a powerful tool for bringing people together, and NSF activities will continue to stimulate global collaboration.

In response to a question from Congressman Lipinski on the rationale for providing only a 2.1 percent increase to funding for the National Nanotechnology Initiative (NNI) in a year in which the directorates with the most significant role in the initiative are getting 20 percent increases, Director Bement indicated that the leveling of funding results from a decline in the number of meritorious research proposals.

Q5. What have been the trends over the past three years in the numbers of proposals received and in the proposal funding rates across the various NNI program component areas? Are there significant differences in proposal pressure or funding rates among the directorates supporting research that is part of the NNI portfolio?

A5. Proposal and funding rates are available for a few solicitations related to NNI over the past three years. These rates are comparable to those of the Engineering Directorate which provides the majority of funding for these solicitations. There has been a decline in proposals submitted, in part, because of submission limitations. For the Nanoscale Interdisciplinary Research Teams (NIRT) program, 518 proposals were received in 2005 and 260 in 2007; funding rate was 10 percent in 2005 and 11 percent in 2007. For the Nanoscale Exploratory Research (NER) program, 372 proposals were received in 2005 and 274 in 2007; funding rate was 22 percent in 2005 and 15 percent in 2007. In comparison, the Engineering Directorate had an average proposal level of 6,800 and a funding rate of 14 percent during the same three year period.

The funding level requested for NNI is the result of the priority setting process that takes place among the participating directorates.

Information on funding rate by Program Component Area (PCA) is not readily available, however, because the majority of NSF's NNI funding is provided through core programs. NSF Program Directors report that funding rates and proposal pressure for NNI research have been comparable to the overall levels in their respective programs over the past three years.

NSF supports fundamental research, infrastructure, and education in all areas of nanoscale science and engineering, excluding research involving clinical testing. Activities are guided by long-term objectives which may be used by industry, the community, and other agencies. NSF supports over 3,000 active awards, 24 large centers and trains over 10,000 students and teachers each year. The modes of support include single investigator, multi-disciplinary team, center, and network awards.

Q6. Is there any significant difference from fiscal years 2008 to 2009 in the allocation of NNI funds or the focus of research supported within each of the directorates with NNI designated funding? Will NSF readjust priorities within the NNI portfolio to address areas of greater research promise?

A6. NSF efforts within the NNI through the NSF Nanoscale Science & Engineering Priority Area (FY 2001–FY 2006) were directed at establishing and fostering the growth of a newly emerging nanotechnology community. As this community blossomed, nanotechnology research has been transitioned and is now embedded and pervasive throughout NSF core programs. As a result of these efforts, other federal agencies with a more applied research mission are now in position to partner with industry to further the basic research knowledge gained from prior support.

NSF has an annual process of establishing its priorities on nanoscale science and engineering (NSE) research that includes proposals from the internal NSE Working Group, input from workshops and meetings with the grantee communities, interagency coordination through the National Nanotechnology Initiative—the Nanoscale Science, Engineering and Technology Subcommittee (NSET) of the National Science and Technology Council (NSTC), international context, industry, and non-governmental organizations (NGOs). As a result of this input, an increase in focus for FY 2009 is planned in the following areas:

- Research on the application of quantum mechanics and self assembling
- Research on integrated nanosystems that:
  - will support key applications of nanotechnology, such as petascale computing
  - design-in properties by manufacturing materials from the nanoscale
  - regenerate human tissue and organs from the nanoscale; designing systems of nano-sized sensors
  - selectively filter harmful particles from water; and manufacturing devices, such as solar cells, that efficiently convert and store renewable energy
- The use of nanotechnology for addressing sustainable use of water, energy and materials
- Nanoscale processes in the cell, at the intracellular level, in the neural systems, at the interfaces between biotic and abiotic materials
- Developing the network around a planned center to study the environmental implications of nanotechnology
- Including environmental, health and safety aspects of nanotechnology in additional core programs

For the new initiative Science and Engineering Beyond Moore's Law:

Q7. How does the initiative relate to current activities supported under NNI and will funding now allocated to other areas within the NNI portfolio be reallocated to this initiative?

A7. This initiative will be partially funded from the NNI funds allocated to nanoelectonics and particularly beyond Complementary Metal Oxide Semiconductor (CMOS), and partially new funds in MPS, ENG and CISE for the software, cyberinfrastructure, and other related aspects. In ENG and CISE, this activity is an extension of the existing activities beyond-CMOS initiated in FY 2004 in collaboration with the Semiconductor Industrial Association (SIA) and the Semiconductor Research Corporation (SRC).

A working definition of "nano" suggests a range of dimensions between about one and 100 nm, with physical behavior arising as a consequence of the size. The bulk of the current NNI science portfolio falls into the nanoscale region, within the context of the working definition, and will not be subject to reclassification. The approach by MPS will be to classify only newly funded activities as SEBML, with any potential overlap with NNI only occurring for special cases that might satisfy the working definition.

