S. HRG. 110–1107

THE FISCAL YEAR 2009 BUDGET PROPOSAL TO SUPPORT U.S. BASIC RESEARCH

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND INNOVATION

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED TENTH CONGRESS

SECOND SESSION

MARCH 11, 2008

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SECOND SESSION

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TUESDAY, MARCH 11, 2008

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

The Subcommittee met, pursuant to notice, at 10 a.m. in room SR–253, Russell Senate Office Building, Hon. John F. Kerry, Chairman of the Subcommittee, presiding.

OPENING STATEMENT OF HON. JOHN F. KERRY, U.S. SENATOR FROM MASSACHUSETTS

Senator KERRY. Good morning. This hearing will come to order. Thank you, gentlemen for being here. We appreciate it. I apologize for being a few moments late.

We're all very well aware of the challenge that we face as a nation to maintain our dominance in the fields of science and technology. The sheer volume of recent undergraduate degrees awarded worldwide in science and engineering underscores this concern.

In 2004, China graduated more than 600,000 engineers while India graduated over 350,000, the U.S. graduated fewer than 70,000. Some have tried to do a sort of comparative population analysis on that, but I think the raw numbers annualized really speak for themselves and raise enormous issues, not to mention that in recent travels, as I've been to various countries, it is quite remarkable how much money, effort, public commitment, private commitment, other countries are making to this endeavor and anybody who isn't watching what these other countries are doing is missing the big picture of this challenge to our country.

It's well established that in order to remain competitive, we're going to need to invest in basic research and that's the type of research that is not targeted to produce a short-term financial gain.

A generation ago, this type of research was being performed by the private sector, specifically by the private sector leaders in the laboratories that we all became so familiar with as we grew up, whether it was the Bell Laboratories or others, but today, the demands have really shifted, driven by the quarterly earnings reports, Wall Street, and a different way of looking at investment and so private sector research budgets have really been shifted toward the type of applied research that produces a quick turnaround on investment.

From the Council on Competitiveness to the National Academies of Sciences, the call has been made for the Federal Government to step up and fill the void. Already in the 110th Congress, we've taken some steps, big steps toward addressing what Bill Gates referred to last March as our "contentment with living off the investments of previous generations."

Last year, we passed the COMPETES Act, which set a course for doubling the research budgets at critical agencies, at NSF, N–I–S–T, NIST, and the DOE, Office of Energy, within the next several years. Among its many contributions, the COMPETES Act authorizes the Technology Innovation Program and the TIP, which replaces the successful Advanced Technology Program, is designed to provide Federal grant funding to promote the kind of high-risk, high-reward research that is too often avoided by risk-averse private investors.

The COMPETES Act also reinforces our commitment to struggling manufacturing companies by reauthorizing the Manufacturing Extension Partnership, a program designed to transfer expertise in technologies developed under the NIST programs to specifically help small and mid-sized U.S. companies, manufacturers.

While the President's budget adds back a portion of the funding that was eliminated during the last gasps of the Fiscal Year 2008 appropriations process, it just doesn't come close to providing the level of funding authorized under the COMPETES Act. So, on the one hand, we have Congress embracing a national policy and on the other hand, we have an administration that is, frankly, choosing to ignore those authorized levels and submit its own lesser numbers.

In fact, even after considering proposed increases for NIST, NSF and the Department of Energy's Office of Science, the fact is that funding for basic and applied research across all agencies will fall by .5 percent. In real terms, if the President's budget proposals were to be enacted, the Federal R&D investment would have fallen by 9 percent in inflation-adjusted dollars between 2004 and 2009 and that, I would respectfully suggest, is the only honest way to measure where we're heading.

To top it off, the administration remains inexplicably steadfast in its commitment to eliminating the Technology Innovation Program and the Manufacturing Extension Partnership, and I don't really completely understand either of those choices, folks, for the simple reason that there are scores of success stories generated from the very modest Federal investment in these two programs.

It was an ATP partnership that led to the creation of the digital mammogram. In my state of Massachusetts, it's estimated that the MEP has generated nearly $500 million in increased or sustained sales over the past 5 years, translating into more than 4,400 new or sustained jobs.

It just makes no sense to eliminate funding for programs that retain and create high-paying, high-tech jobs while Asia and the European Community are implementing precisely what we're busy eliminating: large-scale, long-term R&D projects.

Government policy cannot and should not singlehandedly dictate events and we all feel that very strongly. We're not trying to pick winners over losers, but creating incentives and committing to ex-

ploration in certain sectors advances the ability of the private sector to make its choices with respect to those sectors and ultimately to create competitive entities within those sectors.

The government can do a great deal to encourage innovation by investing in a certain kind of research that is largely ignored by today's corporate structure and that means investing in long-term solutions that address priorities, such as broadband infrastructure, energy technologies, basic science and research, and high school and college education, and government can certainly do more to assist manufacturing companies that are struggling to keep up with global competition. I'm not talking about a bailout, I'm talking about providing the tools to be able to compete and thrive.

The purpose of today's hearing is to examine the budgets and programs of our Federal science agencies. We're delighted to have before us the Nation's preeminent science and technology agencies, and I welcome the leaders of those agencies. You have broad expertise in the programs that you administer, provide enormous opportunities for strengthening the American economy. They also act as a tremendous resource for addressing some of the most critical policy challenges of our time.

One of the key areas obviously for Federal research is the area of clean energy and climate change. Since this time last year, the warnings from the scientific community about the magnitude of this threat have become increasingly stark, increasingly clear, and, I might add, increasingly urgent.

An article in yesterday's Washington Post highlighted the latest science which cites the needs to reduce emissions to practically zero, in all effect to zero, by mid century. We need our best minds and our best technology working at full capacity to find the solutions to this challenge as well as to the challenge of alternative fuels as a substitute eventually for fossil fuels which would indeed be the fastest way to move to zero emissions, and we know that the companies that provide these transformational energy technologies and green products, whether it's more efficient batteries, cleaner engines, more efficient appliances, electronics that consume less, all of those are going to be companies that make a lot of money for someone.

Our challenge is to fund research and development that can enable the green revolution in energy and consumer products and to educate our students to invent, manufacture, and distribute these products to the global community as rapidly as possible.

So, I look forward to hearing from our distinguished panel, Dr. John Marburger, the Director of the Office of Science and Technology Policy; Dr. Arden Bement, Director of the National Science Foundation; and Dr. James Turner, National Institute of Standards and Technology. I will grant unanimous consent that the written testimony provided by the American Association for the Advancement of Science be included in the record.

[The testimony is included in the appendix.]

Senator KERRY. So, thank you, gentlemen, each of you, for being here again. We welcome you back, appreciate it, and Dr. Marburger, why don't you lead off?

STATEMENT OF HON. JOHN H. MARBURGER III, PH.D., DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Dr. MARBURGER. Thank you very much, Senator, members of the Subcommittee. I am pleased to come once again to present the President's Fiscal Year 2009 R&D Budget, and I thank you. My written testimony has quite a bit of detail about the——

Senator KERRY. I'll put everybody's written testimonies into the record as if read in full, and if you want to summarize, that'd be great, then we can have a dialogue about it.

Dr. MARBURGER. Thank you. So, I'll just say a few words about some high points.

I would like to thank this subcommittee for its support of the President's American Competitiveness Initiative through passage of the America COMPETES Act of 2007 that you referred to, Senator, in your opening remarks. The President does remain committed to the ACI and is once again requesting funds to ensure our future economic competitiveness.

The President's Fiscal Year 2009 Budget substantially funds authorizations under the COMPETES Act. Of the $13.8 billion authorized for Fiscal Year 2009 and the Act, the President's Budget would fund 12.25 billion or about 85 percent of the authorized level. This total compares favorably with the 82 percent level at which Congress funded the Act in the 2008 Omnibus bill.

If the President's request is funded, COMPETES Act budgets would grow by almost 15 percent. To place this in context, the President's overall request for all non-defense R&D increases by 6 percent compared with the remainder of the non-security discretionary budget which increases by less than 1 percent.

Total Federal R&D in the 2009 budget stands at a $147 billion, an increase of $4 billion over Fiscal Year 2008 appropriated, which represents $1 out of every $7 requested by the President in the discretionary budget. This is a growth of 61 percent during this Administration.

My written testimony summarizes the President's requests for several key research programs that cut across agencies and gives some detail for agencies under the jurisdiction of this subcommittee. Overall, the President's requests an increase of $850 million in the basic research category for a total of $29.3 billion which includes a 15 percent increase of $1.6 billion for the three agencies prioritized in the ACI, the National Science Foundation, Department of Energy, Office of Science, and the laboratories of the National Institute of Standards and Technology.

I might add that basic research at the Department of Defense would grow by 19 percent in this budget or $270 million over the Fiscal Year 2008 request.

The budget provides for key multiagency science programs. $2 billion for climate science which is up 12 percent over the 2008 enacted budget, an increase of about 9 percent for the entire range of climate-related activities, including science, technology, international assistance and tax incentives. It's a climate package of nearly $9 billion in all of the provisions of the budget.

The budget includes increased funding for a number of earth observation programs, $74 million for NOAA for climate sensors that had been de-manifested from the National Polar-orbiting Operation

Environmental Satellite System or NPOESS, $103 million for NASA to begin a series of Earth-observing missions recommended by the National Research Council's Decadal Survey, and $102 million for ocean science and research at NOAA, NSF, and the U.S. Geological Survey.

There are increases for the information technology, for nanotechnology, and a number of other important programs related to our future competitiveness.

At the agency level, you'll hear more detail about the National Science Foundation from Dr. Bement, but the NSF budget would increase 14 percent to $6.85 billion, more than $800 million above the Fiscal Year 2008 appropriation. Physical science directorates, which are important there, would receive increases of about 20 percent.

Dr. Turner is here to describe the NIST budget proposal. The NIST core research and facilities budgets would receive $634 million in 2009, an increase of 22 percent over the 2008 Omnibus provisions.

I've already mentioned the new earth-observing programs at NASA. The NASA budget would increase by 3 percent over Fiscal Year 2008 enacted to about $17—more than $17 billion.

NOAA. The 2009 budget request for NOAA provides $383 million for oceanic and atmospheric research and again requests $20 million for ocean science research as part of a $40 million interagency effort for the ocean research priorities plan.

And finally, my own office, OSTP, which sustained a 6 percent reduction in Fiscal Year 2008, is requesting $119,000 above the 2008 appropriation but is $215,000 below the Fiscal Year 2008 request on a budget of $5.3 million.

FY 2009 takes us through the end of the current Administration and the beginning of next year, and I believe the increased funding is important for this transition.

I'm also requesting that the Science and Technology Policy Institute continue to be funded within the NSF budget and I would be glad to explain why this is important.

So, thank you for this opportunity to highlight the President's Fiscal Year 2009 Budget. I think it's a strong proposal and I urge your support of it, and I'll be glad to respond in more detail to your questions either in today's hearing or in writing.

Thank you.

[The prepared statement of Dr. Marburger follows:]

PREPARED STATEMENT OF HON. JOHN H. MARBURGER III, PH.D., DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Chairman Kerry, Ranking Member Ensign, and members of the Subcommittee, I am pleased to appear before you once again to present the President's Fiscal Year 2009 research and development (R&D) budget. In the eighth and final year of this Administration, today's hearing provides an opportunity to take stock of how far we have come, where we are today, and, most importantly, what remains to be done for U.S. science and technology. Last year I came before this Subcommittee seeking your support for the American Competitiveness Initiative (ACI). With Congressional passage and enactment of the America COMPETES Act you delivered that support.

Now I am asking for your help again. The basic research programs prioritized in the ACI and authorized in the America COMPETES Act remain critically important to the long-term strength of our Nation's economy, and should be fully funded at the level of the President's request for 2009. The National Science Foundation, the

Department of Energy's Office of Science, and the National Institute of Standards and Technology's core lab research and facilities provide basic research infrastructure for every field of science, and produce the new knowledge that make technology breakthroughs possible. This Subcommittee has a commendable history of bipartisan support for science funding, for effective advocacy of basic scientific research, and for its technical applications that benefit every part of our society. On behalf of the Administration, I thank the Subcommittee for the good working relationship it has established with the science agencies and with my office, and look forward to campaigning together for robust funding of our mutual innovation and competitiveness agenda.

Overall, Federal R&D in the 2009 Budget is $147 billion, $4 billion more than FY 2008. That represents one out of every seven dollars requested by the President in the discretionary budget. This total exceeds the Fiscal Year 2001 amount by $56 billion and represents growth of 61 percent since then. Over these 8 years, the cumulative Federal R&D investment will total over $1 trillion.

The growth in non-defense R&D is even more dramatic in the 2009 Budget. The President is seeking a 6-percent increase in this category. By comparison, the remainder of the non-security discretionary budget is up less than 1 percent. And I draw your attention to the chart of Federal non-defense spending over time (see Attachment #1). With the 2009 Budget, *real* growth in outlays for the conduct of non-defense R&D, with the effect of inflation factored out, is up 31 percent in 8 years. Real non-defense R&D growth for the previous 8 years was 11 percent. The President's commitment to the government's R&D enterprise is strong, and the advancement of science remains among his top budget priorities.

The most recent and dramatic evidence of this commitment can be found once again in the President's State of the Union address in January. In the President's words:

> "To keep America competitive into the future, we must trust in the skill of our scientists and engineers and empower them to pursue the breakthroughs of tomorrow. Last year, Congress passed legislation supporting the American Competitiveness Initiative, but never followed through with the funding. This funding is essential to keeping our scientific edge. So I ask Congress to double Federal support for critical basic research in the physical sciences and ensure America remains the most dynamic nation on Earth."

Increased funding for critical basic research in the physical sciences is my highest budget priority. This Subcommittee has led by fully authorizing these basic research increases in the bipartisan America COMPETES Act. Unfortunately, the Subcommittee's good work was not ultimately realized in the 2008 Omnibus funding bill (see Attachment #2), but I urge you to maintain your commitment. We now must succeed in implementing ACI/COMPETES with actual funding. If we fail, it will significantly impair and delay all our efforts to strengthen long-term economic competitiveness through innovation-enabling basic research in the physical sciences and engineering. Lost research time delays innovations, slows development, misses market opportunities, and costs jobs and economic growth.

ACI: As described above, the centerpiece of the Administration's basic research agenda is the American Competitiveness Initiative. The 2009 Budget calls for a 15 percent or $1.6 billion increase for the ACI's three priority civilian science agencies: the National Science Foundation; DoE's Office of Science; and the laboratories of the National Institute of Standards and Technology. This level of total funding, $12.2 billion, is necessary to restore the doubling path we all committed to last year (see Attachment #3).

In addition, planned basic research at the Department of Defense will grow by $270 million over the FY 2008 request—a 19 percent increase, yielding a total of $1.7 billion—consistent with the President's commitment to support high value research in the physical sciences. These investments are made to support national security but, due to the broad effects of basic research, also contribute to ACI innovation goals as well.

I know this Committee is as disappointed as I am at the current shortfall. In order not to lose yet another year of enhanced and expanded high-impact innovation research, this year Congress must complete the FY 2009 budget process on time.

America COMPETES Act: With respect to programs authorized by America COMPETES in the President's budget, the Administration's approach is straightforward: among the many activities in the bill, establish priorities to ensure that limited resources are allocated where they are needed most. To this end, the Administration has accepted the conclusions of many studies and reports that funding for ACI basic research is most important and needs to be addressed first. This prioritization reflects a broad endorsement by the business and academic communities, most re-

cently as part of last year's "American Innovation Proclamation," which states as its first conclusion that "Congress must act to: Renew America's commitment to discovery by doubling the basic research budgets at the National Science Foundation, the National Institute of Standards and Technology, the Department of Energy's Office of Science and the Department of Defense" (see Attachment #4).

Prioritizing within the constraints of budget realities necessarily means that some of the programs and activities authorized in America COMPETES could not be requested in this Budget (see Attachment #5). The lack of funding in the FY 2008 Omnibus appropriations bill for the priority basic research increases authorized in the COMPETES Act makes it even more imperative to address these priorities in the forthcoming fiscal year. The President signaled this policy when he signed America COMPETES in August of last year, stating that "These new programs . . . and excessive authorizations will divert resources and focus from priority activities aimed at strengthening the basic research that has given our Nation such a competitive advantage in the world economy. Accordingly, I will request funding in my 2009 Budget for those authorizations that support the focused priorities of the ACI, but will not propose excessive or duplicative funding based on authorizations in this bill" (see Attachment #6).

As just one example of this prioritization, the Budget does not request funding for the new Commerce Department Technology Innovation Program or new math and science education programs at NSF. This is because the Administration believes very strongly that the fundamental research programs at NIST and NSF are a higher leverage investment and in greater need of funding than new programs, especially given the devastating impacts of last year's Omnibus appropriations bill on these agencies.

Earmarks: Before summarizing this year's Federal R&D budget, because research earmarks returned in the 2008 appropriations, I want to express my concern about the very serious deleterious impacts earmarks have on the science budget. I make these remarks knowing that this Subcommittee fully understands the impact of the problem and supports best practices in the allocation of research funding.

In FY 2008, DOD basic and applied research earmarks total about $1.1 billion (about 1/6 of DOD research's total budget); $124 million of the DoE Office of Science is earmarked; and $83 million in earmarks and unrequested grants seriously dilute the core research and facilities proposed at the National Institute of Standards and Technology. Altogether, research earmarks are estimated at $2 billion of the $16.8 billion of overall appropriations earmarks government-wide in FY 2008. In nominal terms, this is more than the $1.8 billion increase in the overall FY 2008 Federal Science & Technology (FS&T) budget and earmarks therefore result in an actual real cut in merit-reviewed research at the agencies that are included in the FS&T budget. As we discuss the importance of pursuing the best science to contribute to U.S. competitiveness, I hope the Congress will significantly reduce research earmarks in the FY 2009 appropriations process, as it did in Fiscal Year 2007. Earmarks that divert funding from a merit-based process undermine America's research productivity. The Administration commends Congress for not subjecting NSF and the National Institutes of Health to this debilitating practice. It is now time to end this practice for all research programs.

Basic Research: Looking at overall basic research in the 2009 Budget, $29.3 billion is requested, an $850 million increase. Since the effect of FY 2008 earmarks only enhance this difference and make the real programmatic increases even bigger, in my view this is a clear indication of the Administration's strong focus on fundamental research and the discovery of new knowledge as a leading mission of the Federal Government. I want to emphasize that this favorable treatment of basic research is occurring in a year of spending reductions for many other domestic programs, indicating the high priority this Administration places on the importance of this activity.

Climate Science: While basic research in the physical sciences for long-term innovation and competitiveness is the priority driver in the 2009 Federal R&D budget, other science areas remain very important to our Nation's goals. Since FY 2001, the Administration will spend approximately $14.6 billion on climate change science research through the multi-agency Climate Change Science Program, and the President's 2009 CCSP budget exceeds $2 billion, a 12 percent increase over FY 2008 enacted. The U.S. leads the world in advancing climate change policy and programs, with planned expenditures of nearly $9 billion in climate-related science, technology, international assistance, and tax incentive programs proposed in FY 2009—much more than any other country and a 9 percent increase over 2008 enacted levels.

Earth Observations and Ocean Initiative: In other programs relevant to the environment, the 2009 Budget includes increased funding for a number of Earth Observations programs, most notably $74 million for the National Oceanic and Atmos-

pheric Administration (NOAA) to sustain the highest priority climate measurement capabilities that once were part of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program, and $103 million for NASA to embark on the new series of space-based Earth observing missions recommended by the National Research Council's recent Earth Sciences Decadal Survey. A new National Land Imaging Program office to ensure long-term continuity of multi-spectral imaging of the Earth's surface is established in the U.S. Geological Survey (USGS). This year's budget again includes the Administration's Ocean Initiative, which calls for $102 million in 2009 funding for ocean science and research at NOAA, NSF and the USGS.

Information Technology: President Bush's 2009 Budget of $3.5 billion for Networking and Information Technology R&D (NITRD) represents a doubling since 2001. This brings the 8 year total investment in this area to more than $20.9 billion. The 2009 Budget emphasizes the NITRD priorities of high-end computing R&D and infrastructure, advanced networking, and cyber security and information assurance. The tools and capabilities that result from the NITRD program affect every area of science and technology and enhance the Nation's competitiveness.

Nanotechnology: This Administration's National Nanotechnology Initiative (NNI) continues strongly with over $1.5 billion in FY 2009 for this well-coordinated multi-agency, investment in fundamental research, multi-disciplinary centers of excellence, and development of focused cutting-edge research and education infrastructure. With the 2009 request, nearly $10 billion will have been invested in nanoscale R&D in 7 years. The NNI includes important research on the societal implications of nanotechnology, including human and environmental health and methods for managing potential risks.

Office of Science and Technology Policy (OSTP) As you know, this Subcommittee also oversees OSTP itself. After sustaining a 6 percent cut in FY 2008, we are requesting $5.3 million in the 2009 Budget. This amount is $119,000 above the FY 2008 appropriation, but $215,000 below the FY 2008 request. FY 2009 will take OSTP through the end of the current Administration and into the beginning of the next. Full funding of the OSTP request is important for both of these transition phases to proceed smoothly. The next Administration will undoubtedly propose an organization and funding level for OSTP to fulfill the agency's functions in FY10 and beyond. The current request reflects our desire to continue to fulfill OSTP's mission in a robust manner to the end of the current term, and to provide the new Administration with flexibility to bring OSTP rapidly to an effective level of operation.

OSTP also seeks full funding for the Science and Technology Policy Institute (STPI) within NSF's request. STPI is a Congressionally-chartered federally funded research and development center that provides excellent objective, technical support to OSTP and other agencies. Because the congressional statute mandates that NSF sponsor STPI, OSTP requests that this amount be fully funded within the NSF budget in support of OSTP's mission. We have included such language in the OSTP budget narrative in response to the 2008 Omnibus report language that directed OSTP to request this funding. We respectfully request the Subcommittee's support.

Agency Budget Highlights

National Science Foundation (NSF)

Funds are requested to increase the budget for NSF to $6.85 billion in FY 2009, 14 percent or $822 million above 2008's $6.03 billion. As one of the three key agencies in the American Competitiveness Initiative, NSF is the primary source of support for university and academic research in the physical sciences, funding potentially transformative basic research in areas such as nanotechnology, advanced networking and information technology, physics, chemistry, material sciences, mathematics and engineering. The NSF physical sciences directorates receive increases of about 20 percent.

NSF leads two previously mentioned Administration priority research areas that promise to strengthen the Nation's economy: the National Nanotechnology Initiative (NNI) and the Networking and Information Technology R&D program (NITRD). NSF-funded nanotechnology research, sustained at $397 million in FY 2009, a 165 percent increase since 2001, has advanced our understanding of materials at the molecular level and has provided insights into how innovative mechanisms and tools can be built atom by atom. This emerging field holds promise for a broad range of developing technologies, including higher-performance materials, more efficient manufacturing processes, higher-capacity computer storage, and microscopic biomedical instruments and mechanisms. NSF's investments in NITRD, funded at $1.1 billion in 2009, up $159 million over 2008 and 71 percent since 2001, support all major areas of basic information technology (IT) research. NSF also incorporates IT advances into its scientific and engineering applications, supports using computing

and networking infrastructure for research, and contributes to IT-related education for scientists, engineers, and the IT workforce. NSF will continue to support the development of a petascale computing capability widely accessible to the science and engineering community. A new $20 million cross-Foundation investment that is part of both the NNI and NITRD, Science and Engineering Beyond Moore's Law, is a multidisciplinary effort to advance the fundamental science and technology of semiconductor electronics.

The 2009 NSF Education and Human Resources (EHR) budget will continue efforts to prepare U.S. students for the science and engineering workforce with a 9 percent overall increase (+$65 million) over the level in the 2008 Omnibus. Specifically, the 2009 EHR budget provides a 5 percent increase for the Math and Science Partnerships program at NSF, and a 7 percent increase for the Noyce Scholarship program. NSF-wide Graduate Research Fellowships are proposed for a 32 percent increase and will support an additional 700 graduate students.

NSF's investment in Cyber-enabled Discovery (CDI), begun in FY 2008, more than doubles for a total of $100 million in FY 2009. The CDI investment promotes the advancement of science and engineering along fundamentally new pathways opened by computational thinking.

NSF will continue to fund research on cybersecurity foundations, network security, and systems software that supports the objectives of the *Federal Plan for Cyber Security and Information Assurance Research and Development.* Emphasis will be placed on usability, privacy, and theoretical foundations.

Department of Energy (DOE)

DOE is the lead agency for the President's Advanced Energy Initiative (AEI). The 2009 AEI investment of $3.2 billion in energy-related science and technology, a 25 percent increase over FY 2008 enacted, will keep us on track to meet the President's goal of reducing greenhouse gas intensity 18 percent by 2012 and on an achievable path to energy independence. Perhaps most critically, the FY 2009 AEI includes over $788 million in basic research at DOE's Office of Science, a 55 percent increase, to overcome major technical barriers to the use of solar energy, cellulosic ethanol, energy storage, hydrogen fuel cells, and fusion energy, including critical commitment support for the ITER international fusion energy research project. Before leaving this topic I should note that ITER represents a long-term solution to an energy future without fossil fuel, and I was alarmed to learn that the FY 2008 Omnibus eliminated the U.S. contribution to this international project.

The 2009 AEI budget proposes:

- $588 million for the Coal Research Initiative, R&D focused on coal gasification and carbon sequestration processes and systems, including $156 million for the FutureGen program to demonstrate these technologies;
- $343 million for biomass R&D to help enable cellulosic ethanol to become practical and competitive;
- $225 million for solar R&D to accelerate development of cost-effective photovoltaic materials;
- $238 million for R&D on hydrogen production, storage, distribution and use;
- $103 million for R&D of hybrid electric systems including $49 million for high-energy, high-power batteries for hybrid-electric and "plug-in" hybrid vehicles;
- $53 million for wind energy research to help improve the efficiency and lower the costs of wind technologies for use in low-speed wind environments;
- $30 million for geothermal research; and
- $544 million for the GNEP and Nuclear Power 2010 initiatives to demonstrate advanced fuel cycle technologies, to expand the domestic use of nuclear power, and to provide for safe, environmentally responsible global nuclear energy systems that support nonproliferation objectives.

Full funding of $215 million for the U.S. contribution to the ITER international fusion energy project is imperative to meet our international commitment.

The Office of Science in DOE (DOE SC) is another of the three priority research agencies in the President's American Competitiveness Initiative, providing many of the major cutting-edge scientific facilities and labs for a wide range of basic research related to potentially significant economic innovations. The 2009 Budget provides $4.72 billion for DOE SC, an increase of 19 percent over the FY 2008 omnibus. The budget includes funding for priorities such as nanotechnology ($300 million), materials science research facilities ($719 million), basic research in support of hydrogen production, use and storage ($75 million), the advanced energy initiative including electrical battery storage and an advanced nuclear fuel cycle ($788 million), and ad-

vanced scientific computing facilities and research ($368 million). The budget also includes funding ($93 million) to begin construction of the National Synchrotron Light Source II, a new x-ray light source that will enable the study of materials properties and functions at a level of detail and precision (nanoscale) never before possible. It continues support for construction of the Linac Coherent Light Source ($37 million)—a materials research facility that will provide laser-like x-rays allowing an unprecedented real-time glimpse of chemical and biological processes, fully funds operations for the five nanoscale science research centers, and provides $29 million for the upgrade of the Continuous Electron Beam Accelerator Facility.

National Institute of Standards and Technology (NIST)

The Department of Commerce's NIST "core" research and facilities receive $634 million in 2009, an increase of 22 percent over the 2008 Omnibus after accounting for earmarks and unrequested grants. In 2009, the American Competitiveness Initiative proposes NIST funding increases of nearly $114 million for new initiatives in research and measurements in high-leverage areas such as nanotechnology manufacturing; expanding NIST's neutron facility to aid in characterizing novel materials in high-growth research fields; and improving our understanding of complex biological systems to accelerate innovations and enable investment in biosciences, including disease diagnosis and treatment.

Department of Education (ED)

ED is the lead agency for academic competitiveness and the President requested the following under America COMPETES authority:

- $95 million for the Math Now program which authorizes competitive grants to improve instruction in mathematics for students in kindergarten through 9th grade. Grantees will implement research-based mathematics programs to enable all students to reach or exceed grade-level achievement standards and prepare them to enroll in and pass algebra courses.
- $70 million under the America COMPETES Act for a new vision for advanced placement, as embodied in the President's American Competitiveness Initiative, the purpose of which is to support state and local efforts to increase access to advanced placement classes and tests for low-income students in order to better prepare them for success after high school. The new authority targets Federal support more specifically on the preparation of teachers to teach classes in the critical subjects of mathematics, science, and the critical foreign languages, and on encouraging more students from high-need schools to take and pass AP and IB courses and tests in those subjects.
- $24 million for Foreign Language Partnerships, which is part of the Administration's National Security Language Initiative. These funds would support partnerships between institutions of higher education and school districts, in order to increase the number of American students who are proficient in languages that are critical foreign languages to national security.

The President's American Competitiveness Initiative also called for the creation of an Adjunct Teacher Corps to support qualified math and science professionals to become adjunct high school teachers. The President's 2009 Budget requests $10 million for this program.

Additionally, the President's National Mathematics Panel will issue the final report within the next month. The panel's recommendations will help teachers teach all K–7 students pre-algebraic concepts so that every student can take and pass more rigorous courses in middle and high school, particularly Algebra I in middle school and Algebra II in high school.

Science, Technology, Engineering and Math (STEM) education programs in the COMPETES Act and ACI are but a small subset of the total number of such programs—roughly 100 at 12 Federal agencies for which the President is proposing $3.6 billion in FY 2009. The 12 agencies are continuing to work together to implement the recommendations of the Academic Competitiveness Council to improve coordination and effectiveness of these STEM education investments.

National Aeronautics and Space Administration (NASA)

The President's 2009 Budget for NASA is $17.6 billion, a 3 percent increase over FY 2008, reflecting a steady commitment by the Administration to the continued pursuit of the Vision for Space Exploration and to using the Shuttle to assemble the International Space Station until the Shuttle retires in 2010. Maintaining NASA budget appropriations is extremely important for the continued viability of its programs.

In 2009, NASA requests $3.5 billion in direct costs for exploration systems including the Orion Crew Exploration Vehicle (CEV) and the Ares I launch vehicle that will carry astronauts to the Moon. 2009 will see the Ares I–X test flight, the first test flight of the Ares I launch vehicle. Ares I–X will involve a first stage with a functional four segment solid rocket booster and an inactive fifth segment, and an upper stage mass simulator. Ares I–X will test first-stage flight dynamics, controllability, and separation of the first and upper stages. Having already initiated the acquisition process for certain elements of this architecture during 2006, NASA now has all Orion CEV and Ares I elements under contract with the first crewed-flight planned to occur in 2015.

The 2009 Budget requests $4.44 billion in direct costs to continue operating the nearly 60 spacecraft of NASA's Science Mission Directorate and to support investments in future Earth and space science missions, vital technologies, and frontier research. NASA will launch seven new Earth observing missions in the next several years, including projects such as the Landsat Data Continuity Mission and the Global Precipitation Measurement mission. In a significant new initiative, NASA also will embark upon a series of high-priority, space-based Earth observing missions, informed by the recommendations of the National Research Council's recent Decadal Survey on Earth Sciences. At the same time, NASA will continue its roles in the interagency Climate Change Science Program and the international initiative on the Global Earth Observing System of Systems. NASA will expand its program of scientific exploration of the Moon through a new series of low-cost robotic missions that will advance our knowledge of Earth's closest neighbor as we prepare for a human return to the Moon. Following up ongoing missions to Mars, Saturn and Mercury, NASA also will send ever-more-capable spacecraft to Mars and other outer planets. In addition, NASA will continue its vibrant astrophysics and astronomy efforts through programs such as Beyond Einstein and the Great Observatories, and will upgrade the Hubble Space Telescope in late 2008 to provide five more years of productive on-orbit life. NASA also will maintain its important heliophysics research through projects such as the Radiation Belt Storm Probes.

In December 2007, the President approved the Nation's first National Plan for Aeronautics R&D and Related Infrastructure. Consistent with this Plan, the 2009 NASA aeronautics budget prioritizes fundamental aeronautics research, the improvement of aviation safety, and research supporting the development of the Next Generation Air Transportation System. In addition, NASA will continue to address infrastructure upgrades and maintenance requirements for aeronautical test facilities across NASA centers that are of vital importance to the Nation. The 2009 budget requests $447 million for NASA aeronautics direct costs.

National Oceanic and Atmospheric Administration (NOAA)

For NOAA in the Department of Commerce, the 2009 Budget provides $383 million for Oceanic and Atmospheric Research (OAR), 22 percent more than in FY 2001. OAR provides for ongoing research on climate, weather, air quality, and ocean processes.

The FY 2009 NOAA budget again requests $20 million for oceans science and research (with another $20 million from NSF and USGS) as part of a $40 million interagency effort to implement the Ocean Research Priorities Plan called for in the President's U.S. Ocean Action Plan. Unfortunately, the 2008 Omnibus provided about 25 percent of the $40 million requested. Nevertheless, the President remains committed to enhancing ocean science that will make our oceans, coasts and Great Lakes cleaner, healthier and more productive and is again requesting new funding to support efforts in these areas. The $20 million will address the four near-term ocean research priorities established by the Ocean Research Priorities Plan and Implementation Strategy, published in January 2007. The NOAA budget also proposes $8 million to continue extended continental shelf scientific analysis to define and map its U.S. outer limits and an additional $21 million to develop an operational ocean monitoring network.

National Institutes of Health (NIH)

The budget sustains biomedical research at the current FY 2008 level of $29.3 billion in the FY 2009 NIH budget. The budget includes an additional $38 million, an 8 percent increase, for the NIH Common Fund, bringing the total to $534 million for this interdisciplinary incubator for new ideas and initiatives that will accelerate the pace of discovery across the NIH Institutes and Centers. The 2009 Budget also includes increased funding to assist young scientists as they begin their independent research careers. The Pathway to Independence program is funded at a total of $71 million to lower the age at which young scientists get their first grant award and to encourage future generations to pursue careers in science. With the 2009 Budget,

NIH discretionary budget authority is up $8.9 billion since FY 2001; that's 44 percent—more than the 31 percent average for overall Federal S&T.

U.S. Geological Survey (USGS)

The FY 2009 request for the USGS in the Department of the Interior is $969 million, 10 percent more than FY 2001. The USGS portion of the Landsat Data Continuity Mission remains steady at $24 million, while a new National Landsat Imaging Program office is established. $31 million is targeted for climate change; an $8 million increase is proposed for the Water for America initiative, including a national water census; and for the interagency ocean science initiative referred to in NOAA, $3 million is requested for the Ocean Research Priorities Plan and $4 million for extended continental shelf mapping. Since State and local governments, industry and universities should pay for their own mineral assessment products, the Minerals Resources Program is again proposed for reduction by half to $25 million and accounts for most of the difference with FY 2008.

Environmental Protection Agency (EPA)

The FY 2009 budget for science and technology funding at EPA is $790 million, $4 million more than FY 2008. Research priorities include supporting the agency's nanotechnology program, funded at $15 million, an increase of $5 million over 2008 enacted. Additionally, to ensure EPA's ability to attract and retain the highest caliber scientists, the budget proposes expanded special authority that will allow EPA to hire up to 40 scientists quickly and competitively. $35 million is also requested to support high priority Water Security activities.

Department of Agriculture (USDA)

USDA science and research programs total $1.95 billion in the 2009 Budget, a $235 million reduction from FY 2008 mostly due to the removal of earmarks and lower priority projects and a reduction of formula grants. Still at 9 percent more than FY 2001, the Administration favors competitive research grants which are allocated based on an objective peer-reviewed process. This is reflected in a requested 74 percent increase for the National Research Initiative since FY 2001.

Department of Transportation (DOT)

The FY 2009 Budget request for highway-related research is $430 million, the same as current funding and consistent with the level in the multi-year surface transportation research authorization. Highway research includes the Federal Highway Administration's transportation research and technology contract programs as well as some programs administered by the Research and Innovative Technology Administration. These research programs include the investigation of ways to improve safety, reduce congestion, improve mobility, reduce life-cycle construction and maintenance costs, improve the durability and longevity of highway pavements and structures, enhance the cost-effectiveness of highway infrastructure investments, and minimize negative impacts on the natural and human environment.

The 2009 Budget request for Federal Aviation Administration (FAA) Research, Engineering, and Development is $171 million, 16 percent more than current funding and includes $56.5 million focused on the advancement of the Next Generation Air Transportation System (NextGen). FAA's Air Traffic Organization account also includes $41.4 million for NextGen R&D. This NextGen R&D is coordinated by the inter-agency Joint Planning and Development Office.

In addition, the 2009 Budget requests $12 million for the Research and Innovative Technology Administration to coordinate and advance the pursuit of transportation research that cuts across all modes of transportation, such as hydrogen fuels, global positioning and remote sensing. DOT research programs also support the National Nanotechnology Initiative, the U.S. Climate Change Technology Program, and the President's Hydrogen Fuel Initiative.

Department of Defense (DOD)

DOD's FY 2009 R&D budget (including pay for military personnel engaged in the research, development, test and evaluation enterprise) is over $80 billion. This level of funding will support the Department's transforming commitment to reorient its capabilities and forces for greater agility, while enabling effective responses to asymmetric and uncertain challenges of future conflicts. These funds will also help address emergent threats through countermeasures to biological agents and novel technologies to detect and neutralize improvised explosive devices, mines, rockets and mortars.

The Science and Technology (S&T) component of the overall DOD R&D budget includes basic research (6.1), applied research (6.2), and advanced technology development (6.3). At $11.5 billion in the 2009 Budget, DOD S&T exceeds the 2001 enacted

level by $2.5 billion. From 2000 to 2008, Congressional "adds"—almost all of which would be classified as earmarks according to Congress' and the Administration's definitions—to DOD S&T quadrupled. For 2008, there were 999 adds (totaling over $2.3 billion) that must be identified and tracked down, advertised in a way specific to the Congressional mark, evaluated, negotiated and awarded, all separate from other potential awards. This means that those awards consume several times the staff and management resources of the average research award, and may not even target a military-specific research need. The large number of such additions creates impediments to the creation of effective research programs throughout the Department, and, when seen in the big picture, should be cause for concern to Congress as well as to the Administration.

A record $1.7 billion is provided for DOD basic research (6.1) in 2009. That's $270 million or 19 percent above the 2008 request, consistent with the ACI and the FY 2009 OSTP–OMB Federal R&D Priorities Memorandum. $1.7 billion is also $65 million over the nominal basic research (6.1) appropriated level in FY 2008 even with non-program earmarks included. In the 2009 Budget, DOD basic research represents 14.8 percent of the DOD S&T budget, more than last year's 13.3 percent share.

Department of Homeland Security (DHS)

The President's FY 2009 request includes $869 million for the DHS Directorate of Science and Technology. $564 million is also requested for the Domestic Nuclear Detection Office, $79 million or 16 percent over FY 2008 funding. R&D continues to play a key role in securing the Nation against the terrorist threat. The President's 2009 Budget maintains an aggressive investment in scientific research, technology development, and research infrastructure aimed at continuing to enhance our Nation's security. Priority research areas include: $360 million government-wide in transformational R&D aimed at enhancing our ability to detect, identify, prevent and attribute nuclear and radiological materials; $96 million at DHS for explosives countermeasures research; $691 million in USDA, HHS and DHS to improve food and agriculture defense, and $280 million government-wide to fund cyber security and information assurance R&D.

Conclusion

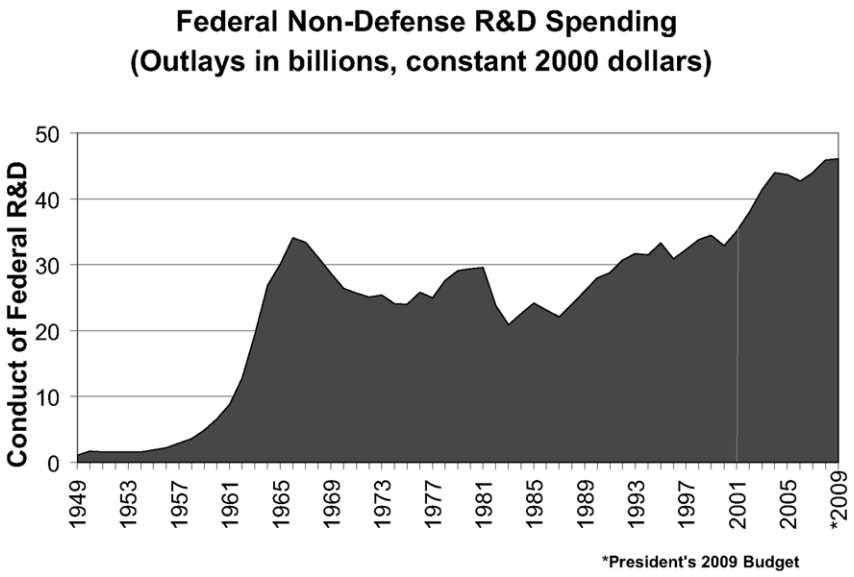
Making choices is difficult even when budgets are generous, but tight budgets require focused priorities and strong program management. This year's R&D budget proposal provides robust levels of investment that allow America to maintain its leadership position in science and move ahead in selected priority areas. The ACI properly focuses R&D investments in areas that will increase our economic competitiveness.

America leads all nations in research and development expenditures. In 2006, U.S. R&D investment at $340 billion exceeded that of all the other G7 nations combined. After a worldwide slowing in R&D expenditures in the early 1990s, R&D spending rebounded in the late 1990s, with the United States experiencing the most robust growth. Our scientists collectively have the best laboratories in the world, the most extensive infrastructure supporting research, the greatest opportunities to pursue novel lines of investigation, and the most freedom to turn their discoveries into profitable ventures if they are inclined to do so. Combined with the merit review process that has ensured the quality of American science in the past half century, these factors make American science the strongest in the world.

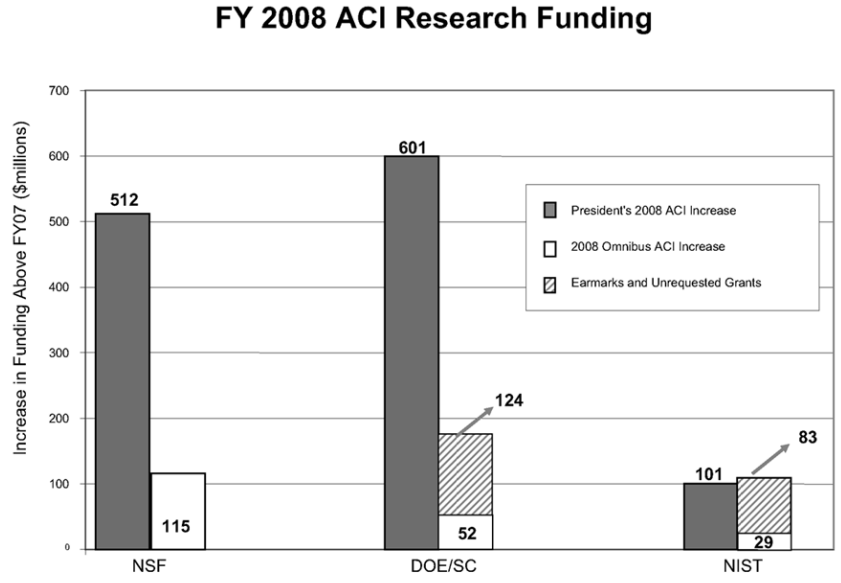
This budget will sustain this leadership and maintain science and technology capabilities that are the envy of the world. I ask that Congress fully fund the R&D initiatives advanced in the President's 2009 Budget.

I would be pleased to respond to questions.

ATTACHMENT 1



ATTACHMENT 2



ATTACHMENT 3

President Bush's ACI Research Commitment

(in millions of dollars)

ACI Basic Research Agencies	FY 2006 Funding	President's FY 2007 Request	FY 2007 Funding	President's FY 2008 Request	FY 2008 Omnibus	President's FY 2009 Budget	FY 2009 Budget Above FY 2008 Omnibus
NSF	5,582	6,020	5,917	6,429	6,032	6,854	+822
DoE Office of Science	3,596[2]	4,102	3,797	4,398	3,973[5]	4,722	+749[8]
NIST Core[1]	568[3]	535	493	594	605[6]	634	+29[9]
ACI Total	9,747[4]	10,657	10,207	11,421	10,610[7]	12,210	+1,600[10]

[1] NIST Core consists of NIST lab research and construction accounts
[2] Includes $135 million in earmarks
[3] Includes $137 million in earmarks
[4] Includes $272 million in earmarks
[5] Includes $124 million in earmarks
[6] Includes $83 million in earmarks and unrequested grants
[7] Includes $207 million in earmarks and unrequested grants
[8] +$873 million after accounting for earmarks.
[9] +$112 million after accounting for earmarks and unrequested grants
[10] +$1,807 million after accounting for earmarks and unrequested grants

ATTACHMENT 4

American Innovation Proclamation

We, the leaders of American business and higher education, call on Congress to act quickly on an innovation agenda that will ensure continued U.S. competitiveness, enabling Americans to succeed in the global economy.

Innovation leadership creates high-wage jobs and rising incomes for Americans. Innovation drives productivity and economic growth, giving American workers the tools to remain the most productive in the world and creating products, processes—and even new industries—that expand employment and boost living standards.

The United States has remained the world's innovation leader through a commitment to basic research, a world-class workforce and a climate that rewards innovation. But America cannot rest on past economic success. Our competitors are investing in innovation, improving their competitive position and, in some respects, surpassing us.

Therefore, Congress must act to:

Renew America's commitment to discovery

by doubling the basic research budgets at the National Science Foundation, the National Institute of Standards and Technology, the Department of Energy's Office of Science and the Department of Defense;

Improve student achievement in math and science

through increased funding of proven programs and incentives for science and math teacher recruitment and professional development;

Welcome highly educated foreign professionals,

particularly those holding advanced science, technology, engineering, or mathematics degrees, especially from U.S. universities, by reforming U.S. visa policies;

Make permanent a strengthened R&D Tax Credit

to encourage continued private-sector innovation investment.

We, the signatories, hereby proclaim our support for these initiatives and stand ready to do our part.

Craig Barrett
Chairman
Intel Corporation

Richard K. Templeton
President & CEO
Texas Instruments

Carl F. Kohrt
President & CEO
Battelle

Arthur F. Ryan
Chairman & CEO
Prudential Financial, Inc.

Harold McGraw III
Chairman, President & CEO
The McGraw-Hill Companies, Inc.

Norman R. Augustine
Former Chairman & CEO
Lockheed Martin Corporation

Charles O. Holliday, Jr.
Chairman & CEO
DuPont

Nicholas M. Donofrio
Executive Vice President,
Innovation & Technology
IBM Corporation

Robert C. Dynes
President, University of California

Additional Signatories on the Back.