Q8. What are the current funding levels, by directorate, for activities in nanoelectronics?

A8. NSF is currently investing approximately $100 million per year in nanoelectonics and the related topics of nano-magnetics and nano-optics. It is estimated that the Directorate for Engineering (ENG) invests approximately $45 million, Mathematical and Physical Sciences (MPS) approximately $45 million, and Computer Information Science & Engineering (CISE) approximately $10 million.

Q9. Will NSF issue a request for proposals for this initiative?

A9. Currently NSF has no plans for a specific SEBML solicitation in FY 2009. NSF has been active in advertising this new potential investment to the science and engineering community and anticipates a large volume of unsolicited proposals.

Q10. Your office provided a summary of FY 2008 consolidated appropriations impacts. Please expand on facilities reduction impacts, including staff layoffs at the National Center for Atmospheric Research, the National Superconducting Cyclotron Laboratory, and any other NSF-supported facilities that are reduced in FY 2008.

A10.

Directorate for Mathematical and Physical Sciences

Cornell Electron Storage Ring (CESR)

NSF provided support for the operations and maintenance of the CESR storage ring at Cornell University and supported operations of the CLEO detector. Impacts of omnibus funding include these areas:

- NSF support for CESR operations was scheduled for a phase-out over fiscal years 2008 and 2009. Staff reductions were anticipated as part of the phase-out plan. The FY 2008 Omnibus bill resulted in a $1 million reduction over FY 2008 Request in CESR operations funding, which accelerated the phase-out, leading to the reduction of 10 positions beyond those already planned.
- The CLEO detector at Cornell had been scheduled to cease operations at the end of March, 2008. As a result of the Omnibus, operations were terminated on February 29, one month ahead of schedule. Additional calibration runs planned for this period would have improved the assurance in the analysis of the data.

Large Interferometer Gravitational Wave Observatory (LIGO)

LIGO operated at $33 million in FY 2007. The FY 2008 current plan level is $29.5 million. This funding decrease from FY 2007 to FY 2008 was planned as part of the approved construction start of AdvancedLIGO (AdvLIGO). However, because AdvLIGO did not begin until April 2008, LIGO continued to fully operate for six months. Although planned 'savings' were available to support these operations during this time, due to the Omnibus, about $1 million of these funds were diverted for other uses and not available for LIGO.

National Astronomy and Ionosphere Center (NAIC) and Arecibo Observatory

The FY 2008 current plan amount of $12.15 for NAIC is about level with FY 2007 funding. However, within this total the base operations budget for the Arecibo Observatory has been reduced in FY 2008 relative to FY 2007, following recommendations of the AST Senior Review. This reduction is not apparent because of the need to cover personnel termination costs and other one-time costs required to implement the recommendations of the Senior Review. The FY 2009 Request for NAIC is reduced to $11.40 million ($9.6 million from the Mathematical and Physical Sciences Directorate and $1.8 million from the Geosciences Directorate).

National High Magnetic Field Laboratory (NHMFL)

The FY 2008 current plan for NHMFL is $26.5 million, or $2.5 million less than the FY 2008 Request. The FY 2009 Request increases funding by $5 million, for a total of $31.5 million. This increase in FY 2009 would bring support back in line with the funding schedule outlined in the cooperative agreement, or an estimated $162.0 million over five years.

National Optical Astronomy Observatory (NOAO)

Impacts of FY 2008 omnibus funding include:

- Postponement of some infrastructure improvement projects recommended by the recent Astronomy Senior Review and begun in FY 2007. For example, at Cerro Tololo Interamerican Observatory in Chile, the construction of a mountaintop clean-room, new detector array controllers (electronics) for some of the older instruments, and a new calibration system have all been postponed until funds are available in future years. At Kitt Peak National Observatory in Arizona, modernization of telescope control electronics and improvement of the support system for the Mayall 4–m telescope's primary mirror, as well as the acquisition of new guide cameras have been similarly delayed.
- Exhaustion of NOAO's Director's reserve funds. For example, the Director holds a small portion of the Observatory budget in 'reserve' to provide merit raises, promotion raises, peso/dollar exchange rate adjustments, and similar one-time uses. By depleting this fund, the Director has reduced the merit raise pool modestly and the promotion pool significantly and has lost the small but helpful capability he had for addressing fluctuations in the Chilean peso/dollar exchange rate.

- Three to five vacant positions will be left unfilled.
- Reduction in the support of Giant Segmented Mirror Telescope (GSMT) activities funded by the base NOAO program. This will result in the deferral of several GSMT activities to future years. For example, one activity deferred until FY 2009 is the identification of technical areas (e.g., durable mirror coatings) in which design and development work would be helpful to both current U.S. project teams.
- Reduction in the support of Large Synoptic Survey Telescope (LSST) activities funded by the base NOAO program. NOAO has both dedicated LSST funding from NSF and allocated LSST funding in the base program budget. In FY 2008 NOAO will direct its LSST expenses to the dedicated LSST account rather than use the base budget account. This reduces base budget expenditures from those anticipated in the Congressional Request in accord with the level funding for FY 2008.