ATTACHMENT 5

Comparison of America COMPETES Act of 2007 with the 2008 Omnibus and the 2009 President's Budget

($ in millions)

	FY 2008				FY 2009			
	FY08 COMPETES	FY08 OMNIBUS	Omnibus vs. COMPETES	% of COMPETES funded in Omnibus[1]	FY09 COMPETES	FY09 Budget	Budget vs. COMPETES	% of COMPETES funded in Budget[1]
Title 1, Sec 1002, Study on Barriers to Innovation	1	0	-1	0	0	0	0	
Title 3, Sec 3001-A-1, Laboratory Activities, NIST	502	446	-56	89	543	535	-7	99
Title 3, Sec 3001-A-2, Construction and Maintenance, NIST	151	160	9	106	66	66	13	116
Title 3, Sec 3001-B-1, Industrial Technology Services, MEP	110	90	-20	82	122	4	-118	3
Title 3, Sec 3001-B-1, Industrial Technology Services, TIP	100	46	-54	46	132	0	-132	0
NIST Subtotal	863	742	-121	86	862	638	-244	74
Title 5, Sec 3171-I, DOE MSE Pilot Program	14	0	-14	0	33	0	-33	0
Title 5, Sec 3179-F, DOE Experimental Based Learning Ops.	8	0	-8	0	8	0	-8	0
Title 5, Sec 3185-P, DOE Summer Institutes[2]	15	2	-13	13	20	6	-14	30
Title 5, Sec 3191, National Energy Education Development	1	0	-1	0	"as needed"	0		
Title 5, Sec 5004-F-1, Nuclear Sci Program Expansion Grants	4	0	-4	0	7	0	-7	0
Title 5, Sec 5004-F-2, Nuclear Sci Competitiveness Grants	3	0	-3	0	6	0	-6	0
Title 5, Sec 5005-F-1, Hydrocarbon Systems Sci Prog. Grants	4	0	-4	0	7	0	-7	0
Title 5, Sec 5005-F-2, Hydrocarbon Systems Sci Competitiveness Grants	3	0	-3	0	6	0	-6	0
Title 5, Sec 5006-H, DOE Early Career Awards	25	8	-16	34	25	10	-15	40
Title 5, Sec 5007, DOE Basic Research Extension to 2010	4,586	3,973	-613	87	5,200	4,722	-478	91
Title 5, Sec 5008, Discovery Sci and Engineering Innov. Instr[3]	10	0	-10	0	10	0	-10	0
Title 5, Sec 5009, PACE Fellowships	8	18	10	240	12	19	7	158
Title 5, Sec 5011, Distinguished Scientist Program	10	0	-10	0	20	0	-20	0
Title 5, Sec 5012, ARPA-E[4]	300	0	-300	0	"such sums"	0		
DoE Subtotal	4,994	4,002	-992	80	5,641	4,757	-884	84
Title 6, Sec 6113, Programs for Baccalaureates' in Sci/Tech	101	1	-100	1	101	0	-101	0
Title 6, Sec 6114, Programs for Masters' in Sci/Tech	125	1	-124	1	125	0	-125	0
Title 6, Sec 6123, AP and IB programs[4]	78	44	-31	56	"such sums"	70		
Title 6, Sec 6131, Promising Practices	1	0	-1	0	--	--		
Title 6, Sec 6201, Math Now for Elem/Middle Sch Programs[4]	95	0	-95	0	"such sums"	95		
Title 6, Sec 6202, Summer Term Education Grants	"such sums"	0			"such sums"	0		
Title 6, Sec 6203, Math skills for secondary school students	95	0	-95	0	95	0	-95	0
Title 6, Sec 6304, Foreign Language Partnership Program	28	0	-28	0	"such sums"	24		
Title 6, Sec 6401, Alignment of education programs	120	0	-120	0	"such sums"	0		
Title 6, Sec 6502, Math and Science Partnership Bonus Grants	"such sums"	0			"such sums"	0		
ED Subtotal	693	46	-644	7	689	189	-500	27
Title 7, Sec 7002, National Science Foundation	6,900	6,032	-868	91	7,338	6,866	-472	94
Research and Related Activities	5,156	4,821	-335	94	5,743	5,594	-149	97
Major Research Instrumentation Program	115	94	-21	82	123	119	-4	97
Faculty Early Career Development Program	166	168	2	101	184	182	-2	99
Research Experiences for Undergrads Prog	62	58	-4	94	68	63	-7	90
Experimental Program to Stimulate Competitive Research	120	111	-9	93	133	114	-20	85
Integrative Graduate Education and Research Traineeship program	47	38	-9	80	53	39	-14	74
Graduate Research Fellowship Program	9	8	-1	90	10	8	-2	81
Professional Sci Masters degree program (Sec 7034)	10	0	-10	0	5	0	-5	0
Education and Human Resources	696	706	+10	81	988	798	-203	79
Math/Sci partnerships under Sec. 9, NSF Auth Act 2002	100	49	-52	49	111	51	-60	46
Robert Noyce Scholarship, NSF Act Sec 10	90	11	-79	12	110	12	-102	10
Sci/Math/Eng/Tech Talent expansion program, NSF Act	40	30	-10	74	50	30	-20	59
Advanced Tech. Education Program (Sci-Ad. Tech Act of 1992)	52	52	-0.4	99	58	53	-6	89
Integrative Graduate Education and Research Traineeship program	27	25	-2	93	30	25	-5	83
Graduate Research Fellowship Program	97	88	-9	91	107	117	10	109
Research Equipment and Facilities Construction	345	221	-24	90	263	149	-114	56
Agency Operations and Award Management	299	282	-8	95	310	305	-5	98
Office of the National Science Board	4	4	+0.1	98	4	4	0	96
Office of the Inspector General	12	11	-1	93	13	13	0	103
Title 7, Sec 7026, Laboratory Science Pilot Program[4]	5	0	-5	0	"such sums"	0		
NSF Subtotal	6,905	6,032	-873	91	7,331	6,854	-477	93
Title 8, Sec 8005, Study of the Provision of Online Degree Programs	"such sums"	?			--	--	--	
TOTAL	13,152	10,822	-2,330	82.1	14,548	12,438	-2,108	85.5
TOTAL (without Dept. of Ed.)	12,464	10,776	-1,688	86	13,857	12,249	-1,608	88

Denotes American Competitiveness Initiative programs. Omnibus funding of ACI activities includes $124 million and $88 million of earmarks and unrequested grants at DoE and NIST, respectively.

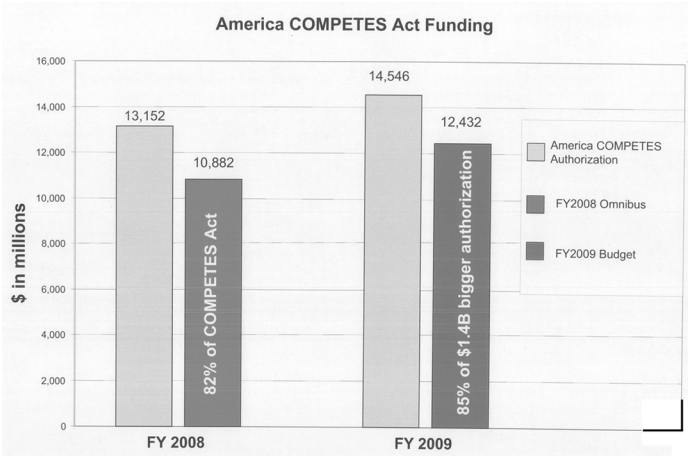
[1] Percentages exclude amounts in excess of authorized levels for individual programs.

[2] Funded through DoE Academies Creating Teacher Scientists Program.

[3] Though not included in table, total Budget funding for DoE research center partnerships similar to those in Section 5008--Energy Frontier Research Centers, Bioenergy Research Centers, and SciDAC Institutes--is $183 million.

[4] When applicable, authorized levels of "such sums" are assumed to be equal to the prior year amount.

ATTACHMENT 6



Senator KERRY. Thanks very much. I appreciate it.
Dr. Bement?

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

Dr. BEMENT. 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 charted 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.

Let me begin by expressing my sincere appreciation of this subcommittee's support for the America COMPETES Act. I would also like to thank you for recognizing the importance of our agency operations in the 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*.

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 the two essential ingredients of a healthy high-tech economy: basic research discoveries and a highly trained workforce. 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

multinational 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 merely 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 responsive to emerging potentially transformative areas of research. I would like to highlight some of our new cross-cutting multidisciplinary initiatives. We created these initiatives in response to the input that we received from the research communities we serve.

We request $100 million to continue Cyber-enabled Discovery and Innovation, our bold two-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 freshwater systems of regional and local waters.

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 target students at all educational levels and from all geographic areas.

We train the Nation's skilled workforce by providing research opportunities for undergraduates, graduate students and postdocs. We research and evaluate effective STEM curricula for the Nation's K–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 our outreach activities that touch the imaginations of millions of Americans.

Mr. Chairman, time does not permit me to describe the 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'm hardpressed 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 DR. ARDEN L. BEMENT, JR., DIRECTOR, NATIONAL SCIENCE FOUNDATION

Chairman Kerry, Ranking Member Ensign, 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 underpins all of the technology that constitutes the lifeblood of today's global market. America's sustained economic prosperity is based in part on technological innovation resulting from previous fundamental science and engineering research. Innovation and technology are engines of the American economy, and advances in science and engineering provide the fuel.

While the United States still 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.[3]

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."[4]

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 4 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

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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] Augustine, Norman. Is America Falling off the Flat Earth? National Academies Press.

in diagnostic medicine, the research that led to the development of silicon-coated 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 postdoctoral 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.[5]

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.

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[5] 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 postdocs 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 postdocs 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 data bases.

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 underrepresented 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 re-think old categories and traditional perspectives. This ability is more important than ever, as conventional boundaries constantly shift and disappear—boundaries between nations, between disciplines, between science and engineering, and between what is basic and what is applied. NSF, with its mandate to support all fields of science and engineering, is uniquely positioned to meet the needs of researchers exploring human knowledge at these interfaces, whether we're organizing interdisciplinary conferences, enabling cyber-sharing of data and information, or encouraging new collaborations and partnerships across disciplinary and national borders. No other government agency comes close to our flexibility in STEM education and basic research.

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

Industry 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.

Senator KERRY. Thank you very much, Dr. Bement.

Dr. Turner?

STATEMENT OF DR. JAMES M. TURNER, ACTING DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, U.S. DEPARTMENT OF COMMERCE

Dr. TURNER. Chairman Kerry, thank you for the opportunity to present the President's Fiscal Year 2009 budget request for NIST.

This budget puts us back on the doubling path as envisioned in the President's American Competitiveness Initiative, and as reflected in the America COMPETES ACT, that Congress enacted last year. I want to thank you, sir, and the ranking member for your leadership in the America COMPETES Act.

The Fiscal Year 2009 request of $638 million includes $634 million for NIST core research programs, encompassing NIST research and facilities, and $4 million for the Hollings Manufacturing Extension Partnership.

The funding level decisions for the MEP as well as for the TIP Program were very difficult and tough choices that had to be made in tight budget times. The budget for NIST core programs represents a 22 percent increase over the Fiscal Year 2008 appropriations for these programs.

The president's request focuses on high-impact research that will spur economic growth and improve the quality of life and thereby accomplish NIST's mission to advance innovation in industrial competitiveness.

The ACI and the America COMPETES Act enable NIST to continue to aggressively lay the science and technology foundation recommended by so many reports and proclamations on U.S. innovation and competitiveness. It is paramount for the sake of innovation and competitiveness that NIST move rapidly and wisely toward realizing the vision of being the world's leader in creating critical measurement solutions and promoting equitable standards. Well targeted measurement in standards investment is a proven path to stimulate innovation, foster industrial competitiveness, increase economic security, and improve the quality of life for all Americans.

The Fiscal Year 2009 budget proposal contains a total of 17 initiatives. These initiatives were developed using a rigorous process that includes talking with industry, stakeholders, and our visiting

committee or VCAT. Five of the initiatives are new for Fiscal Year 2009. The rest were previously proposed in the Fiscal Year 2008 budget but to all of our collective disappointment, the Fiscal Year 2008 budget took us off the doubling track.

At NIST, it has a real consequence. Three hundred new employees and guest workers were not hired, a number of important research projects were stopped or delayed, and the maintenance of facilities will slow down, increasing the risk of equipment and facility failures.

Our experience last year makes this year's budget request that much more important. We must not lose this historic moment to make significant necessary investment in basic research.

Let me briefly describe our initiatives. We have grouped the initiatives in three major areas. First, addressing urgent environmental, safety and security needs which includes initiatives in nanotechnology, climate change, biometrics, earthquake hazards and disaster resilient structures.

The second, investing in strategic and rapidly advancing technologies which includes initiatives in bioscience measurements, quantum, cyber security, optical light communications, hydrogen fuel and manufacturing supply chain integration.

And finally, third, building our science and engineering capacity and capability which includes a proposed expansion of the JILA Facility in Boulder, a new Boulder lab facility, an expansion of the NIST Center for Neutron Research in Gaithersburg, and an increase for our major repairs and maintenance.

For a 107 years, NIST research has been critical to our Nation's innovation and competitiveness. The increased funding in the President's Fiscal Year 2009 budget for NIST will directly support technological advances in broad sectors of the economy that will quite literally define the 21st century as well as improve the safety and quality of life for all of our citizens.

This is an historic moment. The ACI was truly a once-in-a-generation opportunity to enable cutting edge advances in measurement science that will ensure the U.S. drives technological change.

I look forward to working with you, Mr. Chairman, and members of this subcommittee, throughout this process.

Thank you very much, sir.

[The prepared statement of Dr. Turner follows:]

PREPARED STATEMENT OF DR. JAMES M. TURNER, ACTING DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, U.S. DEPARTMENT OF COMMERCE

Chairman Kerry, Ranking Member Ensign, and members of the Subcommittee, thank you for the opportunity to appear before you today to present the President's Fiscal Year 2009 budget request for the National Institute of Standards and Technology (NIST). This budget reflects NIST's growth path under the President's American Competitiveness Initiative (ACI) and under the America COMPETES Act (P.L. 110–69) that this committee passed last year. The levels reflected in this budget will further enhance NIST's ability to provide the Nation's critical measurement and standards needs.

NIST will meet this challenge by relying on partnerships with industry and academia to plan and carry out research and provide services. These partnerships also allow NIST to stay abreast of current high priority needs and to anticipate emerging needs. More than 1,800 guest researchers work with nearly 3,000 NIST staff members in NIST laboratories and facilities on several campuses to provide the Nation with the most advanced measurement and standards research and services.

The FY 2009 request of $638M includes $634M for NIST's core programs (encompassing NIST's research and facilities) and $4M for the Hollings Manufacturing Extension Partnership. The budget for the NIST core represents a 22 percent increase (excluding Congressionally-directed grants) over the FY 2008 appropriations for these programs. The President's request focuses on high-impact research that will address critical national needs, spur economic growth and accomplish NIST's mission to advance innovation and industrial competitiveness.

Supporting Innovation and the Economy

The well-being of U.S. citizens is affected every day by NIST's measurement and standards work. Virtually every segment of the economy—transportation, computers, banking, food processing, health care and communication—depends on NIST research, products and services. More broadly, the quality of the water we drink, the air we breathe, and the food we eat depends in part on that work. NIST standards—which are not regulatory—ensure that consumers are confident of the quantity and quality of the product purchased whether it is a gallon of gasoline or the amount of electricity used and stated in the monthly bill. They protect our banking at ATMs and our online purchases. Soon, these standards will help to protect the privacy of our health records.

They improve the accuracy of our medical tests and treatments and help to make sure that we know the nutritional content of what we are eating. They help to convict criminals and free the innocent through more accurate and faster DNA tests. They provide crucial timekeeping that we depend upon for navigation, telecommunications, financial transactions, and basic research. And they improve the readiness of our first responders and our homeland security. The measurement and standards infrastructure provided by NIST paves the way for U.S. innovation and economic competitiveness. In many instances, NIST work in measurement science is the critical path to discovery and innovations.

While companies strive to make their latest products and services as easy to use and as simple for consumers as possible, the underlying knowledge and technology base that makes this possible is certainly not simple. Consider the web of fiber optic networks that makes broadband communication—from long distance telephone, to cable television, to high-speed Internet—possible. The system includes dozens of independent networks, tens of thousands of connections and millions of miles of optical fibers, each fiber capable of carrying hundreds of separate signals simultaneously. Yet, despite its already mind boggling complexity, this fiber optic system that our economy depends on may soon suffer with the same kind of traffic congestion currently clogging highways around many major metropolitan areas.

To prevent this, communications manufacturers and service companies need faster, more accurate ways to measure the quality of optical signals, data analysis tools to diagnose transmission problems, and nanoscale monitoring systems for ultra fast microchips that use light instead of electrons to store and process information. NIST is uniquely positioned to help meet these challenges. NIST has the right combination of world class scientists and engineers, outstanding scientific facilities, and strong ties with both the industrial and service sectors to provide the tools needed to realize next-generation optical technologies. As a result, the consumer will receive information faster, with fewer disruptions, and be able to interconnect between networks to get work done that suits their needs.

Medicine is facing a similar complexity explosion. As the project to decode the 3 billion "letters" of the human genome has demonstrated, the frontiers of medicine have moved in the last few decades from often qualitative assessments to increasingly quantitative measures down to the level of individual biological molecules. As a result, medical researchers skilled in the biological sciences are increasingly finding that they need to integrate physical scientists, and their quantitative measurement skills into their research teams.

Just as a systems engineer might study an entire fiber optic network from its individual components to its overall efficiency, life science researchers are beginning to treat medical and biological research problems with a "systems approach" long used in engineering and the physical sciences. Life sciences researchers are attempting to fully integrate what they know at the nano and microscale of molecules, DNA, and proteins with the macroscale problems of disease and other medical problems experienced by patients. Again, NIST, with its interdisciplinary research staff and expertise in creating groundbreaking new measurement methods and standards, can provide the tools needed to advance the field. The payoff will be faster development of new drugs, more personalized medicine, and better prediction, diagnosis, and understanding of disease. This approach leverages NIST's core competencies.

Similar opportunities exist for NIST to undertake the equally complex measurement challenges involved in safely exploiting the promise of nanotechnologies or

transforming the field of computer modeling and visualization to a truly quantitative, predictive science.

To accomplish all of these goals and to meet the challenges of the ACI, NIST must continue to update and expand its own laboratory facilities. Consequently, this budget also includes a request for the final year of funding for the continued construction of an extension to NIST facilities at its laboratory in Boulder, CO (Building 1) to provide new high performance space; a new request for an expansion of facilities and capacity to train future U.S. scientists in cutting edge atomic, molecular, and optical physics at JILA–NIST's world renowned joint institute with the University of Colorado at Boulder; as well as funding for the third year of a program to expand and upgrade NIST's Center for Neutron Research-the Nation's leading facility of its kind and a critical research tool for more than 2,200 researchers annually who work in nanotechnology, advanced materials, biotechnology, and other fields.

FY 2008 Impacts

The ACI and the passage of the America COMPETES Act provide an unprecedented opportunity to further enhance and accelerate NIST's contributions to innovation and competitiveness.

Unfortunately, FY 2008 appropriations were well below the requested level. Those appropriations do not provide funding for NIST's laboratory research and facilities efforts at the President's request level for the ACI. We are pleased that the President's FY 2009 request would restore NIST to the path to double over a ten-year period its core research activities. NIST will make every effort to optimize the funds provided, but the lower 2008 funding provided compared to the President's budget request will have negative impacts on NIST and its customers and partners in industry, academia, and other agencies. Those impacts include a real loss in timely research that yields positive benefits for the Nation. The FY 2008 omnibus appropriation included $83M in earmarks and unrequested grants for NIST, the impact of which is to slow down or limit the core research and facilities proposed at NIST. This means that research areas critical to U.S. innovation will not be advanced as aggressively as originally proposed in critical areas such as nanotechnology, quantum computing, climate change and earthquake and other disaster resistant structures.

It also means that NIST falls $13.5M short of the amount needed to cover salary increases and other anticipated costs, requiring several actions. Consequently, NIST will slow down new hires with specialized skills and will not be able to bring on board the estimated 300 additional staff and guest researchers anticipated with the budget initiatives requested by the President. NIST managers are reviewing laboratory and administrative activities to ensure that ongoing high priority projects receive the funding that they need and that all funds are used as efficiently as possible.

As part of the ACI, NIST received $79.1M of its requested $93.9M for two new facilities initiatives and for operational maintenance, major repairs and safety of the NIST campuses. To compensate for the shortfall, NIST has adjusted its overall facilities plans in order to proceed with the two major projects. NIST will slow down its plans to reduce the backlog of deferred maintenance projects on existing facilities. This increases the chances of unanticipated major equipment outages and temporary loss of facilities use, resulting in higher repair costs and loss of researchers' productivity.

The President's FY 2009 request for NIST would get the Institute back on a doubling track—enabling NIST to continue to aggressively lay the science and technology foundation recommended by so many reports and proclamations on U.S. innovation and competitiveness. It is paramount that NIST move rapidly and wisely toward realizing the vision of being the world's leader in creating critical measurement solutions and promoting equitable standards. Well-targeted measurement and standards investments is a proven path to stimulate innovation, foster industrial competitiveness, increase economic security, and improve the quality of life of all Americans.

FY 2009 President's Budget

NIST's FY 2009 budget request totals $638M, which includes $634M for core research and facilities programs, a 22 percent increase (excluding Congressionally-directed grants) over the FY08 appropriations for these same core programs. The increased funding for NIST's core programs provided through the FY 2009 request will directly support innovative advances in broad sectors of the economy as well as improve the safety and quality of life for our citizens. The FY 2009 budget contains a total of 17 initiatives. Five of the initiatives have not been requested before.

The balance of the initiatives was proposed in the FY08 budget. After being updated, all went through a rigorous internal process to assess their value and connection to NIST's mission. Their relevance, technical merit, and priority were reaffirmed.

The following table summarizes the proposed FY 2009 budget. In this table, we show both the FY 2007 and FY 2008 enacted levels without Congressionally-directed projects for comparison.

National Institute of Standards and Technology (NIST)

FY 2007–FY 2009 Budget Excluding Congressionally-Directed Projects

[Dollars in Thousands]

	FY 2007 Enacted	FY 2008 Enacted*	FY 2009 President's Budget
National Institute of Standards and Technology (NIST)			
Scientific and Technical Research and Services (STRS)	434,371	439,624	535,000
Construction of Research Facilities (CRF)	58,686	79,148	99,000
NIST Core Subtotal (STRS + CRF)	493,057	518,772	634,000
Percentage increase from preceding fiscal year	14%	5%	22%
Industrial Technology Services (ITS)			
Advanced Technology Program (ATP)	79,078	N/A	0
Technology Innovation Program (TIP)	N/A	65,200	0
Hollings Manufacturing Extension Partnership (MEP)	104,741	89,640	4,000
Subtotal, ITS	183,819	154,840	4,000
NIST Total	676,876	673,612	638,000

*The FY 2008 amount for Scientific and Technical Research and Services appropriation does not include $893,000 for a Congressionally-directed project. The FY 2008 amount for Construction of Research Facilities appropriation does not include $51.3M in Congressionally-directed projects and $30M for a new competitive construction grant program that was not requested by the President.

The total request of $638M for NIST is divided into three appropriations accounts:

I. Scientific and Technical Research and Services (STRS) $535M. This category includes $526.5M for NIST laboratory research and $8.5M for the Baldrige National Quality Program. Major components of the FY 2009 request include four new STRS initiatives (in *italics* nine initiatives requested—but not funded—in FY 2008.

Addressing Urgent Environment, Safety and Security Needs (+$26.2M)

- *Nanotechnology: Environment, Health and Safety*
- Climate Change Science: Measurements and Standards
- National Earthquake Hazards Reduction Program
- Disaster Resilient Structures and Communities
- Biometrics: Identifying Friend or Foe

Investing in Strategic and Rapidly Advancing Technologies (+$42.8M)

- *Innovation in the Biosciences Measurements and Standards*
- *Comprehensive National Cyber Security Initiative: Leap-Ahead Technologies*
- *Optical Communications and Computing*
- Quantum Information Science
- Nanotechnology: Discovery to Manufacture
- Innovations in Measurement Science
- Enabling the Use of Hydrogen as a Fuel
- Manufacturing Innovation through Supply Chain Integration

II. Construction of Research Facilities (CRF) $99M. This category includes $37.3M in base funding for operational maintenance, major repairs and safety of the NIST sites; and $63.7M for three initiatives outlined below.

Boosting U.S. Science/Engineering Capacity and Capability ($63.7M)

- *A Building Expansion: Pushing the Scientific Frontiers*
- Boulder Building 1 Extension: 21st Century Tools

- Safety, Capacity, Maintenance and Major Repairs
- NIST Center for Neutron Research (NCNR) Capacity and Capability

III. Industrial Technology Services (ITS) $4M. The Hollings Manufacturing Extension Partnership (MEP) program and the Technology Innovation Program (TIP) compose NIST's Industrial Technology Services account.