National Solar Observatory (NSO)

In FY 2008, the Advanced Technology Solar Telescope design project faces a shortfall of $700,000. While the Division of Astronomical Sciences (AST) is working to find a solution, which may include reductions in other programs within the division, AST will also need to delay or suspend several project-related contracts.

National Superconducting Cyclotron Laboratory (NSCL)

Substantial impacts include: reduction of six to eight staff positions, delayed procurements of cutting edge equipment, curtailment of already scheduled beam time and investigator experiments, delay of final theses for Ph.D.s candidates, and cancellation of a summer workshop for promising undergraduates from eight collaborating colleges.

Directorate for Geosciences

Academic Research Fleet

The FY 2008 funding level constrains resources for the fleet; however, schedule shifts in ocean sciences construction projects funded through the Research and Related Activities account, in particular the delay in construction of the planned Regional Class Research Vessels, has enabled the redirection of some funding to ship operations and will allow NSF to support approximately 2,300 ship days at sea, approximately the same number as 2007.

Earthscope

NSF has implemented a phased funding plan to support the operation of Earthscope that reduces the impact of the FY 2008 appropriations on this facility. Earthscope operations support is awarded at the end of the year to support operations for the following year. NSF anticipates compensating for any potential shortfall with FY 2009 funding.

National Center for Atmospheric Research (NCAR)

NCAR reduced its NSF-supported workforce by 30 positions. This reduction was accomplished in several ways: terminating jobs, moving staff to other funding sources, and not filling position vacancies.

Office of Polar Programs

OPP anticipates deferring several activities critical to ensuring resupply of the Antarctic, leaving the USAP at risk for disruptions to the U.S. presence in Antarctica. These include:

- Delayed completion of additional fuel storage capacity at McMurdo Station that would provide storage adequate to meet science and operations needs for two seasons in the event of a failure of the ship-borne resupply effort ($3.8 million);
- Delayed completion of the South Pole Traverse project that was instituted to diversify the means of delivering fuel and cargo to the South Pole, including delivery from locations other than McMurdo, and to reduce the cost of those deliveries. As a result, the Traverse will operate at one third capacity until FY 2010 ($4.7 million);
- Delayed commencement of plans to replace the current pier at Palmer Station that is critical to continuity of cargo and personnel embarkation/debarkation ($2.17 million).

Upgrades for science support at South Pole Station will also be deferred ($4.9 million):

- The planned TDRSS (Tracking and Data Relay Satellite System) upgrade at South Pole Station will be deferred, delaying development of the back-up broad bandwidth capabilities needed to transmit large data sets that are generated by major science projects. Until this upgrade is completed, the USAP would not be in a position to shift to TDRSS Flight–3 (F–3) if TDRSS F–1 were to fail. In that case, communications capabilities at the South Pole would be severely limited.
- The 10m telescope has been completed and is operational. However, shielding the telescope from ground "noise" will dramatically improve the sensitivity of the telescope. Planned construction of the shield will be deferred, reducing operational efficiency.

Across-the-board reductions ($6.85 million) were made in budgets for labor, maintenance, and equipment replacement. While operational requirements will be met, there likely will be erosion in preventive maintenance and a degradation in equipment performance. Deferring portions of projects to replace day tanks, to provide secondary containment for station and field fuel storage systems, for fuel piping systems and for the vehicle refueling facility at McMurdo will increase environmental risks and delay the expected fuel conservation benefits of these projects.

Funding for USCG icebreaker support will be reduced ($4 million). Attempts will be made to limit the impact of a budget reduction on the Healy. Therefore it is likely that some maintenance currently planned by USCG for the Polar Sea would be deferred.

The suite of software systems used to manage personnel and cargo movements in the USAP was designed decades ago and is inefficient. Planned replacement of these systems will be deferred ($1.0 million), increasing risks due to supportability and security vulnerabilities.

The USAP will not be able to provide the advanced funding ($1 million) required to secure contracts for planned additional aircraft support in the 2008/2009 season, impacting International Polar Year projects that were scheduled to use these additional assets. For example, the Pine Island/Thwaites Glacier sector of the West Antarctic Ice Sheet study, and setting out instrumentation for PoleNet that would provide ground truth for satellite-based estimates of ice mass change will be deferred. Both of these projects are related to identifying the contribution of ice sheets to sea level, a major unknown for climate change models.