The budget also reflects the Administration's focus on its highest priorities—including basic research, consistent with the American Competitiveness Initiative—and the need to restrain spending. The request for the Hollings Manufacturing Extension Partnership is $4 million, enough for an orderly end to Federal funding for the program, while no funds are requested for the Technology Innovation Program.

FY 2009 Initiatives in Detail

The initiatives are described in more detail below. They are organized within appropriations accounts and by FY 2009 initiative categories.

I. Scientific and Technical Research Services (STRS)

Addressing Urgent Environment, Safety and Security Needs (+$26.2M)

Nanotechnology: Environment, Health and Safety Measurements & Standards (+$12M)

Products made with nanometer-scale components and materials—a thousand times thinner than a human hair and smaller—are already dramatically improving the performance of current products from stain-resistant pants to fuel-efficient aircraft. Many more applications beckon such as targeted cancer drugs, ultrafast electronics, and improved diagnostic tools for medicine.

The small size of these components produces new properties not seen in larger-scale "bulk" materials. While nanomaterials promise many useful applications, very little is known about the environmental, health, and safety (EHS) risks associated with them. The safety or toxicity of nanomaterials can be determined only with well-understood materials and well-defined testing methods.

The interagency National Nanotechnology Initiative (NNI) has designated NIST as the lead Federal agency to develop metrology tools and methods for measuring and characterizing nanomaterials. NIST has the interdisciplinary physical-science expertise and the facilities needed to develop accurate, validated methods for understanding the EHS properties of nanoscale materials.

The proposed initiative funding will allow NIST to launch a three-pronged approach to the problem:

- create a classification scheme for determining the characteristics of nanoparticles necessary for assessing toxicity, including size, shape, and chemical composition;
- develop detection and measurement methods for quantifying the number and nature of nanoparticles with EHS impact in biological and environmental samples; and
- predict how modifications to nanoparticles will affect their impact on the environment, health, and safety.

Measurements and Standards for the Climate Change Science Program (+$5M)

The climate is changing. Determining how fast it is changing and understanding the complex relationship between all the environmental variables to allow accurate predictions is part of the objective of the U.S. Climate Change Science Program. Some of the drivers of climate, such as the sun's output, may vary slowly over decades. As a result, climate predictions depend critically on developing absolute measurements of the sun's energy that can be compared accurately over decades from different sensors. Other important variables include the sizes, shapes, and chemical composition of particles or droplets (aerosols) in the atmosphere. Whether aerosols contribute to the warming or the cooling of the Earth depends upon their composition.

With the funding provided through this initiative and in coordination with other agencies, NIST will develop:

- an international irradiance measurement scale to be used in rigorously calibrating satellite light intensity instruments prior to launch to ensure sufficient accuracy to allow valid comparisons among results from different instruments or from data sets taken over different periods of time;

- new instrument design strategies and quality assurance programs to optimize accuracy and stability of satellite and ground-based solar measurement systems;
- techniques for generating specific types of aerosols in the laboratory, measuring aerosol optical and physical properties, and simulating aerosol properties that cannot yet be measured in the laboratory; and
- a database of critically evaluated data on aerosol properties collected at NIST and elsewhere.

National Earthquake Hazards Reduction Program (+$3.3M)

Within the United States, more than 75 million people are located in urban areas considered to be at moderate to high risk for earthquakes. Just the economic value of the physical structures within these regions—not including the potential loss of life and economic disruption—is valued at close to $8.6 trillion. A single large earthquake in the United States, like the one that struck Kobe, Japan, in 1995, can easily cause damage of $100 billion to $200 billion.

A critical gap exists between the results produced by basic research and the implementation of that knowledge in the field. New construction materials, techniques, building codes, and standards do not reflect the current state of knowledge. Through the National Earthquake Hazards Reduction Program (NEHRP), NIST is tasked with conducting problem-focused research to bridge this gap and to promote its application by the private sector.

At the proposed funding level, NIST will:

- identify implementation gaps between basic research results and design guidance and national model building code provisions;
- develop rational cost-effective, consensus-based seismic design and analysis procedures for use in national model building codes;
- design guidelines for the testing and design of major structural systems;
- characterize fully the seismic capacities of typical older building structural components and systems as they are built; and
- develop structural performance criteria, analytical models, and cost-effective rehabilitation techniques for existing buildings.

Disaster Resilient Structures and Communities (+$4M)

For the past few years, natural hazards, including hurricanes, extreme winds, storm surge, wildland fires, earthquakes, and tsunamis, as well as terrorist actions, have been a continuing and significant threat to U.S. communities.

The disaster resilience of our physical infrastructure and communities today is determined in large measure by the building standards, codes, and practices used when they were built. With few exceptions, these are oversimplified and inconsistent with current risk assessments. As construction and rebuilding costs continue to rise, there is increasing recognition of the need to move from response and recovery to proactively identifying and mitigating hazards that pose the greatest threats.

NIST and the National Oceanic and Atmospheric Administration (NOAA) have coordinated their programs in this area. Initiative funding in FY 2009 will allow NIST to develop:

- standard methods to predict losses, evaluate disaster resilience, and estimate cost-to-benefit of risk management strategies at the community and regional scales as opposed to the individual building scale;
- decision support tools to modernize standards, codes, and practices consistent with the risk;
- a validated "computational wind tunnel" for predicting extreme wind effects on structures; and
- risk-based storm surge maps to be used in designing structures in coastal regions and an improved hurricane intensity classification scale.

In addition, the funding will expand and accelerate research results for projects begun with funding in FY 2007 on prediction of fire hazards at the wildland/urban interface; and improved tools for designing and constructing earthquake-resistant structures.

Biometrics: Identifying Friend or Foe (+$2M)

NIST has decades of experience improving human identification systems and currently is working with other Federal agencies, including the Department of Homeland Security, the Federal Bureau of Investigation, and the U.S. Department of

State, to evaluate and improve the ability of biometrics to enhance border security. The USA Patriot Act and the Enhanced Border Security and Visa Entry Reform Act call for NIST to develop and certify a technology standard for verifying the identity of individuals and to determine the accuracy of biometric technologies, including fingerprint, facial, and iris recognition.

Biometrics technologies, primarily fingerprints, are being used broadly in the United States for border security. New technologies under development, in particular, "multimodal" systems that combine two or more biometric technologies, such as fingerprint, facial, and iris, promise to bring significant improvements. But NIST studies have shown that the accuracy of today's facial recognition systems is relatively poor compared to fingerprints, and iris recognition needs more study and testing to determine its accuracy in operational environments.

In conjunction with several other Federal agencies, including the FBI and Department of Homeland Security, private industry and universities, NIST is managing the Multiple Biometric Grand Challenge, which aims to reduce errors in both face and iris recognition systems. Also, NIST is performing large-scale evaluations of iris recognition to promote its standardization.

NIST is also supporting the development of standards for interoperability between different fingerprint systems through large-scale testing.

With additional funding, NIST will:

- enable facial recognition technologies to be used for border security;
- build on its testing program to determine the accuracy of multimodal systems;
- develop tests and guidelines to assure that future biometric systems are interoperable, and work efficiently in real-time applications by:
  - improving the use of fingerprints with real-time fingerprint readers;
  - improve the interoperability, robustness, and usability of fingerprint systems and facial recognition systems;
- improve biometric systems by enabling simultaneous use of facial recognition, fingerprint, and iris-scan technologies

NIST will coordinate this work with other government agencies and the private sector while taking international standards developments into account.

II. Investing in Strategic and Rapidly Advancing Technologies (+$42.8M)

Measurements and Standards to Accelerate Innovation in the Biosciences (+$10M)

Inaccurate bioscience measurements sometimes make it hard to tell when treatments are healing or causing harm. They often increase costs and lower the quality of healthcare. The lack of reliable, quantitative measurements in the biosciences is also impeding progress in a number of promising life-science research areas. Compared to the measurements made in the physical sciences, medical tests and bioscience-based measurements need to be repeated and rechecked far too frequently. Today, even standard measurements on a limited number of blood proteins often yield variable results among expert laboratories.

The research initiatives newly proposed in FY 2009 will focus on three intersecting areas of research:

- make biological data more quantitative and reliable by establishing methods, standards, and benchmark data for the fundamental measurements that underpin the life sciences in techniques such as mass spectrometry and molecular imaging;
- devise new methods for simultaneously measuring hundreds to thousands of molecules at a time by developing and validating new technologies in areas such as microfluidics and live cell imaging; and
- help laboratories more easily compare and combine their measurements and computer models with one another by developing standards for the exchange of biological data and information.

Comprehensive National Cyber Security Initiative: Leap-Ahead Security Technologies (+$5M)

Many of today's tools and mechanisms for protecting against cyber attacks were designed with yesterday's technology in mind. Information systems have evolved from room-size computer workstations shut off from the rest of the world to ubiquitous mobile devices interconnected by a global Internet. In this diverse ecology of communication devices, no cyber security solution works on all operating systems and can protect every type of computer and network component. Operating systems

are now composed of millions of lines of code, rather than thousands, and have many more potential holes.

The NIST request is part of the Administration's Comprehensive Cyber Security Initiative. NIST is a recognized world leader in the field of cyber security. Working with other Federal agencies, NIST proposes an initiative in three essential elements of cyber security infrastructure:

- create technical standards for generating, distributing, using, storing and destroying secret numbers known as cryptographic keys, commonly used to grant access to authorized individuals on encrypted computer networks and systems. This effort will be conducted in technical consultation with the National Security Agency (NSA) and the Department of Defense (DOD), as well as other government agencies and non-government organizations;
- nurture the development of "multifactor authentication" methods. Such methods require users to verify their identities through multiple methods, such as passwords and iris scans, rather than just one. NIST will develop a standardized framework that ensures these methods work across different computer platforms and operating systems. The effort will be coordinated with vendors and Federal departments, including the Department of Homeland Security; and
- extend the Federal Desktop Core Configuration, a set of standard security settings that optimize security, to other operating systems, applications, and network devices beyond the existing support for Windows XP and Vista.

Going at Light Speed: Optical Communications and Computing (+$5.8M)

As demand on the U.S. communications network continues to grow, a new generation of transmission and networking technologies is required to keep pace. Keeping pace is critical because communications fundamentally drives productivity gains and economic growth; it cradles innovation in many current and future industries, including telemedicine, entertainment, and security.

This initiative will promote advances in light-scale communications ranging from the nanoscopic innards of an individual computer to the continent-spanning scale of the Nation's optical communications network. Already the world leader in measurements of high-speed devices and of hybrid optical and electronic devices, NIST will work closely with industry and expand its work to include research and development of:

- new measurement capabilities to accommodate higher-speed, next-generation communications networks;
- measurements that diagnose and locate transmission problems on data networks, and provide the information needed to reconfigure and redirect traffic to match demand; and
- new measurement techniques for analyzing computer circuits that transmit light instead of electricity, enabling the manipulation of light within computer chips, and interconnecting very small electronic and optical devices.

Quantum Information Science (+$7M)

NIST scientists are world leaders in the emerging field of quantum science. Three NIST scientists have won separate Nobel Prizes in the last 10 years based on their work in the field. Many of the best minds in physics today believe that applications of quantum science will transform the 21st century just as integrated circuits and classical electronics transformed the 20th century.

Having developed potential components for quantum computers and demonstrated other advances, NIST is proposing to expand further its quantum science program in FY 2009. Several of the projects proposed under this initiative will be in collaboration with the Joint Quantum Institute established by NIST, the University of Maryland, and the National Security Agency. NIST will:

- begin development of quantum "wires" that use "teleportation" techniques to reliably transport information between the components of a simple quantum computer based on manipulation of atoms, other elementary particles, or solid-state quantum devices;
- begin development of quantum memory analogous to the random access memory of today's computers to allow more complex logic operations;
- begin development of methods for transferring quantum-based information from one form (such as atoms) to another form (such as photons);
- develop an all-optical clock for more precise time and frequency measurement; and

- exploit the unusual quantum properties of "coherence" and entanglement to provide exquisite physical science measurement capabilities with improved sensitivity, accuracy, and speed.

Enabling Nanotechnology from Discovery to Manufacture (+$7M)

In FY 2007, NIST began a major initiative to address the measurement barriers hindering rapid development of nanotechnologies. A new NIST Center for Nanoscale Science and Technology (CNST) has been established that combines both research and a state-of-the-art nanofabrication and nanometrology user facility.

While a complementary NIST initiative will provide important groundwork in measuring environmental, health, and safety (EHS) risks of nanotechnology, this research initiative will build on recent NIST advances in developing nanoscale science and technology by:

- devising ways to measure strength, stress, strain, optical, and electronic properties of nanostructures to improve processes and understanding of failure mechanisms;
- creating three-dimensional, high-resolution imaging methods that reveal details of structure, chemical composition, and manufacturing defects and allow researchers to view nanostructures as they interact with their environment;
- simulating nanoscale phenomena with computer models to allow economical development of production methods for complex nanodevices; and
- pushing existing computer technology to its ultimate limit by developing measurements and standards that support "ultimate CMOS," or the development of current transistor technology to its technological limit.

Innovations in Measurement Science (+$3M)

As new science and technology areas emerge, NIST must quickly develop the measurement methods needed to support them. The Innovations in Measurement Science Program is one of NIST's primary mechanisms for keeping pace with the measurement requirements needed for innovation in U.S. industry.

Established in 1979, the program supports high-risk, leading-edge research projects that anticipate industry needs and develop measurement science for the next generation of technology. At some point in their careers, all three of NIST's Nobel laureates have had their research funded by this program. Current NIST expertise in quantum information science, fuel cell science, three dimensional chemical imaging, and many other areas important to national priorities were launched with "measurement innovations" funding.

This initiative will expand the scope and nature of projects selected for the Innovations in Measurement Science Program to allow this program to keep better pace with the evolving needs of industry and science. Emphasis will be placed on the development of multidisciplinary research areas with the greatest potential for fostering innovation.

The NIST Laboratories carefully evaluate the technical merit, potential impact, and staff qualifications for detailed research proposals submitted by the NIST technical staff. Successful proposals are funded for 5 years—ensuring enough time for the innovative measurement science approach to be developed—and are reviewed throughout the program to ensure satisfactory progress.

Enabling the Use of Hydrogen as a Fuel (+$4M)

Hydrogen offers the possibility of lowering the impact of motor vehicles on the environment, and reducing our Nation's dependence on foreign oil. While the burning of fossil fuels produces carbon dioxide and other emissions harmful to the environment, hydrogen fuel can be made from many energy sources, including renewables.

Technical challenges need to be overcome to make hydrogen-powered vehicles more practical and economical. Hydrogen can embrittle metals and other container materials, is highly combustible, and requires storage containers larger than those for other fuels with equivalent energy. Moreover, the technical infrastructure must be developed to ensure safe production, storage, distribution, delivery, and equitable sale of hydrogen in the marketplace.

Expansion of research efforts at NIST is essential to achieving widespread use of hydrogen as a fuel. NIST has been a leading provider of data on the chemical and physical properties of hydrogen for more than 50 years. It has statutory responsibility under the Pipeline Safety Act of 2002 to develop research and standards for gas pipeline integrity, safety, and reliability. It is the lead U.S. agency for weights and measures of vehicle fuels, and the distribution and sale of hydrogen will require entirely new systems for ensuring equity in the marketplace.

NIST's Center for Neutron Research is a premier facility for real-time, three-dimensional imaging of hydrogen in operating fuel cells. Using the unique resources developed at this NIST facility will help reduce technical barriers for efficient hydrogen production, storage, and use. NIST expertise will be essential for making fuel cells less costly and more reliable.

Manufacturing Innovation Through Supply Chain Integration (+$1M)

America's large manufacturers are globally distributed enterprises that rely on a system of small manufacturers, parts suppliers, shippers, and raw materials producers organized in extended "supply chains." Using the auto industry as an example, the average car has more than 15,000 parts coming from 5,000 manufacturers that are made to the precise specifications of the auto company and must arrive on time.

Production costs are no longer the major cost component in these global supply chains—the dominant cost is in the engineering and business activities, which depend critically upon clear and error-free exchange of information among partners.

Inefficiencies and needless roadblocks in the exchange of product design and business data in manufacturing and construction are estimated to cost the U.S. economy more than $25 billion per year. Small manufacturers are particularly hurt by these problems, but they affect the competitiveness of entire industries.

In the 1980s NIST pioneered work in developing early open standards for data exchange. Under this initiative, NIST will conduct a much more extensive, wide-ranging, and technologically advanced program. Working closely with U.S. manufacturers to develop seamless data transactions throughout global supply chains, NIST will work to shorten the design-to-manufacturing cycle, improve quality, and lower costs for large and small U.S. firms.

Major goals will include:

- creating "roadmaps" for the development of open standards for enterprise integration in target industry sectors;
- developing validation and conformance tests to help ensure the performance of these standards as well as their proper use; and
- ensuring the standards are integrated and consistent with developing international standards and easily available to small and medium-sized U.S. manufacturers.

III. Construction of Research Facilities (CRF)

Boosting U.S. Science and Engineering Capacity and Capability (+$63.7M)

JILA Expansion: Preparing the Next Generation of Physicists (+$13M)

Space has run out at one of the Nation's most valuable training grounds of top scientific talent. JILA, a joint institute of NIST and the University of Colorado at Boulder, has produced three Nobel Laureates and two MacArthur Fellows, all named in this decade alone. JILA researchers are leaders in atomic, molecular, and optical (AMO) science, a field that the National Academies says is "key to training our best scientists, engineers, and technical professionals."

JILA is already over capacity, and the situation is getting worse. The existing group of 28 JILA research scientists could train approximately one-third more postdocs and student researchers, but there is literally no place for them to work. An expert external assessment of the JILA laboratories warned that this shortage of space threatened JILA's ability to retain and recruit world-class scientists.

NIST proposes a limited expansion of the laboratory and office space at JILA. With the expansion costing an estimated $27.5M, NIST would contribute $13M in FY 2009 and an additional $9.5M in FY 2010. The University of Colorado will contribute $5M in funding, as well as land and infrastructure services such as electricity, chilled water, and steam.

The funding would add approximately 4,610 square meters (49,600 square feet) of new space. Improving the laboratory facilities at JILA will ensure that the current world-class research staff maximizes its potential for both training a new generation of scientists and producing the nanoscale manipulation tools needed to keep U.S. industry at the forefront of science. The expansion is expected to increase the number of AMO grad students at JILA by approximately 50 percent. Because JILA produces 5 to 10 percent of all AMO science Ph.D.s in the United States per year, this will step up significantly the Nation's production of scientists in this important field.

NIST Center for Neutron Research Expansion (NCNR) and Reliability Improvements (+$2M, added to a previously funded initiative)

Serving more scientists and engineers (over 2,100 annually) than all other U.S. neutron research facilities combined, the NIST Center for Neutron Research (NCNR) is the Nation's leading neutron facility. The NCNR is especially valued for its "cold" (low-energy) neutron source, which greatly increases the utility of the neutron beam, particularly in biotech and materials research.

Although the NCNR is widely regarded as the most cost-effective and efficiently managed neutron facility in the United States, presently this critical research tool cannot possibly meet the demands placed on it.

This is a planned increase in funding for the NCNR Expansion Initiative, begun in 2007. When completed, this five-year project will provide:

- a new generation of world-class cold neutron instruments directly supporting the needs of science and industry;
- more than a 30 percent increase in the overall measurement capacity;
- the ability to serve at least 500 additional researchers each year; and
- increased operational efficiency.

The FY 2009 funding request supports the next phase of the NCNR expansion to initiate installation, testing, and commissioning of the new neutron instruments (such as spectrometers). These instruments will bring new neutron measurement capability to U.S. researchers by either exceeding the capabilities of current instruments by more than a factor of a hundred, or by providing capabilities that are not currently available in the United States.

In FY 2009, the project will focus on:

- installation of new neutron spectrometers and neutron beamlines;
- modification of beamlines and beamline shielding;
- modification of some existing instruments affected by new beamlines; and
- testing of new beamlines and instruments.

2-of-the-Art Laboratory Space at NIST's Boulder, Colorado Campus Building 1 Extension (+$43.5M)

The Building 1 Extension (B1E) will provide the environmental control needed to reliably measure and manipulate atomic-scale phenomena in order to further enable 21st-century technologies. Improvement in environmental conditions within NIST's Boulder, Colorado research laboratories is required to make further progress in measurements related to high-frequency electronics, advanced materials characterized at the atomic level, subcellular forces, timing accuracy, and other areas.

As the final funding request for a three-year program, the $43.5M proposed in the FY 2009 budget will complete state-of-the-art laboratory space that will meet the stringent environmental conditions required for 21st-century scientific advances. With a total cost of $77.2M, the Building 1 Extension is the most cost-effective approach to enabling world-class measurement science in support of some of the country's most important economic sectors.

Construction of the B1E will dramatically enhance NIST's measurement capability and will directly support the needs of industry and academia. Some of the anticipated impacts include the ability to:

- make precision frequency measurements above 100 GHz (100 billion cycles per second), which are required for advanced commercial electronics, military systems, and homeland security;
- measure and perform research on the properties of materials at the single-atom level needed for the development of quantum and nanotechnologies;
- measure forces below 10-12 newtons (one billionth the weight of a feather) to understand the inner workings of cells and to apply this measurement capability to other physical systems; and
- make timing measurements with uncertainties reduced to one part in 10-18 (the equivalent of 1 second in 30 billion years), enabling whole new generations of position, navigation, and guidance systems.

Safety, Capacity, Maintenance and Major Repairs (SCMMR) (+$5.2M)

Aging and deteriorating buildings and infrastructure threaten NIST's ability to meet the needs of the Nation's scientific and industrial enterprise. NIST maintains about 50 specialized laboratories, offices, and support buildings at its two major sites in Gaithersburg, Maryland, and Boulder, Colorado, as well as critical infra-

structure in Fort Collins, Colorado, and Kauai, Hawaii. Most of the Gaithersburg structures were built in the 1960s, and the Boulder facilities are a decade older.

Since 1995, the Construction of Research Facilities (CRF) appropriation has funded building construction and the safety, capacity, maintenance, and major repairs (SCMMR) of NIST's physical plant. Although recent increases to SCMMR have led to improvements in these facilities and infrastructure, the current state of NIST facilities—whether measured in terms of safety, capacity, or state of repair—remains a serious impediment to NIST's mission. Funding for renovations has not kept pace with NIST needs. The failure rate of major building systems such as air-handling systems and piping systems has increased dramatically in the last 5 years. NIST's aging facilities and their extensive backlog of deferred maintenance and repairs have resulted in lost productivity and increased costs.

These problems are not confined to the most advanced research and development projects. For example, the relatively straightforward NIST task of calibrating precision pressure gauges is the critical first step in a national measurement chain that ensures the accuracy of airplane altimeters and supports a wide variety of manufacturing sectors, including semiconductors and pharmaceuticals. However, carrying out this process has been limited by vibration problems, poor temperature control, and a pervasive black grit distributed by a 40-year-old air-conditioning, ventilation, and heating system.

Based on independent architectural and engineering reviews and in conjunction with the need to maintain world-class research facilities, NIST proposes to target the most critical SCMMR projects. These areas include repair and replacement of aging mechanical and electrical systems removal of hazardous material, including remediation of asbestos; structural repairs and replacements; and efforts to ensure accessibility in all NIST facilities.

Industrial Technology Services.

Hollings Manufacturing Extension Partnership (MEP) ($4.0M)

The requested $4M provides the orderly end to Federal funding for the Hollings Manufacturing Extension Partnership (MEP) program. The elimination of Federal funds to the local centers may have to be compensated through a combination of increased fees derived from the benefits accrued by individual companies and cost-savings in the operations of the centers.

Technology Innovation Program (TIP) ($0)

No funds for TIP are requested in the President's FY 2009 budget. Anticipated prior year recoveries will be sufficient to phaseout the program.