At Toolik Field Station in Alaska, deferral of planned upgrades ($750,000) will result in the continued use of non-code compliant facilities, thus limiting the ability to perform winter science. The facilities are also inefficient, contributing to high fossil fuel usage and excessive environmental impacts. Deferred procurement of switchgear ($1.5 million) capable of supporting 50 percent of the (yet to be installed) renewable energy sources at Summit Station in Greenland will result in similar impacts and ever increasing costs. Additionally, reducing pollution from diesel generators would greatly enhance the quality of atmospheric observations taken at this site that inform climate change model prediction.

Q11. Please provide a list and description of all horizon projects under consideration as part of the current major research facilities plan.

A11. While the 2009 Budget Request does not include so-called horizon projects, the items listed below represent ideas and possible future opportunities identified by the research community for development of large-scale research infrastructure. Many of these ideas may never mature and others not yet conceived will emerge.

Water systems: This explores environmental research on human-stressed water systems that may lead to development of a distributed research facility comprising interacting field sites and an integrating cyberinfrastructure.

Coherent X-ray light source: The energy recovery linac is a coherent x-ray light source with the potential for enabling new types of scientific investigations that cannot be done using current x-rays sources, and impacting many scientific disciplines such as chemistry, biology, condensed matter and materials physics, and geology and geophysics.

Underground science: A facility to provide research opportunities in science and engineering in the deep underground environment. The scientific program would provide investigations in a wide array of subjects driven largely by physics, including nuclear physics, nuclear and particle astrophysics, and accelerator- and non-accelerator-based particle physics.

Giant telescope: This general purpose telescope of unprecedented size would provide significant improvements to current technologies and allow it to study galaxies in formation, probe proto-stellar disks, and perhaps image planets orbiting nearby stars. It was the highest priority ground-based recommendation in the 2001 NAS decadal survey report "Astronomy and Astrophysics in the New Millennium."

Large survey telescope: The telescope would produce the deepest, widest-field image of the sky ever taken along with daily catalogs of moving and transient objects. Among the principal science drivers are: understanding the physics of dark energy and dark matter; detection of moderate redshift supernovae; detection and cataloging of small bodies in the solar system; studies of the distances and motions of stars in the solar neighborhood; measurement of the kinematics and structure of the galactic halo; and opening the time domain. Construction of this instrument was the third-ranked major initiative in the 2001 NAS decadal survey report "Astronomy and Astrophysics in the New Millennium."

Next generation radio telescope: Key radio astronomy science drivers include: extreme tests of general relativity with pulsars and black holes; evolution of galaxies, cosmology, dark matter, and dark energy; probing the "Dark Ages"—the first black holes and stars; searching for extrasolar planets and life; and the origin and evolution of cosmic magnetism. Technology development for this possible facility was the third-ranked moderate initiative in the 2001 NAS decadal survey report "Astronomy and Astrophysics in the New Millennium."

South Pole Station communications: Sophisticated experiments, not envisioned when the recently-dedicated South Pole Station was designed a decade ago, require increased communications capability and reliability with a focus on moving from the current 12 hours per day provided by aging satellites, to continuous high-bandwidth connectivity, in order to fully realize the South Pole's research potential and to be able to more effectively respond to medical emergencies.

Questions submitted by Representative Vernon J. Ehlers

Q1. Would you please provide us with more specific details on the Teacher Initiatives within the EHR Directorate?

A1. EHR proposed a new research and development thematic priority in the FY 2009 Request—Teacher Education in STEM: Enriching Knowledge and Practice. It is designed to advance knowledge and practice in the preparation of K–12 STEM teachers and to encompass the entire continuum—from pre-service education, to induction, to continuing professional development. Ideally, this strategic approach will subsume many of EHR's STEM programs under a rubric that creates linkages among the four divisions, allowing shared responsibilities and programmatic management for the teacher education continuum. The effort will help NSF meet the teacher preparation goals of the American Competitiveness Initiative (ACI), which stress the criticality of replacing the Nation's aging teacher corps, reducing attrition of STEM teachers, and broadening participation in STEM teaching.

This integrative effort is grounded in research and practice, builds on current knowledge while addressing critical issues and gaps in teacher education, and expands current and prior efforts to enable STEM teacher learning. It will address a number of objectives, including assuring that our nation's K–12 teachers are: proficient in STEM concepts and topics; confident in their own grasp of STEM content; life-long learners of this content; aware of rapidly changing STEM disciplinary content; able to guide and assess STEM learning in age-appropriate ways; confident in the use of cyber-enabled tools; prepared to engage an increasingly diverse student population; and supported by STEM faculty, in collaboration with teacher education faculty and practitioners.

All of these objectives require a research knowledge base about STEM teacher learning that will serve as a foundation for improved models of teacher education. A rigorous evaluation component, both at the project level as well as program-wide, will measure outcomes in terms of increased production of well-qualified teachers; knowledge and dissemination of proven strategies that contribute to this production; and evidence of a relationship between teacher education components and improved K–12 student learning. Research questions will address new areas of national importance concerning teacher preparation, induction, and professional development.