Summary

For 107 years, NIST research has been critical to our Nation's innovation and competitiveness. The increased funding in the President's FY 2009 budget for the NIST core will directly support technological advances in broad sectors of the economy that will quite literally define the 21st century—as well as improve the safety and quality of life for all our citizens.

Today, more than at any other time in history, technological innovation and progress depend on NIST's unique skills and capabilities. Helping the U.S. to drive and take advantage of the increased pace of technological change is a top priority for NIST.

The new technologies that are determining the global winners in the early 21st century—including nanotechnology, information technology, and advanced manufacturing—rely on NIST-developed tools to measure, evaluate, and standardize. The technologies that emerge as a result of NIST's development of these tools are enabling U.S. companies to innovate and remain competitive.

Technology-based innovation remains one of the Nation's most important competitive advantages, but that advantage is in danger of being lost. The American Competitiveness Initiative (ACI) and the enactment of the America COMPETES Act are bold initiatives to maintain this advantage. They have cast a spotlight on NIST's critical importance to U.S. economic competitiveness and innovation. To ensure that NIST programs deliver the highest impact, the Institute, working with our stakeholders in Congress, industry, academia, and other government agencies, will continue to identify the most critical measurement, standards, and technological challenges. We look forward to working with you, Mr. Chairman, and members of the Subcommittee, throughout this process.

Senator KERRY. Thank you very much, Dr. Turner. Appreciate it. Appreciate each of your testimonies.

Let me try to sort of sort through squaring, if we can, some of what you've talked about in terms of importance with where we find ourselves.

Let me begin with the issue, Dr. Marburger, perhaps I direct this to you, at least initially, and also Dr. Turner to some degree. The Fiscal Year 2009 request for NIST is $638 million. That's 15.6 percent below the Fiscal Year 2008 appropriated level of $755.8 million and 27.5 percent below the Fiscal Year 2009 authorized level in the America COMPETES.

The Fiscal Year 2009 request does not include any funding for TIP, even though appropriators provided $65.2 million in last year's budget for the program.

Furthermore, the request only includes $4 million to provide for the shutdown of the Manufacturing Extension Partnership. That was funded at $89.6 million last year.

Now I don't know if you're aware of it, I hope you are, Senator Conrad, in the Budget Committee resolution which is currently on the Floor, which I am confident will pass, has requested $87 million for TIP and the full authorization level of $122 million for the Manufacturing Extension Partnership in the budget resolution.

So, let me just give you a quick take on it. In Massachusetts alone, the Manufacturing Extension Partnership clients we've surveyed, the program has had the following impact over the last 5 years: $499,600,000 in new or retained sales, $117,400,000 in new investments, $112 million in cost savings, 4,800+ jobs, almost 5,000 jobs, $187,450,000 in new profit.

So, what's going on here? What is the rationale for this annihilation of a program that works which Congress wants to fund and will, and the lack of funding, adequate funding at the levels in America COMPETES for a program that you underfund?

Dr. MARBURGER. The short answer to that question, Senator, is priorities. The NIST core budget funds absolutely essential activities of basic research and programs that directly support important industry efforts, like the Semiconductor Roadmap, and many other processes directly related to manufacturing and economic competitiveness.

It's not the case that all of the technology transfer interaction with industry activities at NIST are concentrated in a single program, like MEP or TIP. These programs are not bad. It's just that they——

Senator KERRY. Are not what?

Dr. MARBURGER. They're not bad programs.

Senator KERRY. Are they good?

Dr. MARBURGER. They are good programs, but they simply do not have the same potential impact on our future economy as the programs in the NIST core budget.

NIST is an extraordinary institution. Its employees have received three Nobel prizes in recent decades. They're honored throughout the world for their leadership in establishing standards in cutting edge technologies and these are our benefits that issue from funding the core programs, not from the relatively small impact, low impact, shorter-term activities that TIP and MEP are designed to foster.

So, it's strictly——

Senator KERRY. Well, is this a choice made—Doctor, I'm sorry to interrupt you, but let me just follow up. Thank you.

Is this a choice made by you, given a fixed budget within which you have to try to fund all three of the key critical agencies under the ACI, or, go ahead.

Dr. MARBURGER. I wish I had the—I wish I were the only one that could control these budgets. These choices are not made by me alone, but I certainly recommend the prioritization.

Senator KERRY. But is that a priority you recommend if you're given a lump sum that's inadequate and you're forced to make the choice or is that a priority you'd make no matter what?

In other words, Congress is making a different choice.

Dr. MARBURGER. Yes.

Senator KERRY. We're funding each of your core programs to a greater degree and funding that because we make another different set of choices about priorities.

Dr. MARBURGER. The priorities are independent of how much money you have. The highest-impact activities at NIST are the ones in their so-called "core budget." All of the other NIST programs have a lower impact, so with whatever amount of money is on the table, I would still prefer to support the NIST core.

I believe that the NIST core budget is very substantially underfunded. I would like to see it significantly greater, even greater than the doubling that's been proposed under the ACI and COMPETES. Frankly, I think it's the most underfunded program in science and technology in our Nation.

So, I am very strongly in favor of concentrating our resources as much as we can in the NIST core budget.

Senator KERRY. Can you quantify in any way that's comparable to those two? For instance, the MEP figures I gave you, can you quantify core programs?

Dr. MARBURGER. Only generally, because the—since the activities funded under MEP and TIP are shorter range, focused on industry and the immediate production of jobs, which are easier to count, it's easier to do the accounting for the impact on those types of programs than it is for the overall longer-term impact of the basic work that NIST does.

However, economists have indicated very large—NIST, actually Commerce's own economists have indicated very large returns on the type of basic research that is conducted at NIST, and NIST activities are responsible for the capabilities of global positioning systems, for our ability to detect and reproducibly manipulate matter at the nano scale.

There's just an extraordinary impact on almost every part of our economy from those core activities.

Senator KERRY. Well, none of us are going to disagree. I mean, we obviously want to fund them to a greater degree, to a much greater degree than the administration, but at the same time in an economy that is painfully lagging in growth behind others and where there is a lot of pain being felt right now at the local level, it's very hard to turn your back on something that produces 5,000 jobs in one state in 5 years and a $187 million of profit.

Dr. MARBURGER. I agree, Senator, but I don't want to give up our long-term leadership——

Senator KERRY. That's because it's being made either/or and what I'm saying is it shouldn't be and it's being made an either/or because you're given a smaller nut with which to make those choices.

We are going to provide a budget which proves that you can do both. So, there is a different approach here, that is really what I'm trying to underscore, that I don't think you should be put, I'm not sitting here to, you know, suggest I know how it works and I know you're not the person who makes the final cut here, we've had this debate before, but the bottom line the Committee wants to underscore is that the budget that we're going to vote on on the Senate Floor does both, and provides a greater degree of funding for your core and I think that's pretty critical.

I might further add this for both you, Dr. Marburger and Dr. Turner. As I mentioned, the NIST total is 15.6 percent below the appropriated levels of last year, which raises a lot of questions. Even though you're getting more money, I agree and you can sort of characterize it as moving further down the road, but it's below the 2008 appropriated level and, as I said, almost 30 percent, 27.5 percent below the authorized level.

Both of you emphasize the importance of research and development and how the fruits of that affect science, technology, engineering, mathematics, et cetera. We all understand that.

How does cutting those two programs I talked about previously affect us competitively in your judgment?

Dr. MARBURGER. In my judgment, their impact on competitiveness is negligible or very minor compared with the impact that the core budget has, and I would like to point out that the core budget request for NIST is greater than the Fiscal Year 2008 authorized enacted amount. My figures indicate that the 2008 Omnibus had $605 million for NIST core and the President's 2009 request is $634 million, an increase of $29 million above the Omnibus and that's not——

Senator KERRY. For NIST?

Dr. MARBURGER. For NIST.

Senator KERRY. I think it was $638 million but anyway $4 million. It's government work.

Dr. MARBURGER. I think the $4 million is for the MEP part of the program. So, I'm just——

Senator KERRY. I see. Fair enough. OK. I accept that.

Dr. MARBURGER. So, there is an increase in the President's request relative to last year, consistent with the priorities.

Senator KERRY. Last year, the appropriated level was $755 million.

Dr. MARBURGER. For the total?

Senator KERRY. For the total, yes.

Dr. MARBURGER. Yes, I'm only referring to the high-leverage, long-term impact of NIST core activities which I think is absolutely crucial for our long-term competitiveness.

Dr. TURNER. Can I address the——

Senator KERRY. Please.

Dr. TURNER. In 2008, MEP was funded at a level of about $89 million. In 2008, TIP was funded at a level of about $65 million, and then there were about $80 million in one-time Federal—I

mean Congressionally-directed activities and so when you take those out, that's the apparent difference between the two, why there is an apparent decrease, because if you back those programs out, you do have the 22 percent increase.

I also would like to take a moment to address MEP and TIP, sir. First of all, I've been at NIST now a little bit less than a year and one of the things that I've done is gone out to visit MEP centers and to talk to MEP clients and I agree, it is a good program, but that wasn't the issue. The issue was, as Dr. Marburger mentioned, priorities and limited resources and so that's why the decisions were made that were made.

As far as TIP is concerned, we are moving forward aggressively with having an 2008 competition. The rule for TIP is now out for public comment and we are working very hard to make sure that the 2008 competition for TIP is in fact successful, but again, the core programs affect entire sectors of the economy and they literally create new industries in and of themselves and that's one of the things that led to the prioritization given for the core programs.

Senator KERRY. Fair enough. I understand that, and I can understand the point of view if I were in your shoes. I don't think you ought to be in your shoes. So that's the distinction here.

Dr. TURNER. Well, sir, if I may add, too, that NIST supports manufacturing in a variety of ways. It's very important to us and it's in our mission to support innovation and competitiveness and so our labs do it in several ways, in advancing nanotechnology, advanced manufacturing techniques, advanced materials, standards calibrations, laboratory accreditations. So, we are doing a lot of things that impact manufacturing.

Senator KERRY. No question, no question about it. Everything that you do in that regard in terms of the measurements, accountability, standardization, all those things are a critical element of our economy and the measurements by which people can make judgments and money flows. We understand that, we applaud it, and we want you to be able to do more, and the problem is that we're in a voracious, intensive competition with other people who seem to have a better sense of their priorities and that's the struggle here.

Obviously the Congress has a slightly different point of view here than the Administration about how significantly we should be committing to this and in our judgment it shouldn't be either/or. It should be all of the above because this is perhaps the most important critical sector in terms of preparing a workforce for the future as well as creating the high value-added jobs which are going to grow our economy and our tax base and strengthen us competitively.

So, you're a key player in it and this sector, this Committee believes, is perhaps the most critical in terms of the nature of the playing field as it is evolving and changing.

Let me pick up on that a little bit, if I can. Then I want to let Senator Klobuchar have a chance to have a round here, then we'll come back.

This issue of climate change is something, and I'm not going to focus the whole hearing on it, I want to come back to some of the other areas, but for 20 years now, this committee has had a leader-

ship role. Senator Gore and I held the first hearings on climate change in this committee in 1987. The next year, Jim Hanson made his announcements and then 5 years later, we all went down to Rio, President George Herbert Walker Bush took part in that, and here we are in 2008 still debating whether or not we ought to respond to something that we entered into an international treaty on in 1992.

So, our commitment to this is critical and the science, whether you listen to, you know, John Holdren up at Harvard and Woods Hole or Bob Corell down here in Washington or a whole host of people all over the country who are weighing in on this or the IPCC folks, is that it's becoming more urgent, not less. The science is becoming more firm, not less. The evidence of damage is becoming greater, not less. I mean, you run through every sequence of measurement.

Notwithstanding that, we are still waiting. In August of 2007, a Federal judge found that the Bush Administration violated the Global Change Research Act by failing to produce a National Assessment of Climate Change Science which was due in November of 2004, and, you know, we're hoping this is going to be delivered by the court's deadline, but OSTP staff has indicated that the Administration believes that the 21 ongoing assessment reports, only four of which have been completed, comply with the law and with the court's decision.

So, we've got a conflict brewing here about what science is going to be provided and what kind of report is going to be provided. The assessment that those assessment reports comply with the 2005 GAO assessment runs contrary to the current plan and requirement to provide a single comprehensive national assessment.

So, my question to you is will a national assessment be delivered by May 31st deadline, and is it going to take the form of a single integrated comprehensive report?

Dr. MARBURGER. Yes, Senator, I'm very pleased to report that the Climate Change Science Program is making good progress. The court order that you referred to required a summary of the revised research plan to be published in the Federal Register for public comment prior to March 1st. That plan was published in the Federal Register in December of last year and the comment period is now closed.

The full revised research plan is due by May 30th and the scientific assessment that you referred to that is due by May 31st have—are in process. I have seen drafts of both reports. They're very substantial and I'm pleased that they're making this progress, and I obviously appreciate the patience of this committee as we get these important documents out.

Senator KERRY. Well, that's excellent, and we obviously will look forward to receiving that and hope that it will be really comprehensive and perhaps help to resolve some questions. So, we look forward to that.

One thing I do note is that the budget was presented as a lump sum rather than broken down in terms of agency distribution and makes it very difficult to figure out how you draw the line between climate science and climate technology and so forth.

There's $2 billion point something in that. Is there some way to get that breakdown? Could you submit that to us?

Dr. MARBURGER. I would be glad to submit a breakdown to the extent that it's possible. I believe it can be broken down in a much finer way.

[The information referred to follows:]

CCSP [1]	FY 2007 Actual Budget Authority	FY 2008 Enacted Budget Authority	FY 2009 Proposed Budget Authority	Change in Budget Authority 2008–2009
Department of Agriculture				
Agricultural Research Service	40	39	37	−2
Cooperative State Research, Education and Extension Services	2	4	6	2
Economic Research Service [2]	0	0	0	0
Forest Service—Forest and Rangeland Research	19	22	19	−3
Subtotal—USDA [3]	*61*	*65*	*62*	−3
Department of Commerce				
National Oceanic and Atmospheric Administration—Operations, Research, and Facilities[4]	229	254	239	−15
National Oceanic and Atmospheric Administration Procurement, Acquisition, and Construction [4 5]	7	7	81	74
National Institute of Standards and Technology (NIST) [6]	—	5	5	0
Subtotal—DOC [3]	*236*	*266*	*325*	59
Department of Energy				
Science—Biological & Environmental Research [3 7]	*126*	*128*	*146*	18
Department of Health and Human Services				
National Institutes of Health [3]	*47*	*47*	*47*	0
Department of the Interior				
U.S. Geological Survey—Surveys, Investigations, and Research [3]	*27*	*34*	*31*	−3
Department of Transportation				
Federal Highway Administration—Federal-Aid Highways [3 8]	0	1	0	−1
Federal Aviation Administration—Research, Engineering, and Development [9]	0	0	2	2
Federal Transit Administration—Research and University Research Centers [10]	0	0	0	0
Subtotal—DOT [3]	*1*	*1*	*2*	1
Environmental Protection Agency				
Science and Technology [3]	*16*	*20*	*16*	−4
National Aeronautics and Space Administration [11]				
Science, Aeronautics, and Exploration [3]	1,084	1,078	*0*	−1,078
Science	0	0	1,204	1,204
Subtotal—NASA	*1,084*	*1,078*	*1,204*	126
National Science Foundation				
Research and Related Activities [3]	*207*	*205*	*221*	16
Smithsonian Institution				
Salaries and Expenses [3]	*6*	*6*	*6*	0

CCSP [1]	FY 2007 Actual Budget Authority	FY 2008 Enacted Budget Authority	FY 2009 Proposed Budget Authority	Change in Budget Authority 2008–2009
U.S. Agency for International Development				
Development Assistance [3]	*14*	*14*	*20*	6
Total [3]	*1,825*	*1,864*	*2,080*	*216*

[1] All data supersede numbers released with the 2009 President's Budget. Budget Authority provided in millions of dollars. Discrepancies resulted from rounding and improved estimates.
[2] Funding for the Economic Research Service is less than $500,000 for all years shown.
[3] Agency subtotals and table total may not add due to rounding.
[4] NOAA previously reported its climate research activities to CCSP, which were included under its Office of Oceanic and Atmospheric Research (OAR) line office and the National Marine Fisheries Service (NMFS) line office starting in FY 2006. For FY 2008, NOAA made a decision to report activities for the NOAA climate strategic goal, as defined in the NOAA strategic plan (2005), to ensure consistent reporting and provide the most accurate picture of its climate funding to date. The climate goal includes both research and operations funding under the following offices: OAR, NMFS, the National Weather Service, and the National Environmental Satellite, Data, and Information Service.
[5] Past reports have erroneously presented all of NOAA's CCSP funding in the Operations, Research, and Facilities (ORF) account. Climate-related activities have been and continue to be funded in both the ORF account and the Procurement, Acquisition, and Construction (PAC) account.
[6] 2008 funding is for new measurement and standards-related activities that NIST will undertake to support CCSP.
[7] The majority of the 2009 increase is due to increased climate modeling efforts. Examples include testing new convection and cloud parameterization schemes, research on effects of improved initialization of coupled model components on decadal predictability of climate, and understanding the role of cryospheric processes in the climate system.
[8] The 2006, 2007 and 2009 funding for Federal Highway Administration—Federal-Aid Highways was less than $500,000.
[9] The 2006, 2007 and 2008 funding for Federal Aviation Administration—Research, Engineering, and Development was less than $500,000.
[10] Federal Transit Administration—Research and University Research Centers is FTA's support for DOT's Center for Climate Change. The 2006 through 2009 funding amounts for this program are less than $500,000.
[11] NASA has revised the set of programs and projects it counts as supporting CCSP goals. Beginning in 2006, the funding levels presented do not include the Ground Network and Research Range assets or Congressional interest items but comprise activities not previously counted, including the NPOESS Preparatory Project, portions of the Landsat Data Continuity Mission (LDCM), and the Gravity Recovery and Climate Experiment (GRACE), as well as portions of the High-End Computing and Scientific Computing projects.

CCTP [1]	FY 2007 Actual Budget Authority	FY 2008 Enacted Budget Authority	FY 2009 Proposed Budget Authority	Change in Budget Authority 2008–2009
Department of Agriculture				
Natural Resources Conservation Service—Carbon Cycle	1	1	1	0
Forest Service R&D—Inventories of Carbon Biomass	1	1	1	0
Agricultural Research Service—Bioenergy Research	2	2	2	0
Cooperative State Research, Education and Extension Service—Biofuels/Biomass Research, Formula Funds, National Research Initiative [2]	3	8	27	19
Forest Service—Biofuels/Biomass, Forest and Rangeland Research	2	2	2	0
Rural Business Service—Renewable Energy Program	23	36	0	−36
Rural Business Service—Value Added Producer Grants	3	5	0	−5
Rural Business Service—Biomass R&D, Section 9008 Farm Bill [3]	14	0	0	0
Office of the Chief Economist—Methane to Markets [4]	0	0	0	0
Research Education, Economics Area—Bioenergy and Biobased Products Research Initiative (mandatory funding) [5 6]	—	50	50	0
Forest Service—Forest Wood to Energy (mandatory funding) [5 7]	—	15	15	0
Rural Business Service—Renewable Energy Systems and Energy Efficiency Grants (mandatory funding) [5 8]	—	50	50	0
Rural Business Service—Renewable Energy Systems and Energy Efficiency Loans (mandatory funding) [5 8]	—	21	21	0
Rural Business Service—Biomass R&D, Section 9008 (mandatory funding) [5 9]	—	15	15	0
Subtotal—mandatory funding [10]	14	151	151	0
Subtotal—discretionary funding [10]	34	54	33	−21
Subtotal—USDA [10]	*48*	*205*	*184*	*−21*
Department of Commerce				

CCTP [1]	FY 2007 Actual Budget Authority	FY 2008 Enacted Budget Authority	FY 2009 Proposed Budget Authority	Change in Budget Authority 2008–2009
National Institute of Standards and Technology (NIST)—Scientific and Technological Research and Services	6	6	6	0
NIST—Industrial Technical Services, Advanced Technology Program [11]	16	0	0	0
International Trade Administration—Operations and Administration [12]	0	2	2	0
Subtotal—Commerce [10]	*22*	*8*	*8*	*0*
Department of Defense				
Research, Development, Test and Evaluation, Army	69	74	16	−58
Research, Development, Test and Evaluation, Navy	13	39	11	−28
Research, Development, Test and Evaluation, Air Force	13	36	104	68
Research, Development, Test and Evaluation, Defense-wide—DARPA [14]	6	0	0	0
Research, Development, Test and Evaluation, Defense-wide—Office of the Secretary of Defense	0	0	0	0
Subtotal—DOD [10 13]	*101*	*150*	*131*	*−19*
Department of Energy				
Energy Efficiency and Renewable Energy [15 16]	1,411	1,722	1,255	−467
Electricity Delivery and Energy Reliability [15]	120	130	122	−7
Nuclear Energy [17]	513	685	879	194
Fossil Energy R&D—Efficiency and Sequestration [18]	493	611	744	133
Science—Fusion, Sequestration, and Hydrogen [19]	487	499	833	334
Innovative Technology Loan Guarantee Program [20]	7	5	0	−5
Departmental Administration—Climate Change Technology Program Direction [21]	1	1	2	1
Subtotal—DOE [10]	*3,032*	*3,652*	*3,835*	*183*
Department of Transportation				
National Highway Traffic Safety Administration [22]	1	1	0	−1
Research and Innovative Technology Administration—Research and Development	1	1	1	0
Federal Transit Administration—Research and University Research Centers and Formula and Bus Grants [23]	16	18	19	1
Subtotal—DOT [10]	*17*	*19*	*20*	*1*
Environmental Protection Agency				
Environmental Programs and Management	92	90	87	−3
Science and Technology	13	18	11	−7
Subtotal—EPA [10]	*105*	*108*	*98*	*−10*
National Aeronautics and Space Administration [24]				
Science, Aeronautics, and Exploration	139	139	117	−22
National Science Foundation				
Research and Related Activities	21	21	23	2
Total [10]	*3,485*	*4,303*	*4,416*	*114*

[1] All data supersede numbers released with the 2009 President's Budget. Budget Authority provided in millions of dollars. Discrepancies resulted from rounding and improved estimates.