Examples of specific programs within EHR that support teacher education efforts follow:

- The Robert Noyce Scholarship program (Noyce) directly addresses the need to provide support that attracts students of the STEM disciplines into K–12 teaching and seeks to increase the number of K–12 teachers with strong STEM content knowledge who teach in high-need school districts.
- The Math and Science Partnerships (MSP) engage school districts and higher education in large scale efforts to improve K–12 STEM teaching, working primarily with in-service teachers, but providing programs for pre-service teachers as well.

- The NSF Graduate Teaching Fellowships in K–12 Education (GK–12) engage STEM disciplinary graduate students in K–12 classrooms to provide content support for the K–12 teachers.

Further, there are programs that have other principal objectives but also make significant investments in teacher education, particularly the Louis Stokes Alliances for Minority Participation (LSAMP) program, and the Advanced Technological Education (ATE) program. Teacher Education is also addressed through the Division of Undergraduate Education's core program, Course, Curriculum, and Laboratory Improvement (CCLI,) which seeks to improve STEM teaching and learning for all undergraduates, including the many prospective teachers who are part of the undergraduate population. Finally, there are two programs that aim to increase understanding of effective teaching at all levels as their core objectives: Discovery Research K–12 (DRK–12) and Research and Evaluation on Education in Science and Engineering (REESE).

Additional Program Details:

Noyce

The Robert Noyce Teacher Scholarship Program provides funding to institutions of higher education to provide scholarships, stipends, and programmatic support for undergraduate students majoring in science, mathematics, engineering, or technology and for STEM professionals to enter and complete teacher credentialing programs. Scholarship and stipend recipients are required to complete two years of teaching in a high need school district for each year of scholarship or stipend support. Projects include partnerships with school districts, recruitment strategies, and activities to enable the recipients to become successful elementary or secondary math and science teachers. For example, Noyce Scholars are typically mentored by master teachers and college faculty while they are preparing to become teachers and as they begin teaching in the schools.

MSP

One of the key goals of MSP partnerships is to increase the number, quality, and diversity of mathematics and science teachers. With MSP support, STEM faculty and their departments, often in collaboration with colleagues in the School of Education, have developed new, coherent and long-term courses and programs to enhance the content knowledge of current and future teachers. Teachers-in-residence (teachers on long-term leave and/or sabbaticals) have come on to college campuses to broaden discussions of teaching and learning, and to support new efforts in teacher preparation. STEM professional learning communities, bringing together K–12 teachers and higher education faculty, are new exemplars in professional development. Schools have come to utilize the leadership skills of new Teacher Leaders, and demonstrated stronger school-level achievement outcomes when the Leaders have strongly defined roles and relationships with classroom teachers.

The 40 Comprehensive and Targeted Partnership projects report that over the life of their awards they will impact 137,000 teachers of mathematics and science in the 576 school districts that are in their partnerships. By the 2005–2006 year, 58 of their higher education partners had undergone pre-service teacher program revision as a part of MSP. Three hundred forty courses have been changed or are being changed to impact the future teacher workforce; over 21,000 future teachers are in the pre-service courses modified as a part of the MSP effort.

Graduate Teaching Fellows in K–12 Education

Graduate Teaching Fellows in K–12 Education (GK–12 Fellows) spend up to 15 hours a week during a full academic year working closely with teachers in their classrooms. The fellows bring cutting edge research and expertise in the newest instrumentation and technology into the classrooms. According to research on professional development, this type of embedded professional development that is both ongoing and that supports the curriculum is most effective. The fellows also model the life of a scientist for younger students who might not know other scientists. The program has impacted more than 8,500 teachers and more than half a million K–12 students. Approximately 70 percent of the K–12 settings where Graduate Fellows are placed as "scientists in residence" are rural and urban schools. For this reason, GK–12 has the greatest impact providing high-end science content knowledge to teachers and students in some of the neediest areas of education: inner-city schools that are usually low performing and in need of resources and expertise; and, remote schools far removed from ready access to supplies and specialists.

ATE and Teacher Education

Teachers are part of the technological workforce of the future. Many future teachers will receive STEM preparation in community colleges. Each year ATE supports teacher preparation projects that help prepare a K–12 workforce that is skilled in teaching science and mathematics, understands the technological workplace, and can give a variety of approaches for solving real world, technology-related problems using design processes and principles. For example, Normandale Community College in Minnesota collaborates with Minnesota State University Mankato to prepare highly qualified K–8 teachers. Pellissippi State Technical Community College in Tennessee is coordinating a statewide effort among seven community colleges and two universities to develop a common core of technology, science, and mathematics courses for future elementary school students. While teacher preparation has been a small part of the ATE portfolio, the program has consistently supported several such projects each year. There is now a significant portfolio involving many institutions. The American Association of Community Colleges plans to publish a compendium of these projects in summer of 2008.

LSAMP Bridge To Teaching (2006 Pilot Project)

The Louis Stokes Alliances for Minority Participation Program "Bridge to Teaching (BT) Initiative" piloted a teacher education training program in FY 2006. The initiative funded a graduate degree bridge activity at Arizona State University, University of Alabama–Birmingham, and City College in New York. The initiative broadens participation through the attraction of LSAMP baccalaureate under-represented minority students in STEM disciplines. Additionally, this activity seeks to remove minority students' hesitancy about entering graduate school, and the fear of creating additional financial indebtedness associated with initial graduate education. At the conclusion of the 12–24 month duration each successful participant is awarded a Master's degree and teacher certification.

Questions submitted by Representative Eddie Bernice Johnson

Q1. The America COMPETES Act *created a program called, PALS, or the Partnership for Access to Laboratory Sciences. Will there be any grant solicitations under this pilot program in the current fiscal year? If not, please provide a description of*

- *any current activities that meet the goals of PALS; and*
- *how you will implement the program as intended in fiscal year 2009.*

A1. There will be no grant solicitations under this pilot program in FY 2008. Before proceeding with a PALS program, it is important for NSF to determine the most effective way to meet the intent of the PALS provision. Two existing programs that have the capability for doing this are the National Science, Technology, Engineering and Mathematics, Education Digital Library (NSDL) and the Information Technology Experience for Students and Teachers (ITEST).

This approach will allow NSF to address the objectives of PALS by initiating or incorporating critical components into existing programs, once it has been determined how to proceed most effectively.

Q2. America COMPETES also directed the National Science Foundation to work with the National Academies to publish a Rising Above the Gathering Storm*-style report on minority participation in STEM. Will you report back to the Committee on the status of this effort?*

A2. Assistant Director Cora Marrett has already met with the Michael Feuer, National Academy of Sciences (NAS), to discuss an arrangement in which NAS provides expert guidance to NSF on mutually agreed upon topics via reports and studies. The report on diversity required in the *America COMPETES Act* was part of this initial discussion.

In addition, NSF supports and produces two separate biennial reports on this topic: the report from the Committee on Equal Opportunity in Science and Engineering (CEOSE) and a report entitled "Women, Minorities, and Persons with Disabilities in Science and Engineering" (*www.nsf.gov/statistics/wmpd/about.htm*). NSF reporting on the latter topic is mandated by the *Science and Engineering Equal Opportunities Act* (Public Law 96–516). The data on the web site are updated frequently and a completely new report is issued every two years. NSF also provides considerable support to CEOSE (The Committee on Equal Opportunity in Science and Engineering), which uses this information to advise NSF on its efforts to promote diversity and equal opportunity in science and engineering as stipulated by the

Science and Engineering Equal Opportunities Act of 1980. A biennial report is made to Congress. These reports make full use of NSF data.

Questions submitted by Representative Daniel Lipinski

Q1. How does the NSF plan to implement recently authorized America COMPETES programs in light of recent budgetary shortfalls? Can you point to tangible evidence, such as a projected decrease in the amount of NSF supported researchers that is a direct result of the recent budget shortfalls?

A1. Immediately after the ACA was signed into law, a working group was assigned to develop options and recommendations on how to implement the provisions of the Act pertaining to NSF. The working group is developing plans for ramping up new programs or redesigning existing programs, processes and procedures to implement the statute.

To date, NSF has already implemented some of the Act's provisions, such as:

Section 7036, Major Research Instrumentation: With regards to cost sharing for the Major Research Instrumentation Program, implementation actions included issuance of a Dear Colleague Letter to the community, revision of the solicitation, and conducted briefings.

Section 7037(a), Limit on Proposals: For programs that require preliminary proposals as part of the selection process, and that also limit the number of pre-proposals that may be submitted by an institution, NSF allows the subsequent submission of a full proposal based on each pre-proposal that is determined to have merit. It should be noted that this was already the Foundation's policy and only one solicitation limited the number of full proposals that could be submitted based on the outcome of the preliminary proposal competition. This solicitation will be corrected when it is next issued. NSF is now in compliance with this provision of the Act.

We are also in the early stages of implementing several other sections, such as:

Section 7018, Meeting Critical National Science Needs: NSF will recommend to the National Science Board (NSB) that the relevance of critical national needs be made explicit in the NSB-approved criteria, and that reviewers assess this in the review of proposals submitted to the Foundation.

Section 7008, Postdoctoral Research Fellows: NSF will implement the statute as enacted and also plans to encourage Principal Investigators to apply this approach to mentoring graduate students.

Section 7020, Cyberinfrastructure: NSF is beginning to identify the "scientific research requirements of broadband access," and to collect recent data that describe the current status of broadband access at relevant institutions. In fashioning a plan, we are gathering input from academic institutions, State and local government, and private sector organizations, as well as organizations like Educause, Internet2 and NLR whose missions are directly relevant to support for broadband access at colleges and universities.