[2] The FY 2008 level includes increased funding for research in cellulosic ethanol.
[3] Though initially run through the Natural Resources Conservation Service, the Biomass R&D, Section 9008 Farm Bill program was transferred at the end of FY 2006 to the Rural Business Service. The program activities, historical funding levels, and treasury account number remain the same.
[4] The Methane to Market partnership is a new initiative for the Office of the Chief Economist in FY 2008.
[5] These are mandatory programs proposed in the Administration's Farm Bill. The Farm Bill has not been enacted for 2008, however funding is included in this column assuming the Administration's Farm Bill is passed in 2008.
[6] This new program will advance scientific knowledge for the improved production of renewable fuels and biobased products.
[7] This new program will be used to accelerate development and use of new technologies to more productively utilize low-value woody biomass resources, offsetting the demand for fossil fuels and improving forest health.
[8] The discretionary funding for the renewable energy program has historically been and continues to be included in this report. The program is proposed for reauthorization in the 2007 Farm Bill proposals and the associated mandatory funding has been included here.
[9] The discretionary funding for the Biomass R&D program has historically been and continues to be included in this report. The program is proposed for reauthorization in the 2007 Farm Bill proposals and the associated mandatory funding has been included here.
[10] Agency subtotals and table total may not add due to rounding. All data supersede numbers released with the 2009 President's Budget. Discrepancies resulted from rounding and improved estimates.
[11] The 2007 Budget authority, obligations, and outlays for NIST's Advanced Technology Program are less than $500,000. The program has been proposed for elimination in 2008.
[12] The Department of Commerce provided funding in this account for the Asia-Pacific Partnership on Clean Development and Climate beginning in 2008.
[13] The 2008 enacted budget authority funding represents Congressional action on the 2008 budget and includes earmarks that are not proposed for extension in the 2009 President's Budget request.
[14] The reduction in DARPA funding from 2007 to 2008 represents the natural conclusion of an R&D program to investigate the use of waste materials to produce electricity for military installations.
[15] In 2008, Congress enacted a new account structure. In 2007, funding for these programs was provided in the Energy Supply and Conservation account. 2008 and 2009 funding is provided in the new accounts listed.
[16] The Reduction from 2008 Enacted to the 2009 Budget level is largely due to the elimination of Congressional earmarks and other terminations and redirections, including a reduction in facilities construction funding.
[17] Funding levels do not include the MOX facility. The 2009 Budget includes increases in funding over the 2008 enacted levels for the Advanced Fuel Cycle Initiative/Global Nuclear Energy Partnership and Nuclear Power 2010 programs. The 2008 Budget includes increases in funding over the 2007 enacted levels for the Generation IV Nuclear Energy Systems Initiative and Nuclear Power 2010 programs.
[18] This activity supports research, development and demonstration of technologies that capture and store carbon dioxide and improve efficiency to reduce greenhouse gas emissions at coal power plants and industrial coal facilities.
[19] The increases in funding from 2008 to 2009 in Science—Fusion, Sequestration, and Hydrogen reflect increased support for programs that are all included within the American Competitiveness Initiative, and are for the most part also included within the Advanced Energy Initiative, including increases to the international ITER fusion project, and for areas identified in the "Basic Research Needs" for energy technologies series of workshops.
[20] This is a new program in 2007. Administrative expenses are reported to establish a loan guarantee office. In 2009 and thereafter, administrative costs will be fee funded, so there is no net cost to the government.
[21] The increase in 2009 reflects additional funding for modeling and analysis improvements.
[22] The 2009 Funding for the National Highway Traffic Safety Administration was less than $500,000.
[23] Section 3045 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: a Legacy for Users (SAFETEA–LU) establishes a National Fuel Cell Bus Technology Development Program (NFCBP). The NFCBP's goal is to facilitate the development of commercially viable fuel cell bus technologies and related infrastructure to reduce fossil fuel dependence and emissions from bus transportation. These grants were funded for the first time in 2006.
[24] NASA's 2006 funding level increased markedly from the 2006 level reported in the last report due to Congressional direction to increase the budget for the Fundamental Aeronautics Program budget, NASA's major contributor to CCTP funding. The drop from the 2007 enacted level to the 2008 proposed level reflects differences of opinion between the Congress and Administration concerning the level at which the Fundamental Aeronautics Program should be funded.

Summary of Climate Expenditures [1]	FY 2007 Actual Budget Authority	FY 2008 Enacted Budget Authority	FY 2009 Proposed Budget Authority	Change in Budget Authority 2008–2009
Climate Change Science Program (CCSP)	*1,825*	*1,864*	*2,080*	*216*
Climate Change Technology Program (CCTP) [2]	*3,485*	*4,303*	*4,416*	*114*
International Assistance [3]	*188*	*202*	*657*	*455*
Energy Tax Provisions That May Reduce Greenhouse Gases [4 5]	*1,520*	*1,520*	*1,440*	*−80*
Total [3 6]	*7,004*	*7,875*	*8,573*	*699*

[1] Data supersede numbers released with the President's 2009 Budget. Budget Authority provided in millions of dollars. Discrepancies resulted from rounding and improved estimates.
[2] As comparable 2001 funding has not been generated for the CCTP, the 2001 amount shown for CCTP reflects estimated data for DOE and EPA only.
[3] The International Assistance total contains funds that are also counted in the Climate Change Science Program total. Table total line excludes this double-count.
[4] Tax incentives related to climate change included in this report are currently projected at about $6.0 billion over five years (2009–2013).
[5] Tax expenditures are estimates of the revenue losses due to a tax preference. While not exactly equivalent to budget authority, obligations or outlays, tax expenditure estimates have been included in all columns for completeness.
[6] Table total may not add due to rounding.

International Assistance [1]	FY 2007 Actual Budget Authority	FY 2008 Enacted Budget Authority	FY 2009 Proposed Budget Authority	Change in Budget Authority 2008–2009
Department of State				
Diplomatic and Consular Affairs	3	4	4	0
Economic Support Fund [2 3]	32	32	37	5
International Organizations and Programs	6	5	5	0
Subtotal—State [4]	*41*	*41*	*46*	*5*

International Assistance [1]	FY 2007 Actual Budget Authority	FY 2008 Enacted Budget Authority	FY 2009 Proposed Budget Authority	Change in Budget Authority 2008–2009
Department of the Treasury [5]				
Debt Restructuring—Tropical Forestry Conservation	20	20	20	0
Global Environment Facility [6]	26	26	26	0
Clean Technology Fund	0	0	400	400
Subtotal—Treasury [4]	*46*	*46*	*446*	*400*
U.S. Agency for International Development [2]				
Andean Counterdrug Initiative [7]	0	0	0	0
Assistance for Eastern Europe and the Baltic States	3	11	11	0
Assistance for the Independent States of the Former Soviet Union	5	15	15	0
Development Assistance	89	81	130	49
Economic Support Fund	0	7	7	0
International Disaster Assistance	2	2	2	0
P.L.-480 Title II Food Aid	0	0	0	0
Subtotal—USAID [4]	*100*	*115*	*165*	*50*
Total [4]	*188*	*202*	*657*	*455*

[1] All data supersede numbers released with the 2009 President's Budget. Budget Authority provided in millions of dollars. Discrepancies resulted from rounding and improved estimates.
[2] USAID is currently restructuring its planning, budgeting and reporting methods and electronic applications. Strategic Objectives that were reported for FY 2006 may not track consistently into elements reported for FY 2007, FY 2008, and FY 2009. Estimates for global climate change (GCC) program funding (as a subset of total element funding) are reported here and may change as the restructuring and reform process is completed. Some GCC program activities may not appear in this table at this time and may be added in future accounting.
[3] The increase in the Economic Support Fund in 2007 reflects funding for the Asia-Pacific Partnership on Clean Development and Climate.
[4] Agency subtotals and table total may not add due to rounding.
[5] The 2007 President's Budget included funding for climate-related activities through the Asian Development Bank. That funding was not appropriated in this account. Therefore, that account has been deleted.
[6] The 2009 Budget provides $80 million for GEF. Of this amount, a portion will be allocated to programs related to climate change.
[7] The Andean Counterdrug Initiative account was added in the Fiscal Year 2004 report to reflect new counter-deforestation activities in Peru.

Energy Tax Provisions That May Reduce Greenhouse Gases

[Fiscal Years—Dollars in Millions]

	2007	2008	2009	2010	2011	2012	2013	2009–2013
New technology credit (without coal) [1]	410	800	990	1,020	1,000	990	960	4,960
Tax credit and deduction for clean-fuel burning vehicles	260	150	130	−20	−50	−60	−50	−50
Exclusion of utility conservation subsidies	120	120	120	110	110	110	110	560
Credit for holding clean renewable energy bonds	20	40	70	70	70	70	70	350
Allowance of deduction for certain energy efficient commercial building property	190	170	90	30	0	0	0	120
Credit for construction of new energy efficient homes	20	30	20	10	0	0	0	30
Credit for energy efficiency improvements to existing homes	380	150	0	0	0	0	0	0
Credit for energy efficient appliances	80	0	0	0	0	0	0	0
Credit for residential purchases/ installations of solar and fuel cells	10	10	10	0	0	0	0	10
Credit for business installation of qualified fuel cells [2]	30	50	10	−10	−10	−10	−10	−30
Total	*1,520*	*1,520*	*1,440*	*1,210*	*1,120*	*1,100*	*1,080*	*5,950*

[1] Estimates of revenue loss from coal provisions have been removed from the tax expenditure estimate in the budget.
[2] Estimates of revenue loss from the micro-turbine provision have been removed from the tax expenditure estimate in the budget.

Senator KERRY. It'd be very helpful to us to have a better understanding of how that's going to be allocated.

Dr. MARBURGER. I agree.

Senator KERRY. Thank you very much, Doctor. I'll come back afterwards.

Senator Klobuchar, welcome.

STATEMENT OF HON. AMY KLOBUCHAR,
U.S. SENATOR FROM MINNESOTA

Senator KLOBUCHAR. Thank you very much, Mr. Chairman. Thank you to our panelists.

I want to thank you for being here for this important hearing. Just last Spring, the subcommittee heard from the 2006 Nobel Prize winners in the Sciences and as you know, this year for the first time in 20 years, all of the Nobel Prize winners in the sciences were United States citizens. Such an achievement is no doubt a result of their own hard work, but it's also, I believe, a testament to our country's historic investment and commitment and global leadership in education, research and technology.

Without the support and the leadership, as we heard from those Nobel Prize winners, they would not have had the funding to do their research to do their groundbreaking work, and as they told us last year, their fear was that U.S. technological leadership may now be slipping. As Senator Kerry has mentioned, it is increasingly threatened by the other countries around us that are putting a bigger focus on this and we need to change in a new direction.

My questions were, first of all, about how it once was and that was that the U.S. once relied on major industrial laboratories for significant amounts of research in innovation, like the AT&T Labs and General Electric, IBM, RCA, and they no longer exist or the funding has been so depleted that they can no longer be the research powerhouses that they once were, and can government-supported research serve as a replacement for these industrial laboratories?

Dr. Marburger?

Dr. MARBURGER. Well, I knew a lot about the old Bell Labs and it would be hard to replace it, but times have changed and it's true that those labs have lost a good bit of their basic research flavor.

So, the mantle has fallen to government labs and university-based facilities and the three agencies that have been highlighted in the American Competitiveness Initiative and the America COMPETES Act all operate facilities that have some similarities to the function of the old Bell Labs.

So, for example, NIST operates one of the premier neutron research facilities, a user facility, that's used by thousands of people, including industry, especially industry, to do their materials work. The Department of Energy operates a number of laboratories with facilities and now nanotechnology and materials centers that do in fact perform some of the functions that Bell Labs and other industrial group research labs of the past used to fill.

I believe this is an important function of the Federal Government and I believe that funding of these competitiveness initiatives is very important to foster the growth of these labs and their quality and ability to compete with other countries.

Senator KLOBUCHAR. But if we believe this, why aren't we putting the funding into it?

Dr. MARBURGER. Well, the President has requested funding for these facilities for the NIST core budget, for the National Science Foundation, for the Department of Energy, Office of Science, for 2 years now. This is the third year, but unfortunately for reasons I think that are certainly beyond my control, the Congress has failed to fund the budgets of these important agencies at the levels requested.

I think it is important. I know this committee has—it's not the fault of this committee. This committee has been very supportive of these increases and I look forward to working with this committee to try to make it a positive change in the future.

Senator KLOBUCHAR. Do you think the America COMPETES Act is also important? As we talk to these Nobel Prize winners, they talked about how their education early on was so important to them and their Congress authorized $115 million, but the President only put forward $11.6 million, as I understand it, in his 2009 budget.

Dr. MARBURGER. It's certainly true that the—well, first of all, yes, I believe the COMPETES Act is important, and I believe that it establishes important principles and priorities that need to be addressed now and in the future.

With respect to the President's request, the President is requesting substantial amounts and the President's request for 2009 would fund the authorization levels of the COMPETES Act at a higher percentage than the 2008 Omnibus bill did.

Senator KLOBUCHAR. And what percentage would that be of $115 million?

Dr. MARBURGER. I think I actually had the numbers here. The President's budget funds 85 percent of the authorized level and in the Omnibus bill, the Congress funded the Act at 82 percent of the authorized level.

Senator KLOBUCHAR. But how come the President would put right when this bill passed and he supported it in the 2009 budget only $11.6 million?

Dr. MARBURGER. Well, there is often a difference between appropriated levels and authorized levels. The authorized levels tend to be more ambitious and I think appropriately so. When all of the dust settles on the budget, when the capacity of the discretionary budget to fund programs is assessed and the budget finally comes out, it has these realities built into it.

I do think it's significant that increases for these key agencies are very substantially above the entire growth of the discretionary budget and even other parts of the science budget. So, I think the President is acting in good faith here and doing everything he can to get funds into these facilities.

Senator KLOBUCHAR. But Dr. Marburger, just to give these statistics, I'm sure you're familiar with, in 2004, China graduated more than 600,000 engineers and India graduated over 350,000 engineers and in our great country, we only produced 70,000 engineers.

Do you think the President's funding priorities do anything to remedy that situation?

Dr. MARBURGER. Absolutely. I think the President's requests under the America COMPETES Act and the American Competitiveness Initiative do address those issues by investing in science and investing not only in the facilities and in the basic research that's attractive and that draws people into this area but also in a number of other areas, including education, immigration policy, and tax incentives for industry to invest in these areas.

Senator KLOBUCHAR. For instance, China and South Korea have boosted their government research by 10 percent or more annually. Are we doing enough to maintain? When we look at what's going on around the world and how we seem to be losing out with some of these technological developments, whether it be scientific research, with stem cell research that the President has a different view on than many in this Congress, or whether it is about looking at this kind of research?

I look at some of the things we've seen in our own state and I have seen a change in the kind of research funding. We've lost several researchers to other countries because of the lack of funding.

Dr. MARBURGER. Well, the President is requesting a 14 percent increase for the National Science Foundation and a 22 percent increase for NIST core operations compared with the previously enacted budget.

I don't think—I think these compare favorably with 10 percent increases, and I hope that Congress is able to pass these appropriations bills that fund the request.

There's no question that the President wants to invest aggressively and in accordance with priorities that are clear to preserve our competitiveness far into the future.

Senator KLOBUCHAR. And then I had a few questions for you, Dr. Bement. As you may know, the legendary Seymour Cray, the father of supercomputing, founded Cray Research in my state of Minnesota in 1972, and today Cray, although based in Washington state, maintains a strong presence in Minnesota and they continue to build large supercomputers for the government.

What has the National Science Foundation done in the last few years to strengthen the role of supercomputing as a key enabler for advancing the frontiers of science and engineering?

Dr. BEMENT. Thank you. Senator, first of all, we have provided ongoing support for three national supercomputing centers under our major program for that purpose, but we're now recognizing the need to go to a much higher level of computation. We're investing in teraflop-type machines and also petaflop. Now that's the number of operations per second. We're talking about trillions of operations per second.

We recognize that we also have to replace machines that are becoming obsolete. So, in addition to soliciting proposals for new centers, we're also keeping existing centers up to date.

We now have an award to develop a petaflop machine at the University of Illinois. We have an award at Texas for a ranger-type machine that will operate high in the teraflop regime and also one at Oak Ridge through the University of Tennessee.

These machines rank very, very high relative to the very high-end machines in the world today. Most of these are in the top 10.

We're well ahead of the Japanese machine that created a big stir about 5 years ago.

So, first of all, I think we're keeping up in the technology. I think we're serving the broad science and engineering community at large, and I think we're also coupled very well with industry, especially the supercomputing industry, in pushing the technology envelope to be sure that that industry remains competitive.

Senator KLOBUCHAR. Thank you very much. Appreciate it.

Dr. BEMENT. You're welcome.

Senator KLOBUCHAR. Senator Kerry.

Senator KERRY. Thank you very much. There is also not one area of ocean in the world that is not suffering consequences of development, pollution, change of one kind or another. Every major fishery in the world is in extremis and we face enormous challenges with respect to the ocean ecosystem.

Most of the money, as I can determine it, in the proposed Climate Change Science Program budget seems to be directed at space-observing systems.

I wonder if you could share with us your thinking about the focus, the priority, what priority is CCSP putting on ocean research at this point?

I might add, as a 20-year whatever plus veteran of this committee and I served at one point as the Ocean Subcommittee Chairman, the great struggle in producing adequate fisheries laws in our own country is lack of adequate science and the captains and the fisheries are all complaining that there isn't adequate science knowledge on stocks and so forth.

So, help us, if you would, to understand how we square this space versus ocean research.

Dr. MARBURGER. Well, both space-based and land- or ocean-based instrumentation are important to do the science. The advantage of space-based observations is that they do enable you to see everything and scientists are becoming more and more clever in how they can extract information from space-based observations, such as looking at the color of the water and detailed measurements of height and wavelength properties and various radiations from the ocean.

But it is necessary to have instrumentation out there and there has been an effort to provide more ocean-based instrumentation. NOAA has a program on this. Dr. Bement might be interested in commenting on what NSF is doing there, but it is true that you have to have both. In a way, it's less expensive to put buoys and various other kinds of equipment in the ocean, but it only samples a very small fraction of the ocean environment. So, both are important.

The President is funding some critical earth-observing systems in his proposal. These are systems that have been well planned and I think likely to be very successful in achieving their scientific objectives. The president is also asking for, as I mentioned in my remarks, a $102 million for ocean science and research at the three agencies, NOAA, NSF and USGS.

I'd be glad to provide more detail on that in written testimony, but there is an effort to cover these areas in this budget request,

and I certainly agree with the importance of these programs for climate science.

[The information requested to follows:]

EARTH OBSERVATIONS

Research and Development Funding in the President's FY 2009 Budget

The U.S. supports space-based, airborne and ground-based instruments to observe, monitor and measure a multitude of the Earth's characteristics around the globe. The President is committed to optimizing these scientific efforts by developing sustained and integrated Earth Observation systems for the Nation and by making these systems an integral part of a global system. The 2009 Budget includes:

- Funds to sustain the highest priority climate measurement capabilities that once were part of the tri-agency National Polar-orbiting Operational Environmental Satellite System (NPOESS) program (but were removed or "de-manifested" during the 2006 restructuring of NPOESS in response to significant NPOESS cost over-runs). This operational climate sensor package will be supported with $74 million in FY 2009 funds requested by the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA).
- $103 million in FY 2009 (with a total of $910 million over 5 years) for the National Aeronautics and Space Administration (NASA) to embark on a series of space-based Earth observing missions that the National Research Council's recent "decadal survey" ranked as the top priorities for Earth sciences, including: (1) SMAP (Soil Moisture Active/Passive), which will enable global soil moisture mapping with unprecedented resolution, sensitivity, area coverage, and revisit times; and, (2) ICESat (Ice, Cloud, and land Elevation Satellite), the benchmark Earth Observing System mission for measuring ice sheet mass balance, cloud and aerosol heights, and land topography and vegetation characteristics. NASA will also continue ongoing work to develop and launch seven new Earth observing missions in the next several years while operating fourteen missions presently on orbit.
- $139 million for NASA to procure the LandSat Data Continuity Mission to continue the 35-year record of land imagery from space critical to Earth Observations data continuity.
- $2 million for the U.S. Geological Survey (USGS) to establish a National Land Imaging Program office to ensure long-term continuity of multi-spectral imaging of the Earth's surface, consistent with the recommendation of the Interagency Working Group on the Future of Land Imaging.
- $126 million for NASA to launch the Global Precipitation Measurement (GPM) mission core spacecraft no later than 2013.
- $21 million to support the NOAA-led Integrated Ocean Observing System and a total of $10.5 million for the National Science Foundation's (NSF) Ocean Observatories Initiative.
- Improvement of U.S. earthquake monitoring and prediction capabilities by NSF and USGS through EarthScope at $26.3 million and the Advanced National Seismic System at $8 million.

Senator KERRY. What I'd like to ask, if I may, is that you provide as a component of the May Climate Change Assessment, if you would include in that a section on the oceans in terms of the ecosystem understanding as it is today in terms of climate and so forth.

Dr. MARBURGER. I think there is a provision for that and I'll check.

Senator KERRY. OK. Dr. Bement, do you want to add to that?

Dr. BEMENT. Yes, I can briefly characterize NSF's contributions to climate change.

Our overall budget is about $221 million in the 2009 request, but it doesn't include everything. In our major facilities programs, we have five major facilities that are contributing to global climate

change research and if you wish, I can go over those, but I could also provide it for the record.

We're quite active in ocean drilling, primarily because by drilling down into the ocean bottom, we can track weather back five million years and look at cyclical events due to the various ice ages and other disruptions.

A lot of our program is focused in the polar regions, primarily because there is more fresh water that is going into both the Southern Ocean from Antarctica but also from the Arctic Ocean in the Arctic Region.

This fresh water not only affects the ecosystem and also fish migration but it especially affects the overturning circulation from the equatorial regions to the northern latitudes and so it could lead to disruptive weather events in the future.

In addition to that, we're quite concerned about the ice sheets in Greenland and also in the Antarctic. These are cold sinks for the earth. They do regulate and moderate the upper and lower temperate regions. But those ice sheets are receding. We need to understand that. And a lot of our research is in cooperation with NASA. NASA does earth-sensing. We do ground truth. We try to help them calibrate and validate their results.

One measurement that we're very much interested in is being able to measure volumetric change in these ice sheets. NASA does have the ability to help us with those measurements and so this is another joint effort with NASA.

We work very closely with NOAA and the Ocean Research Priorities Plan, and you mentioned some of the areas of concern. We are interested in the health of coral reefs because of the acidification of the oceans. We are interested in the impact of violent storms on coastal regions. We're developing advanced sensor technology and advanced observational systems that will assist in ocean measurements and these are just but a few of the things that we're doing in the general area of ocean science but also in climate change research.

Senator KERRY. Do you feel as if there is an adequate budgeting and effort being made with respect to the ground-based/ocean-based research effort itself?

Dr. BEMENT. We have consistently increased our effort in this area. I think that we're hitting most of the grand challenges at the present time.

I might indicate that the work that we have supported over the years in climate modeling, especially at NCAR but also at other universities, was recognized by the Nobel Peace Prize this year through the Intergovernmental Panel on Climate Change. So we have some very good people working in this field.

Senator KERRY. But is it adequate?

Dr. BEMENT. I think it's adequate at the present time, yes.

Senator KERRY. Could you please include for the Committee record those five areas and the breakdown of that current level of effort? I think it would be helpful. I would appreciate it very much.

[The information requested to follows:]

NATIONAL SCIENCE FOUNDATION

Five Major Efforts on Ground-based Ocean Research, Especially as Related to the Effects of Climate Change

Major Efforts in Ground-based Ocean Research Related to the Effects of Climate Change

	Estimated FY 2008	Estimated FY 2009
Integrated Ocean Drilling Program (IODP) Operations, Management and Science Support	$46 M	$54 M
Remote Sensing of Ice Sheets	$23.75 M	$23.75 M
Ocean Research Priorities Program (ORPP) Support for 4 Near-Term Priorities: Sensors for marine eco-system observations Comparative analysis of marine eco-system observations Atlantic Meridiolan Overturning Circulation Coastal Eco-system Response to Extreme Events	$5 M	$17 M
Ocean Acidification: Biological & Chemical Effects	$3 M	$3 M
Impact of Violent Storms in Coastal Regions in addition to ORPP support	$1.25 M	$1.25 M

These five major ground-based efforts in ocean research, described below, will observe and provide insight into the effects of climate change on the oceans.

Integrated Ocean Drilling Program

The Integrated Ocean Drilling Program is an international research program that explores the Earth's history and structure as recorded in seafloor sediments and rocks. IODP seeks to enhance understanding of the deep biosphere, environmental change processes and effects, and the solid earth and geodynamics.

Observation and Remote Sensing of Ice Sheets

The Intergovernmental Panel on Climate Change (IPCC) identified the response of ice sheets to climate change as one of the largest unknown factors in sea-level change. Often in collaboration with other agencies, NSF supports extensive efforts to understand the causes and implications of changes in the earth's great ice sheets in Greenland and Antarctica. NSF's Arctic Observing Network is being implemented in coordination with other countries' efforts to better understand the ocean's role In Arctic climate change.

Ocean Research Priorities Plan

Under the leadership of the Joint Subcommittee on Ocean Science and Technology, recommendations for a "coordinated and comprehensive national ocean research plan serving societal needs" were developed—the Ocean Research Priorities Plan (ORPP). Initial ORPP support is directed toward four near-term priorities: sensors for marine ecosystem observations, comparative analysis of marine ecosystem observations, Atlantic meridional overturning circulation, and the coastal ecosystem response to extreme events.

Ocean Acidification

As the concentration of carbon dioxide in the: atmosphere increases, CO_2 is absorbed by the world's oceans resulting in acidification of the water. NSF supports research to understand the impacts of this shift in water chemistry, which has the potential to significantly impact many marine organisms including corals.