Section 7026, Laboratory Science Pilot Program: NSF will utilize its investments in cyber-enabled learning to test effective ways for enabling authentic learning experiences for high school students. We have several existing programs that have the capability for doing this, such as the National STEM Digital Library and Innovative Technology Experiences for Students and Teachers.

Section 7030 and Section 10 A, Robert NOYCE Teacher Scholarship Program and Teaching Fellowships and Master Teaching Fellowships: NSF will establish a pilot program that would enable it to probe the features of the fellowship requirements, connect these features with ones undertaken through our other fellowship programs, determine what would be needed to implement the components of the new effort, and establish the pathways through which such programs advance K–12 STEM learning.

Section 7031, Encouraging Participation: This provision is an expansion of existing efforts (e.g., in the PAESMEM Program) and reflects NSF's strong interest in community colleges, STEM education, and the STEM workforce. We will seek to devise highly effective strategies for carrying out increased mentoring within the context of our community college and workforce programs. NSF has already negotiated the metrics that we will use through the ACC process.

Regarding the FY 2008 appropriations, NSF estimates that 1,000 fewer research grants will be awarded, impacting an estimated 3,000 senior researchers, postdoctorates, graduate students, and undergraduates.

Q2. The FY 2009 request provides for a 16 percent increase for the Research and Related Activities overall and about 20 percent increases for the directorates that support research in the physical sciences and engineering. In light of this, could

you please provide specifics on the proposed allocation for the National Nanotechnology Initiative of only two percent growth, which is below inflation and represents an actual decrease in level of activity? This lack of budget priority is puzzling since the NNI is a major cross agency research initiative in an area that is generally regarded as critical to the future technological strength and innovative capacity of the Nation.

A2. NSF has an annual process of establishing its priorities on nanoscale science and engineering that includes NNI Working Group proposals with input from periodical workshops and meetings with the communities, coordination with other agencies through the National Nanotechnology Initiative, and consideration of the international and industrial contexts.

NSF efforts within the NNI over the years have been directed at establishing and fostering the growth of the nanotechnology community. As this community blossomed, nanotechnology research has been transitioned and is now embedded and pervasive throughout NSF core programs. As a result of these efforts, other federal agencies with a more applied research mission are now in position to partner with industry to further the basic research knowledge gained from prior support. NSF will continue to support fundamental research, infrastructure, and education in all areas of nanoscale science.

Q3. In your opinion, how essential is long-term, stable, and relatively predictable funding to the NSF's research activities?

A3. Long-term, stable, and relatively predictable funding enhances NSF's ability to engage in long range planning and provide accurate information to the scientific and engineering community on anticipated funding levels for multi-year efforts. NSF's tasks are to keep scientists and engineers focused on the furthest frontier, to recognize and nurture emerging fields, to prepare the next generation of scientific talent and leaders, to provide world-class facilities to advance research, and to ensure that all Americans gain an understanding of what science and technology have to offer. The Nation's ability to innovate and compete, its strength and versatility, depend in part on continued success in achieving these goals. NSF's ability to meet these goals is highly dependent on adequate funding levels that can be used as a basis for developing program plans and priorities. Working at the leading-edge of the U.S. science and engineering enterprise, NSF provides nearly half of the federal investment in non-medical basic research at academic institutions and supports science and mathematics education at all levels. The nature of NSF's programming gives the agency an invaluable level of flexibility and agility. NSF has proven time and again that it can respond decisively and proactively to emerging opportunities and challenges.

Q4. The Administration cited the recently completed Academic Competitiveness Council (ACC) assessment of the effectiveness of Federal STEM education programs as a part of its justification for budget decisions for NSF's Education and Human Resources Directorate. The ACC report, which was chaired by Education Secretary Spellings, found that a number of NSF programs did not have adequate evaluations. Would you agree with the report's conclusions that NSF's education programs are not properly evaluated? If so, how do you plan to address this?

A4. The ACC recommends that "Funding for federal STEM education programs designed to improve STEM education outcomes should not increase unless a plan for rigorous, independent evaluation is in place, appropriate to the types of activities funded." However, this does not mean that a specific form of evaluation is required. Program funding relies on several factors. Importantly, evaluations should address questions of program implementation and impact, and must be calibrated to match the developmental changes that occur as programs become established. In 1992, performance monitoring and evaluation of education programs in EHR became a requirement. EHR has conducted numerous program evaluations since that time. Since 2005, EHR has required that every proposed project include an evaluation plan at the time of proposal submission. Evaluation plans and appropriately rigorous designs are developed for all EHR programs as they evolve.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Steven C. Beering, Chairman, National Science Board

Questions submitted by Chairman Brian Baird

Q1. You mentioned in your testimony that the Board continues to consider appropriate mechanisms for support of graduate students. A report from the National Academies in the mid 1990s suggested the need for an increase in numbers of fellowships and traineeships relative to graduate research assistantships. The 2003 NSB report, The Science and Engineering Workforce, indicated the Board would take no action due to "inadequate data to compel a recommendation of a major shift in funding mode among fellowships, research assistantships, teaching assistantships, and traineeships. . .."

Is the Board still gathering information on graduate student support mechanisms and do you expect the Board's past position to be revised in the near-term?

A1. We do not plan to revisit this position in the near-term. However, we continue to stay informed about all NSF programs to support graduate education and assessments of their effectiveness through the Board's Committee on Education and Human Resources and in discussions of the NSF budget.

Q2. What is the rationale for the FY09 budget proposal that increases the Graduate Research Fellowships program by 32 percent while holding the IGERT traineeship program at flat funding?

A2. The GRF and the Integrated Graduate Education and Research Traineeship (IGERT) programs are very different with respect to purpose and established effectiveness. The Graduate Research Fellowship program (GRF) is NSF's traditional fellowship support program for graduate students and has proven its effectiveness. According to the recent Committee of Visitor's report (2003) GRF "has been a mainstay of technical workforce development in science, engineering, technology and mathematics for many years. . .. The program is old enough now that former fellowship holders can be found in many prominent places within the public and private sectors. . .all stated goals were being met. . .. Clearly, the students who are recipients of these awards end up making significant contributions to the 'scientific' workforce and as 'global' representatives of our scientifically trained citizenry (Committee of Visitors Report, 2003). In FY 2009, 3,075 students would be supported under the proposed budget.

The IGERT program was initiated in 1998. IGERT remains experimental, with results of extensive evaluations of the program effectiveness still under review. Both the GRF and IGERT programs have experienced increases in this decade, but clearly the long-term, proven effectiveness of the GRF in achieving national goals for the science and engineering workforce merits sustaining and expanding support to this program. The IGERT program is focused on institutional innovation in graduate education, and grants are to institutions rather than directly to excellent students. The IGERT program, with funding for 1,425 students under the 2009 budget, would support nearly half as many students as would be supported under the well established GRF program. This level of funding seems appropriate.

Questions submitted by Representative Daniel Lipinski

Q1. How does the NSF plan to implement recently authorized America COMPETES programs in light of recent budgetary shortfalls? Can you point to tangible evidence, such as a projected decrease in the amount of NSF supported researchers that is a direct result of the recent budget shortfalls?

Q2. The FY 2009 request provides for a 16 percent increase for the Research and Related Activities overall and about 20 percent increases for the directorates that support research in the physical sciences and engineering. In light of this, could you please provide specifics on the proposed allocation for the National Nanotechnology Initiative of only two percent growth, which is below inflation and represents an actual decrease in level of activity? This lack of budget priority is puzzling since the NNI is a major cross agency research initiative in an area that is generally regarded as critical to the future technological strength and innovative capacity of the Nation.

A1 and A2. I refer you to the responses of the National Science Foundation Director with regard to the implementation of the *America COMPETES Act* in NSF pro-

grams and the specifics of the National Nanotechnology Initiative as implemented in NSF.

Q3. At present approximately 12 percent of graduate student support from NSF comes from fellowships and traineeships and the remainder from graduate research assistantships, which are tied to specific research grants. Several years ago, a study by the National Academy of Sciences suggested that the balance for such support should be relatively greater for fellowships and traineeships versus assistantships in order to give a student greater freedom in selecting an area of specialization. Has the Board revisited this policy and is the Board satisfied with the current balance among these support mechanisms for graduate education?

A3. The Foundation and the Board continually review evidence of the most advantageous approaches to support for graduate and postdoctoral education toward achieving federal goals for the science and engineering enterprise. In its 1996 *Report of the Task Force on Graduate and Postdoctoral Education,* the Board found insufficient evidence to justify a change in the balance in its funding modes for graduate education at that time. Moreover, though the 1998 report of the National Research Council, *Trends in the Early Careers of Life Scientists,* urged, under Recommendation 3, that "All federal agencies that support life-science education and research. . .invest in training grants and individual graduate fellowships as preferable to research grants to support Ph.D. education," it acknowledged that "There is no clear evidence that career outcomes of persons supported by training grants are superior to those of persons supported by research grants."

The Board has focused on improving outcomes, rather than balance of modes of support, in its more recent studies. Its 2003 report, *The Science and Engineering Workforce—Realizing America's Potential,* recommends encouraging institutions to "promote a wider range of educational options responsive to national skill needs." It goes on to recommend a realistic level of financial support for graduate and postdoctoral students (stipends on NSF fellowships and traineeships have since been raised to a $30,000 annually). In sum, the Board has not specifically focused on balance of support modes since the 1996 report, in favor of a broader focus on desired outcomes and the best approaches to achieve them, which may include as a tool, as appropriate, the modes of support for graduate education in science and engineering.

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