Impact of Violent Storms on Coastal Regions

As seen with Hurricane Katrina, violent storms can have tremendous impacts on coastal regions. NSF is supporting efforts to both understand and mitigate against the impacts of storms on our coasts.

Senator KERRY. With respect to the appropriations themselves, let me just comment on one thing, Dr. Marburger. Incidentally, just for the record, while Congress "didn't provide the funding," I want to assure you they wanted to and it was the President's refusal to go along with it and the threat of the veto and so forth that precluded those numbers from being added. So, the record needs to

show that, you know, Congress was prepared to do more but again the administration chose a lower level and, indeed, I want to follow up on that a little bit.

We had votes in the last session in the House and the Senate on this appropriations bill and we put the funding level at or above the President's 2008 budget request for NSF. NSF received, I think, $364 million below the President's request.

So, it's my understanding that as a result, a number of activities are not going to proceed that we would have proceeded with, obviously, and I know you expect the impact of those cuts to be somewhere in the vicinity of a thousand fewer research grants awarded, 230 fewer graduate research fellows hired, and several major solicitations delayed for at least a year, including in the areas of computer science, cyber-infrastructure, mathematics and physical sciences.

So, can you summarize, give a little color and describe sort of the impact of these reductions in terms of those particular programs, NSF programs?

Dr. BEMENT. Let me touch on the workforce issues. The demand for highly trained STEM graduates for not only industry but national laboratories and aerospace, is growing at the rate of about 5 percent a year. Degree production is only growing at the rate of 1.5 percent a year.

A recent article indicated that in the aerospace industry alone, 60 percent of the workforce is over the age of 45 and we're now entering an era where the baby-boomers are beginning to retire. So, we're at risk of hollowing out our major defense industries and some of our major Federal laboratories of very top talent, especially in the physical sciences and engineering, but most critically in computer science and engineering.

There are many other opportunities for those graduates in the private sector. So, when you focus on our research budget, it's important that we all recognize that it's through research that we train our graduate students. They do the research and then they go out into the private sector and they become the entrepreneurs, they become the scientific and engineering workforce necessary to support our economy.

So, when you look at a thousand research grants that aren't going to be funded, it's not just a thousand ideas that aren't going to be explored that could be very transformative, it's the 1,500 graduate students and undergraduate students that are not going to be supported. It's the younger faculty members that are just getting started in their career that are not going to be supported. That is the major impact.

Yes, there are programs that had to be cut back. There are programs that have to be delayed or deferred. There are some impacts at some of our major university centers where they're having reductions in force, but the critical thing is looking ahead over the next 10 years and providing the national STEM workforce that we critically need.

Senator KERRY. So, we're sort of choking off the future in a sense.

Dr. BEMENT. I think that's the concern.

Senator KERRY. What's your attitude, all of you, about the possibility of a supplemental to try to restore the ACI levels?

Dr. BEMENT. I think it's critically important.

Dr. TURNER. And Senator, may I add, too, that there were some significant impacts at NIST, also, and they fell into three different categories.

One was lost opportunities. There were things that we wanted to do to advance, measurements in detection of things that industry could use to fully exploit nanotechnology that we were not able to do.

We were not able to do work in developing quantum computing which would take us to the next generation of computer use.

We also had an initiative in climate change that we were unable to do.

In addition, there was work on earthquake mitigation in disaster resilient communities and in communities to help reduce the risk and the consequences of communities impacted by hurricanes, floods, wildfires, and so forth. We were unable to do all of that and in areas like the nanotechnology that gave our competitors abroad a year to close the gap between us and them.

We were also unable to bring on 300 researchers who were going to implement those programs.

Second, we were unable to keep up with salaries and benefits for our scientists and so what that amounted to was 71 positions that we were unable to fill as people left or retired.

We also had to reduce funding for R&D for the next generation of computer chips and semiconductors. We also had to cancel the program that would deal with cancer detection and, finally, we had to curtail work on industrial control systems which would help protect our infrastructure, things like communications, electric power, and so forth.

And finally in the construction area, in order to keep the construction projects at the Neutron Center and at Boulder on track, we had to cut back on the maintenance for our decaying infrastructure, both in Gaithersburg, where the campus is 40 years old and in Boulder the campus is 50 years old.

So, again I wanted to assure you that there were some very significant impacts at NIST, also.

Senator KERRY. I'm not sure I feel good about being assured of that but glad to have the record clear on it. I appreciate your comments.

Dr. Marburger, you wanted to comment?

Dr. MARBURGER. And I can speak for the Department of Energy, it's not under the purview of this committee, but there were also serious impacts at Department of Energy, Office of Science, laboratories, layoffs, curtailment of projects, curtailment of operation of key facilities for the Nation's research infrastructure, and these are serious.

Senator KERRY. You know what I'd like to ask each of you to do is to submit to us, if you would, for the record an honest and best judgment of the reality of these impacts, so that I could help use those with the full committee in order to try to figure out how we might proceed with respect to the process in the next months here.

[The information referred to follows:]

National Science Foundation

[Impacts of the FY 2008 Appropriations]

NSF Request:	$6,429.00 million	
Difference:	$−364.00 million	
NSF Appropriation:	$6,065.00 million	
Major Reductions from the FY 2008 Request:		
Research & Related Activities account	$310 million	(−6.0%)
Education and Human Resources account	$25 million	(−093.3%)
Major Research Equipment and Facilities Construction account	$24 million	(−099.8%)
Major Impacts:		
• 1,000 fewer new research grants		
• 230 fewer Graduate Research Fellowships		
• 3,000 fewer people (senior faculty researchers, graduate students, post-docs and undergrads) involved in NSF activities		
• Several major solicitations and new facilities delayed for at least a year, and some existing facilities reduced		
• Participation in the interagency Ocean Research Priorities Plan reduced by $12 million (to a total of $5 million)		
• The Major Research Instrumentation program reduced by more than $20 million (to $94 million)		
• Startups of several planned centers and activities deferred, including McMurdo operations and maintenance and South Pole Station upgrades		

FY08 Omnibus ACI Research Cut Impacts

DOE Office of Science: Increased funding provided in President's ACI request was cut by 91 percent, or $548 million, after removing earmarks

- Impact on Scientists, Engineers and Education
  - Layoffs of about 210 Ph.D.'s and 40 graduate students at National Labs.
  - Roughly, an additional 520 Ph.D.'s and 240 graduate students will not be hired or supported at National Labs because the request to fund competitiveness was denied.
  - Eliminates funding proposed for 700 peer-reviewed energy research grants related to a secure energy future, hydrogen storage, solar energy, superconductivity, advanced nuclear energy systems, etc.
  - Impact on DOE Science
- Zeroes U.S. contribution to ITER, the largest, highest visibility international collaboration in science, designed to be an essential step toward practical carbon-free power generation from nuclear fusion and major long-term solution to climate change.
  - Reduces operations by 20 percent of all light and neutron facilities, and nanoscale science research centers, critical to discovery in energy, nanotechnology, biotechnology, health, and materials science.
  - Delays completing instruments at the Spallation Neutron Source and Linear Coherent Light Source, jeopardizing U.S. global competitiveness in materials S&T in energy, telecommunications, manufacturing, transportation, information technology, biotechnology, and health.
  - Slows construction of the National Synchrotron Light Source-II, preventing capability of new X-ray measurements that will enable new discovery and innovation.
  - Reduces International Linear Collider funding by 75 percent, undermining the credibility of the U.S. as a potential site and particle physics leader, and severely damaging the high energy physics program.
  - Prevents basic research essential to advanced nuclear power systems and reprocessing.

NSF: Increased funding provided in the President's ACI request was cut by 77 percent, or $397 million

- Impact on Scientists, Engineers and Education
  - 230 fewer student scientists supported by Graduate Research Fellowship program.
  - 1,000 fewer basic research projects.
- Impact on NSF Science
  - Nanotechnology research cut $12 million below FY 2007.
  - Supercomputing and advanced networking cut $64 million below President's request.
  - Climate Change Science Program cut below FY 2007.

NIST: Increased lab funding provided in the President's ACI request was cut by 65 percent, or $67 million, after removing earmarks

- Impact on Scientists, Engineers and Education
  - Removes 300 positions for new scientists and engineers working at NIST and throughout the Nation.
- Impact on NIST Science
  - Eliminates proposed funding for advanced measurement and characterization tools needed by industry to fully and safely exploit the tremendous potential of nanotechnology, which will impact in materials, electronics, pharmaceuticals, the chemical industry, aerospace, and healthcare.
  - Significantly cuts proposed funding for quantum computing research that will fundamentally alter a number of fields including secure communications (relevant to both the national security and financial communities) and supercomputing.
  - Curtails improvement of the accuracy of climate change predictions, providing policymakers with accurate information about the advantages and consequences of various policy options.
  - Denies proposed increases for development of improved building standards, codes, and hazard and forecasting metrics for our national infrastructure to proactively reduce disaster-imposed losses (estimated at $52 billion a year from hurricanes, tornadoes, storm surges, fires, earthquakes, and tsunamis).

And let me just ask you. If that money were to be restored, how fast can you get back up to speed? Is it possible to meet those expenditure levels and those grant levels in the 2008 cycle?

Dr. BEMENT. Senator, let me respond this way. I much prefer ramp functions than step functions.

Senator KERRY. Say that again.

Dr. BEMENT. I much prefer ramp functions.

Senator KERRY. Ramp-up.

Dr. BEMENT. Ramp-up, yes, than step functions. To keep on the doubling path, the 13 percent increase or 14 percent increase represents a very big step. It would be much better and would be a much more stable way of investing those funds if it were a ramp function, if we did it in two steps rather than one.

Since we——

Senator KERRY. Meaning what specifically about the 2008 cycle? Translate that.

Dr. BEMENT. That means if there was an emergency supplemental, it would come at the right time to keep continuity in our programs.

Senator KERRY. Fair enough.

Dr. BEMENT. We're an agency that does not do its own research. Ninety-five percent of all of our funds go to the universities and

we're very agile. We could get a lot of grants funded because we have a lot of proposals coming in all the time.

The reason that's critically important is that with the 2008 Omnibus appropriation, it represents about the fifth year in a row that overall funding for colleges and universities in the United States has declined. It's the first time in 25 years. I think it's critically important we turn that around and get it back up on a positive slope.

Senator KERRY. I couldn't agree with you more, and we'll certainly commit to trying to do everything we can to see if we can turn that around.

As you know, the Noyce Teacher Scholarship Program authorized significant increases, we did anyway, for that program.

Tell us about the less-than-robust increases in that program measured against the rhetoric regarding the STEM Education.

Dr. BEMENT. Senator, we like the Noyce Program. First of all, I was a personal friend of Robert Noyce, so I like it for that reason. But we also like it because under the America COMPETES Act, it is designed after the UTeach Program that we initiated some years ago. So, we're very familiar with the provisions under the COMPETES Act.

It's a relatively young program. It started—it was first authorized in 2002, I believe. We got our first grants out a year later, and we started immediately in developing a measurement system and also a baseline assessment program to assess the program in 2005. That assessment has been underway over the past 3 years. We expect to see the results in December of 2008.

As you may know under the Deficit Reduction Act of 2005, we set up the American Competitiveness Council. One of the provisions in the Act was that there needed to be more rationalization of all the math and science programs among the various agencies to eliminate overlap, but more importantly, every program has to be assessed to be effective through an independent rigorous assessment before the funding can be increased. So, we're limited by that provision.

Senator KERRY. Limited in the amount it could be increased now?

Dr. BEMENT. We can't——

Senator KERRY. Despite the authorization? I mean, we authorized spending something like a $115 million and you all have only funded it up to $11 million. This is the Noyce-specific——

Dr. BEMENT. No, that's the reason why it isn't funded up to that level, because it hasn't been fully assessed yet. It hasn't been shown to be effective yet.

We will reach that point near the end of the year and we'll be able to also carry out some pilots in 2008 against the America COMPETES Act, so we'll be in a much stronger position to ramp that program up substantially in the 2010 budget.

Senator KERRY. Well, that's good to hear. I mean, do you think it would get then to the authorized level in representing the kind of commitment we really ought to be making to that? I mean, I gather from your comments you would agree that that's certainly one of the most important things we can do, is get these K–12 and,

you know, educators in a position where they can take those STEM——

Dr. BEMENT. Well, we'll certainly advocate for it as strongly as we can and, as you point out, one factor that has been shown most effective in improving performance in math and science education is having teachers who are well versed in the subject matter.

It's important for us to understand under the Noyce Program whether taking STEM graduates and teaching them pedagogy or taking students in education and giving them formal training in STEM actually achieves what we hope to achieve through the program, and whether it does in fact improve performance in math and science. I'm very optimistic that it will, but we don't have the evidence yet.

Senator KERRY. What proportion of this budget is being dedicated specifically to the National Nanotechnology Initiative?

Dr. MARBURGER. I have, Senator, I have some numbers associated with that. The National Nanotechnology Initiative overall budget is approximately $1.5 billion in this request. I don't know what—I can't calculate right away what fraction of the research budget that would be. It's distributed among the various categories of basic and applied. It's distributed among a number of different agencies, but it is an important priority program and it is one of the programs that would benefit from the funding under the COMPETES Act and the American Competitiveness Initiative.

The agencies that have been singled out under this initiative are key agencies. NSF is actually the lead agency in that initiative and it's doing well.

Senator KERRY. Dr. Bement, do you know specifically how much is dedicated toward researching the environmental health and safety risks that some people are now talking about with respect to nanotechnology?

Dr. BEMENT. Yes, in our budget, we've always designated 7 percent of our total budget to focus on education health and safety issues as well as ethical issues associated with nanotechnology.

In both our 2008 and our 2009 requests, we increased the funding for those areas because we now have additional centers that are focused on education health and safety and we also have crosscutting interagency cooperations with regulatory agencies, like EPA and also with the National Institutes of Health.

So, in our 2009 request, the amount in that account is somewhere on the order of $30 million for education health and safety.

Senator KERRY. $30 million?

Dr. BEMENT. About $30 million.

Senator KERRY. Dr. Marburger, both of you perhaps or all three of you. What kind of concern is there, what kind of effort is being made with respect to that? Are these increasing questions that are being raised with respect to health, safety, the environment, et. cetera, legitimate in your judgment? Do they concern you, and does it require greater effort perhaps to understand the synergy between those impacts and the products themselves?

Dr. MARBURGER. Sir, these issues do concern me. I do think they're important. We have to pay attention to them and try to bring the field along at a rapid rate so that these issues can be addressed appropriately.

This is a high-profile issue not only with health and environmental advocates but also within our administration and in the industry because they see potential of public concern about nanotechnology-based products as possibly leading to public non-acceptance of some of these products. So, there is a great deal of interest in doing this.

One of the important features of research on health impacts particularly, but also environmental impacts, is our ability to characterize the nanoparticles that are being made either as byproducts or as components of products and this is one of the reasons that NIST contributions are so important. We do rely on NIST to establish standards and techniques for measuring nanoparticles and nanomaterials and the absence of techniques for doing this does slow the pace at which the health research can be done.

So, I know people have called on more aggressive funding for this area. I believe that it's the most rapidly expanding part of the National Nanotechnology Initiative and that's healthy, but it has to grow together with our knowledge of how to manipulate these materials.

So, I'm satisfied it's getting the attention that it deserves. I wish it could go even faster, but we have to let it grow. I don't know what the percentage is over the entire program, but it certainly is growing very rapidly.

Dr. TURNER. I'd like to—thank you. And I'd like to thank Dr. Marburger for mentioning NIST's role in this. You will notice that one of our initiatives for 2009 is increased funding for this specific mission of ES&H studies of nanotechnology and so our role is going to be to not only establish measurement techniques but also to establish the ways that you measure, characterize with respect to length, size, purity and so forth of nanoparticles.

We put out standard reference materials for nanotechnology and so we've been working very closely with an interagency group, with agencies such as NIH and FDA and OSHA—I'm sorry—EPA, rather, to be able to turn over to them, ways that they can characterize these particles so that then when they do their studies of potential health impacts, they will be able to say, with certainty that, it was because of this or that or yes, that something is safe, but the point is—before you can study something, you need to have a rigorous definition of what it is that you're looking at and we're providing that.

Senator KERRY. Yes, sir?

Dr. BEMENT. I can't help but take advantage of Jim being here to indicate that we have a joint program with NIST in the area of characterization.

It's very important to understand surface activity of these particles in order to understand how they might interface with living systems, but having now focused on synthetic nanoparticles, it's also critically important to understand the activity of natural nanoparticles as well because some natural particles, due to soot, dust and other sources, can actually have more chemical activity, more surface activity than synthetic nanoparticles. So, it's important to do the comparative studies as well as just focusing on the synthetic nanoparticles.

Senator KERRY. Well, that makes sense. I appreciate that. The authorization expires at the end of this year which raises the great likelihood we're going to confront the reauthorization before too long here.

Any thoughts as the Committee does that, besides the safety issue, what we might want to be thinking about? Dr. Marburger?

Dr. MARBURGER. This is a program that's received a lot of attention and there is good bipartisan support for it. The agencies are not reluctant to spend their budget money, what they do have, on this area, and it has a structure, committee structure, that allows for interagency participation.

In fact, there are quite a lot of structure, reporting requirements and so forth associated with this program because of the interest and I think my plea would be to not to add additional structure, that if changes are made to the structure they be made in a way so as not to increase the reporting requirements and the complexity but either to decrease it or make changes that may be appropriate and would be recommended in hearings and testimony and so forth.

Senator KERRY. Well, we may look to you further as we get into that process. We look forward to it.

Last question, perhaps a couple. Dr. Bement, your budget, as we mentioned, falls $472 million short of the target established under the COMPETES Act.

Can you tell us what programs as authorized under the COMPETES Act were deemed as expendable under the request as it has been met by the administration?

Dr. BEMENT. If I understand the——

Senator KERRY. Well, what makes up the gap? What constitutes the gap in the $472 million, $479 million, I guess, $470?

Dr. BEMENT. Well, OK, let me go back to last summer after the COMPETES Act was enacted. We started immediately establishing working groups to determine how quickly we could comply with many of the sections and provisions under the Act. Some of those we are in compliance now that had to do with practices and policies.

Others, we need to discuss with the National Science Board, but with regard to the new programs and also the largely expanded programs, such as Noyce, it will take us some time to do the planning and also to test some of these programs to see the extent to which we can either incorporate them as part of our ongoing programs or leverage them with some of our ongoing programs, especially our scholarship program, and we have pilot plans—pilot programs planned for fiscal 2008 and going into 2009 to test some of these concepts.

We want to be sure that when we scale them up to the level of the COMPETES Act, that they're effective, that they will have good outcomes, and that they will, to the greatest extent, leverage off of ongoing programs, so that we can get the largest output or the largest outcome from the investment.

So, we take the America COMPETES Act quite seriously. We're moving quite aggressively, but as I indicated earlier, I tend to favor more ramp functions than step functions and we're trying to do this in a systematic way.

Senator KERRY. Well, I don't blame you for that. I think obviously having administrated an agency before, smaller, much, much smaller, but I remember as we got our budget increases, it certainly makes a difference to be able to manage them effectively, both in terms of personnel as well as policy. So, I understand that.

I do, however, reiterate, as I think most of the members of this Committee do, that we want all of these agencies and our country to be ramping up at a faster rate and the ramp can be steeper and it's clear that this is sort of dangerously exposing a gap between the rhetoric and the reality of the challenge and I think that's where a lot of people are increasingly frustrated.

I'm sure you all agree with that, so I'm not going to belabor it. Our hope is to be able to try to find ways to augment this over the course of the year. I am pleased that the chairman of the Budget Committee's budget at least frames a budget resolution that will help us do that. Hopefully the appropriators will follow through that in the appropriate way afterwards.

So, this is a must do for us, as you all know better than anybody, and I know you're preaching that and I don't need to preach to the choir, but it just can't be reiterated enough how critical this is to our long-term economic status.

So that said, we really appreciate your being here today. Thank you for highlighting these areas of the budget. Thank you for your candor about those areas that will be impacted. We look forward to getting from you the detailed sort of analysis of that because it will help us greatly to be able to go at the budgeters and do the work we need to do.

So, I'm grateful to you. We'll leave the record open for a couple weeks here for colleagues on the Committee who may have questions or any additional questions, and we thank you for your cooperation very, very much.

We stand adjourned.

[Whereupon, at 11:45 a.m., the hearing was adjourned.]

A P P E N D I X

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

Mr. Chairman, thank you for holding this hearing today on the important role of basic research.

The importance of basic research cannot be underestimated. Each day, our global interconnectivity increases through competition in the marketplace. In order to remain competitive, the United States must continue its efforts to lead in the field of innovation. By maintaining our role as a leader in technology and innovation, we ensure better jobs and a higher standard of living for all Americans. Basic research remains a key component to continued innovation and increasing the United States' competitiveness in today's economy.

Because of groundbreaking basic research at NSF, NIST, the Department of Defense, and many other Federal agencies, technologies that could only once be imagined, are now realities that we use every day. In each case, basic research investment by the Federal Government was an essential prerequisite. This type of research is crucial in laying the groundwork for the private sector to develop the innovative products that have revolutionized how we live on a day-to-day basis.

Last August, the President signed into law the America Competes Act. This law shares the goals of the President's American Competitiveness Initiative (ACI), a comprehensive strategy to keep America the most innovative nation in the world by strengthening our scientific education and research, improving our technological enterprise, attracting the world's best and brightest workers, and providing 21st century job training. I am proud to have been an original cosponsor of that important piece of legislation.

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

Introduction

Mr. Chairman and members of the Subcommittee, thank you for the opportunity to submit written testimony on the President's Fiscal Year (FY) 2009 research and development (R&D) budget request.

The American Association for the Advancement of Science (AAAS) is the world's largest multidisciplinary scientific society and publisher of the journal, Science. AAAS was founded in 1848, and includes some 262 affiliated societies and academies of science, representing 10 million individuals.

For more than 30 years, the AAAS R&D Budget and Policy Program has strived to be a comprehensive, reliable, and impartial source of information on the Federal investment in research and development. AAAS recently released its analysis of R&D in the FY 2009 budget request, and the numbers presented in this statement reflect that analysis.

Overview

AAAS believes strongly in the importance of a broad, balanced portfolio of R&D investments. The need for strong support across all scientific fields comes both from the increasing interdependence of engineering, physical, biological, behavioral, and social sciences, and from the importance of all these fields to innovation and the growth of the economy, as well as to the improvement of the health and quality of life of all Americans.

The President's FY 2009 budget proposal would increase funding for three key physical science agencies as part of the American Competitiveness Initiative (ACI), and we are pleased by the continued emphasis on investing in basic physical science research. However, we are at the same time concerned that funding would stay constant or even decrease in other agencies and disciplines, like the biological, behav-

ioral and social sciences, which also are critically important to innovation, the economy and the quality of life of all Americans.

The overall Federal investment across all fields of R&D would increase $4.9 billion or 3.5 percent over FY 2008 levels to $147.4 billion (see Table 1). However, this is driven primarily by increases in *development* funding for defense weapons and NASA spacecraft. Federal investment in *basic and applied research,* the vital feedstock for innovation in the U.S. economy, would in fact decline 0.3 percent to $57.3 billion.

The proposed FY 2009 budget continues to provide increases for the three physical sciences agencies as part of the administration's ACI vision of doubling between 2006 and 2016 the budgets of the National Science Foundation (NSF), the Department of Energy (DOE) Office of Science, and the National Institute of Standards and Technology (NIST) laboratories. These three agencies lead the pack in R&D gains, followed closely by proposed gains for development programs in DOE, NASA and the Department of Defense.

The increases for those key agencies, however, are partly offset by flat funding for biomedical research and cuts to key environmental and agricultural R&D agencies. Looking at the funding pictures in longer-term perspective, in inflation-adjusted terms, total Federal investment in basic and applied research would fall for the fifth year in a row for a decline of 9 percent between 2004 and 2009.

Agency Analyses

In this section, AAAS will highlight a few key points in the budget request for agencies under the subcommittee's jurisdiction:

National Science Foundation (NSF): Overall, AAAS is very pleased with the proposed increase for NSF's programs in FY 2009, a 13.6 percent increase that would bring the total budget to $6.9 billion. NSF's R&D investments (excluding education, human resources, and overhead spending) would total $5.2 billion, a 15.5 percent increase, and an all time high in real terms.

The 2009 NSF request clearly favors the physical sciences (see Figure 1), with requested increases approaching 20 percent for three key directorates: Mathematical and Physical Sciences (MPS, up 20 percent), Engineering (ENG, up 19 percent), and Computer and Information Science and Engineering (CISE, up 20 percent). The Biological Sciences (BIO) directorate would increase 10 percent, Geosciences (GEO) 13 percent, and the Social, Behavioral and Economic Sciences (SBE) 9 percent. NSF's education and human resources (EHR) programs would gain 9 percent to $790 million. Although the latter increases are still substantial, we hope that the differential between them and those for the physical sciences does not reflect a misunderstanding of the critical importance of biological, behavioral and social science and of science education to the Nation's innovativeness and the future of America's children.

AAAS would like to emphasize that the NSF is unique among all the R&D agencies in that its purpose is to support fundamental research across *all* scientific fields—not only the physical sciences—illustrating the interdependence of physical, biological, behavioral, and social sciences. While it is certainly appropriate for the remaining mission-oriented agencies to focus their research portfolios in related fields, a successful, innovative future will draw upon contributions and interactions from a broad spectrum of fields of inquiry, and robust support is needed for *all* of them. NSF's critical role includes serving as a bridge that unites all these interdependent fields.

National Aeronautics and Space Administration (NASA): The FY 2009 budget proposes a 2.9 percent increase in the total NASA budget, growing $497 million to $17.6 billion. However, the entire increase and more would go to two human space programs. The Constellation Systems program to develop the next generation human spacecraft could receive $3 billion, an increase of 23.3 percent, which includes $1 billion each for the Crew Exploration Vehicle and the Crew Launch Vehicle. The International Space Station would receive $2.1 billion, a 13.6 percent increase.

Over the last several years, NASA support of research (the "R" part of R&D) has declined dramatically as the costs of the Constellation Systems and the Space Station have escalated. The 2009 budget would continue this disturbing trend. The Science portfolio would fall 5.6 percent to $4.4 billion, with especially steep cuts for the Astrophysics (down 13 percent) and Heliophysics (down 31 percent) portfolios because of the end of a number of large missions (*e.g.,* Hubble Space Telescope). Planetary Science and Earth Science would receive boosts of 7 percent each, however, with a special emphasis on new earth science missions. Aeronautics research funding would continue to tumble with a 13 percent cut to $447 million (see Figure 2).

The NASA R&D portfolio would increase 4.9 percent to $12.8 billion (see Table 1), with the entire increase and more coming from Constellation Systems and the Space Station.

National Institute of Standards and Technology (NIST): We applaud the FY 2009 budget's continuing commitment to the intramural laboratory research programs at NIST, which provide crucial support for the physical sciences that underlie much of U.S. innovation. NIST intramural research would significantly increase 16 percent to $447 million. Once again, however, the budget request would dramatically scale back funding for NIST's external programs. As in previous years, the budget proposes to eliminate the valuable Technology Innovation Program and provide only $4 million for the Hollings Manufacturing Extension Partnership to close out the program.

National Oceanic and Atmospheric Administration (NOAA): NOAA's funding of oceanic and atmospheric research, including crucial research on climate change and fisheries, would increase 7.5 percent in FY 2009, but that is only after one takes out the Congressionally-designated earmarks that would be included in the final FY 2008 budget. If one calculates the NOAA budget with the 2008 earmarks then its budget would fall slightly to $576 million.

Impact of FY 2008 Budget

While there is much to be pleased about in the FY 2009 budget request, it is important to consider the FY09 request in light of the FY 2008 omnibus appropriations. The final omnibus bill was a disappointment to scientists optimistic about potential increases related to the ACI. Despite House and Senate votes that were at or above the President's FY08 budget request, the final omnibus allocated NSF $364 million less than the request. This is having a negative impact on thousands of faculty researchers, graduate students, undergraduates and post-docs. NSF will award 1,000 fewer new research grants (15 percent below request) and 230 fewer graduate research fellowships (8 percent below request) this year.

Several major program solicitations will be delayed for at least a year, including new programs directly focused on the development of a competitive scientific workforce. Many core research programs will have to scale back planned activities and several planned centers will not be funded in 2008. Likewise, critical maintenance and planned equipment upgrades will suffer in numerous operations throughout NSF's portfolio.

NIST, another ACI agency under this committee's jurisdiction, was set to receive a significant boost of $65 million for its labs in FY08 but that shrunk to $6 million in the final omnibus.

Conclusion

The ACI and the America COMPETES Act have done much to recognize that the U.S. economy, now and in the future, will depend on our ability to innovate, and that maintaining the U.S. lead in innovation relies on a strong foundation of Federal investment in research and education. We appreciate and share that recognition. In spite of that acknowledgment, however, actual Federal research investments are shrinking as a share of the U.S. economy, just as other nations are increasing their investments. China and South Korea, for example, are boosting government research by 10 percent or more annually.

Robust research funding is necessary in order for the Nation to craft solutions to pressing issues, ranging from a greater understanding of and technological options for combating global climate change, to safely using nanotechnology, to ensuring sustainable oceans and fisheries, to ensuring critical improvements to health and the quality of life of all Americans.

In an increasingly technology-based economy that relies on federally funded research as the seed corn for technology-based innovation, the Federal Government needs a sustained commitment to a robust, fully balanced research portfolio that recognizes the interdependence and critical role of all scientific disciplines to a future innovative society.

APPENDIX A

American Association for the Advancement of Science (AAAS)

The American Association for the Advancement of Science (AAAS) is the world's largest general scientific society, and publisher of the journal, *Science* (*www.sciencemag.org*). AAAS was founded in 1848, and includes 262 affiliated societies and academies of science, serving 10 million individuals. Science has the largest paid circulation of any peer-reviewed general science journal in the world, with an estimated total readership of one million. The non-profit AAAS (*www.aaas.org*)

is open to all and fulfills its mission to "advance science and serve society" through initiatives in science education, science policy; international programs; and an array of activities designed both to increase public understanding and engage the public more with science.

Every year since 1976, AAAS has published an annual report analyzing research and development (R&D) in the proposed Federal budget in order to make available to the scientific and engineering communities and to policymakers timely and objective information about the Administration's plans for the coming fiscal year. At the end of each congressional session, AAAS also publishes a report reviewing the impact of appropriations decisions on research and development. AAAS has also established a Website for R&D data on which we now post regular updates on budget proposals, agency appropriations, and outyear projections for R&D, as well as numerous tables and charts. The address for the site is *www.aaas.org/spp/rd.*

AAAS Analysis of R&D in the FY 2009 Budget

Table 1.—R&D in the FY 2009 Budget by Agency

[budget authority in millions of dollars]

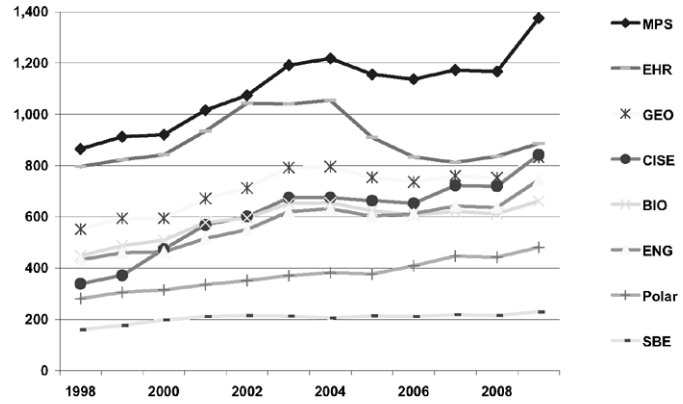
	FY 2007	FY 2008	FY 2009	Change FY 08–09	
	Actual	Estimate	Budget	Amount	Percent
Total R&D (Conduct and Facilities)					
Defense (military)	79,009	77,782	80,688	2,906	3.7%
S&T (6.1–6.3 + medical)	13,518	13,215	11,669	−1,546	−11.7%
All Other DOD R&D	65,490	64,567	69,019	4,452	6.9%
Health and Human Services	29,621	29,816	29,973	157	0.5%
Nat'l Institutes of Health	28,350	28,676	28,666	−10	0.0%
All Other HHS R&D	1,271	1,140	1,307	167	14.6%
NASA	11,582	12,188	12,780	592	4.9%
Energy	9,035	9,661	10,519	858	8.9%
Atomic Energy Defense R&D	3,649	3,718	3,825	107	2.9%
Office of Science	3,560	3,574	4,314	740	20.7%
Energy R&D	1,826	2,369	2,380	11	0.5%
Nat'l Science Foundation	4,440	4,479	5,175	696	15.5%
Agriculture	2,275	2,309	1,952	−357	−15.5%
Commerce	1,073	1,138	1,152	14	1.2%
NOAA	557	581	576	−5	−0.9%
NIST	487	521	546	25	4.7%
Interior	647	676	618	−59	−8.7%
U.S. Geological Survey	574	586	546	−41	−6.9%
Transportation	767	820	902	81	9.9%
Environ. Protection Agency	557	548	541	−7	−1.3%
Veterans Affairs	819	891	884	−7	−0.8%
Education	327	321	324	3	0.9%
Homeland Security	996	992	1,033	41	4.1%
All Other	786	819	821	2	0.2%
Total R&D	141,933	142,441	147,361	4,920	3.5%
Defense R&D	82,658	81,500	84,513	3,013	3.7%
Nondefense R&D	59,276	60,941	62,848	1,907	3.1%
Basic Research	28,168	28,682	29,656	974	3.4%
Applied Research	28,599	28,751	27,626	−1,125	−3.9%
Total Research	56,766	57,433	57,282	−151	−0.3%
Development	81,363	80,567	85,363	4,796	6.0%
R&D Facilities and Equipment	3,804	4,442	4,716	275	6.2%

Source: AAAS, based on OMB data for R&D for FY 2009, agency budget justifications, and information from agency budget offices.

Note: The projected inflation rate between FY 2008 and FY 2009 is 2.0 percent.

FY 2008 figures exclude pending supplementals.

Figure 1. NSF Budget by Directorate, FY 1998-2009
(budget authority in millions of constant FY 2008 dollars)



Source: National Science Foundation data. FY 2009 figures are President's request. CISE includes new Office of Cyberinfrastructure.
R&D and non-R&D components included in directorate budgets.
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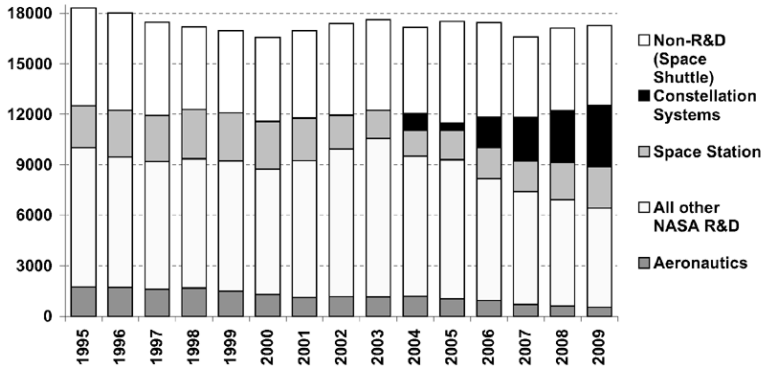
Figure 2. Trends in NASA R&D, FY 1995-2009 *
in millions of constant FY 2008 dollars



Source: AAAS analyses of R&D in *AAAS Reports VIII-XXXIII*. * FY 2009 figures are latest AAAS estimates of FY 2009 request. Program budgets include associated support costs.
R&D includes conduct of R&D and R&D facilities.
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AAAS

PREPARED STATEMENT OF DR. CHARLES M. VEST, PRESIDENT, NATIONAL ACADEMY OF ENGINEERING, PRESIDENT EMERITUS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Mr. Chairman and Committee Members,

I am Charles M. Vest, President of the National Academy of Engineering, and President Emeritus of the Massachusetts Institute of Technology.

I am grateful for the opportunity to submit this testimony. My purpose is to respectfully urge you to initiate strategically increased Federal investment in basic science and engineering research and education by providing the full funds authorized by the America COMPETES Act that have already been delayed by a year. My reason is that these investments are key to our ability to compete and prosper in the global, knowledge-based economy of this century.

In the 20th century, U.S. science, engineering, and medicine nearly doubled our life span; enhanced our Nation's security; fueled most of our economic growth; sent us to the moon; fed the planet; brought world events into our living rooms; gave us freedom of travel by air, sea, and land; established instant worldwide communications; enabled ubiquitous new forms of art and entertainment; and uncovered the workings of our natural world. It was a century of speed, power, and new horizons. We have come to take all this for granted.

The opportunities and challenges of the 21st century will be very different. And nothing can be taken for granted. To grasp the great opportunities of our times and to meet our great challenges—from economic competitiveness to global change, from healthcare to education, from security to transportation—Federal policy and action must be informed and enabled by a vibrant science and technology enterprise. Indeed our national comparative advantage is a strong S&T base coupled to a free market economy and a diverse, democratic society. The full force of global competition will soon be felt. Jobs will follow innovation wherever in the world it is found, and innovation will follow basic research wherever it is conducted.

Last August, the America COMPETES Act was passed by the U.S. Congress, garnering unanimous consent of the Senate and passing with only 57 dissenting votes in the House of Representatives. This authorizing legislation had strong bipartisan support. Its primary features include initial investments to improve K–12 STEM education, especially through transformed teacher preparation, and substantial multi-year increases in funding for basic research in the National Science Foundation (NSF), the Department of Energy (DOE), and the National Institute of Standards and Technology (NIST). This agenda was strongly and actively supported by numerous leaders of American industry and generally reflected recommendations proposed by the National Academies, the Council on Competitiveness, the Presidents Council of Advisors on Science and Technology (PCAST), and virtually every other group that has studied what America must do to prosper in the rapidly emerging global, knowledge-based economy.

Despite the fact that both the Congress, through the America COMPETES Act, and the President, through his American Competitiveness Initiative, proposed support for the increased research funds for physical science and engineering, this funding was not forthcoming when the FY 2008 Omnibus Appropriations Bill was passed. In my view, the systems failure that led to this funding situation will have long-term negative implications for our nation, and funding must, at minimum, be fully restored in the FY 2009 Federal Budget.

The America COMPETES Act, based on bipartisan leadership from this Committee, authorized a budget of $7.326 billion for the NSF in FY 2009. This Committee proposed an increase of $450 million more than the Administration's FY 2009 request in February of $6.85 billion, to allow NSF to sustain and expand its research and education programs. At a minimum, the Congress should match the Administration's proposal, a 13 percent increase, to keep NSF on track with the Administration's proposal to double its funding over the coming decade.

The failure to appropriate FY 2008 funds for the NSF at that level currently is resulting in a long list of real and immediate damage, including: the loss of 1,000 research grants; cutbacks in planned graduate research fellowships; over 3,000 research projects reduced; undergraduate research programs reduced; the program for advanced supercomputing and advanced networking for needed new scientific infrastructure reduced by $64 million; new program initiatives put off in computer science, climate change studies, cyber-physical systems; and new centers in materials, engineering, physics and mathematical and biological sciences interface delayed. Not only is NSF basic research funding not moving forward, it is moving backward, having declined slightly in real dollars since FY 2004.

Similarly, I strongly support strong science funding levels for the other science agencies included in the COMPETES Act, at least at the President's recommended

budget level, for NIST and the DOE Office of Science, which likewise suffered significant FY08 cutbacks from authorized and requested levels.

The real and immediate damage to our science and engineering enterprise done by the failure to fund the America COMPETES Act in FY 2008 did not just slow research progress; it interrupted the working of our Nation's innovation system. This system is the flexible and collaborative partnership of government, academia, and industry that produces new knowledge and technology through research and educates young men and women to further develop knowledge and technology and move them to the marketplace as new products and services.

Mr. Chairman and members of the Committee, much of the rest of the world has studied our innovation system and its success during the last half century. Their goal is to beat us at our own game. They are moving aggressively to prepare their young people and speed their innovation through investment in basic research to create the jobs of the future. A trip to China, India, or many other countries will show the level of their commitment, resolve, and early successes. Observing the amazing economic transformation of nations like Finland, Ireland, and Singapore shows that it can happen and happen fast when there is a strong national commitment to research and education. We have driven our economic growth on our innovation prowess since the end of the Second World War, and this has made us the strongest economy in the world. Yet our comparative and competitive advantage built on innovation is not necessarily eternal—others can grasp and emulate the same model. That is what we are now starting to see. We have a choice: we can respond with renewed energy and dynamism or we can drift. In FY 2008 I fear we drifted.

I understand that you face many immediate demands, but if our national complacency about the real driving forces of today's and tomorrow's economy, health, and security continues, our children and grandchildren will suffer the consequences. I ask that you reassert the bipartisan leadership from this Committee that led to the America COMPETES Act to assure that your legislation receives the critical funding you authorized. It is important, as you understand well, to get on with the job of strategically increasing investment in our research system, infrastructure, and people.

The place to begin this leadership journey is by fully funding the programs of the America COMPETES Act.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARIA CANTWELL TO HON. JOHN H. MARBURGER III, PH.D.

Question. Dr. Marburger, I appreciate your work on and support for the America COMPETES Act. I am also aware that for several years now, you and the OMB director have called on Federal agencies to continue to advance and coordinate investments in supercomputing. With the new legislation and your directive, can you tell us how agencies have responded in the area of supercomputing? What additional steps do you think the Administration should take to make sure agencies get the full benefit of supercomputing for science and engineering advances?

Answer. The budget requests from the Administration for high-end computing, or supercomputing, have risen substantially over the last several years as agencies have prioritized this important area of research in the Networking and Information Technology R&D (NITRD) Program. There are now several agencies that are bringing unprecedented computational performance to bear on problems of national importance, including traditional leaders such as the Department of Energy's National Nuclear Security Administration and its Office of Science, as well as the National Science Foundation and NASA. Agencies are collaborating on the development of new HEC technologies through interagency programs such as DARPA's High-Productivity Computing Systems (HPCS); DOE's Innovative and Novel Computational Impact on Theory and Experiment (INCITE) activities; and the High-End Computing University Research Activities program. All these programs involve multiple agencies coordinating their investments or activities to push the state-of-the-art in high-end computing. In addition, smaller agencies such as NIST and NOAA are obtaining access to the Nation's highest performance supercomputers to conduct leading-edge computational science.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO DR. ARDEN L. BEMENT, JR.

Question 1. Dr. Bement, with regard to the Ocean Observatories Initiative and other project(s) in the Major Research Equipment and Facilities Construction (MREFC) account, understand you are requiring another level of review—the Final Design Review (FDR).

What assurances can you provide that there will be sufficient funding and adequate guidance at the outset of the reviews to ensure that the review process can be completed successfully in 2008?

Answer. GEO/OCE continues to provide funding in FY 2008 to support the Ocean Observatories Initiative (OOI) Project Team as it prepares for the final design review (FDR) currently planned for late 2008. The FY 2009 request for GEO/OCE includes fully sufficient funding for OOI Project Team work through and beyond the FDR phase. This robust funding stream will sustain an effective team and allow the project to maintain progress on final design work.

NSF's Large Facilities Office (LFO) has developed general criteria for FDR, and is working with GEO to map those general criteria onto the specific objectives and needs of OOI. While NSF cannot guarantee the outcome of the FDR process, we are working with the OOI Project Team in development of the final FDR criteria and the Charge to the Review Panel.

Assuming the FDR is completed and acceptable, it is important to me that the projects begin construction promptly in 2009. This is important to keep costs from escalating because of delays and to keep teams in place.

Question 2. What assurances can you provide that there will be no further administrative delays that would impede progress toward construction?

Answer. It is vitally important that we follow our new project management and budgetary processes if we are to begin delivering every MREFC project on cost, scope, and schedule. If the critical FDR phase is fully and successfully completed, I would be prepared to recommend that the National Science Board approve the obligation of the MREFC funds already appropriated by Congress in FY 2008.

Question 3. Dr. Bement, can you tell me what steps NSF has taken to implement the America COMPETES Act, especially with respect to supercomputing? How do you see supercomputing helping the U.S. maintain Its leadership in science and engineering?

Answer. The America COMPETES Act calls for the Foundation to conduct long-term basic and applied research on high-performance computing and networking. Several Foundation activities are responsive to this and are directly related to Section 7024—High-Performance Computing and Networking of the ACA. The relevant sections have been annotated in the text below.

The investments include the deployment of leadership-class computing systems for science and engineering research, most recently at the University of Texas, the University of Tennessee and the University of Illinois [7024 C, D, F, G]. These systems are typically early versions, at extremely large-scale, of technology that the vendor subsequently intends to market more broadly [7024 B]. There are large technical challenges associated with implementing system-level software and libraries on systems of this scale so that they realize their full potential. Partnerships between vendors and the NSF awardees allow vendors to tap the expertise of academic researchers to address these challenges, facilitating the subsequent use of this class of systems by U.S. industry.

Access to world-class, state-of-the-art, supercomputing resources is important to maintaining the strong leadership position of the U.S. in science and engineering [7024 C]. Simulation and modeling is recognized as complementing theory and experimentation in scientific exploration. NSF's funding of the TeraGrid provides sustained access by the research community throughout the United States to supercomputing, storage and networking systems that are among the most advanced in the world in terms of performance in solving scientific and engineering problems, including provision for technical support for users of such systems.

Through programs such as the High-End Computing University Research Activity (HECURA), Strategic Technologies for Cyberinfrastructure (STCI), and Accelerating Discovery in Science and Engineering through Petascale Simulations and Analysis (PetaApps), NSF is supporting the development of new types of system software to improve the movement and storage of data in high-end computing, as well as research and development of software required to address Grand Challenges, sophisticated numerical tools for scientific and engineering use in areas as diverse as nanotechnology research and the study of the climate [7024 A, D, G]. Taken together with the many activities funded through domain-focused programs across the Foundation, the latter help establish a portfolio of computational science and engineering

research on mathematical modeling and algorithms for applications in a broad cross-section of fields of science and engineering [7024 F]. Developments of algorithms and software in these areas offer many downstream benefits, such as the capability to screen rapidly potential pharmaceuticals for their ability to moderate disease, the design of novel nano-materials for manufacturing and construction, and the prediction of potential changes in regional water availability. These, together with some of the research on networking and cybersecurity mentioned below, result in the funding of widely dispersed efforts to increase software availability, productivity, capability, security, portability, and reliability (7024 D).

Research on high-performance networking is supported primarily through the Networking and Technology Systems program (NeTS) and elements of the Strategic Technologies for Cyberinfrastructure program, while international network connections, including a new connection that will allow U.S. researchers to link with collaborators in Pakistan, are supported through the International Research Network Connections (IRNC) program [7024 E]. Through both NeTS and the Cyber Trust program, NSF supports basic research related to advanced information and communications technologies that will contribute to enhancing or facilitating the availability and affordability of advanced communications services for all people of the United States [7024 I].

Education and training are typically integrated into NSF's larger research and infrastructure awards. The expansion of activities in the areas described above and in the research that will be funded through the new Cyber-enabled Discovery and Innovation (CDI) activity will expand the education and training of undergraduate and graduate students in software engineering, computer and information science and engineering, computer and network security, applied mathematics, and computational science. In addition, programs such as Integrative Graduate Education and Research Traineeships (IGERT) and targeted educational and training programs supported by CISE and MPS advance this goal of the America COMPETES Act [7024 H].

The America COMPETES Act became law in August 2007, just before the beginning of FY 2008. Under the omnibus budget resolution passed by Congress for FY 2008, NSF received an increase well below the request. While NSF has been aggressively pursuing research in high-performance computing and networking with the resources that it has, the growing potential of supercomputing and networking in both industry and society at large, means that there are many more opportunities for advanced research in this area that are yet to be exploited.