S. HRG. 110–1197

UNITED STATES COMPETITIVENESS THROUGH 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

FIRST SESSION

APRIL 19, 2007

Printed for the use of the Committee on Commerce, Science, and Transportation

U.S. GOVERNMENT PRINTING OFFICE
78–569 PDF WASHINGTON : 2013

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

DANIEL K. INOUYE, Hawaii, *Chairman*

JOHN D. ROCKEFELLER IV, West Virginia	TED STEVENS, Alaska, *Vice Chairman*
JOHN F. KERRY, Massachusetts	JOHN MCCAIN, Arizona
BYRON L. DORGAN, North Dakota	TRENT LOTT, Mississippi
BARBARA BOXER, California	KAY BAILEY HUTCHISON, Texas
BILL NELSON, Florida	OLYMPIA J. SNOWE, Maine
MARIA CANTWELL, Washington	GORDON H. SMITH, Oregon
FRANK R. LAUTENBERG, New Jersey	JOHN ENSIGN, Nevada
MARK PRYOR, Arkansas	JOHN E. SUNUNU, New Hampshire
THOMAS R. CARPER, Delaware	JIM DEMINT, South Carolina
CLAIRE MCCASKILL, Missouri	DAVID VITTER, Louisiana
AMY KLOBUCHAR, Minnesota	JOHN THUNE, South Dakota

MARGARET L. CUMMISKY, *Democratic Staff Director and Chief Counsel*
LILA HARPER HELMS, *Democratic Deputy Staff Director and Policy Director*
CHRISTINE D. KURTH, *Republican Staff Director and General Counsel*
KENNETH R. NAHIGIAN, *Republican Deputy Staff Director and Chief Counsel*

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND INNOVATION

JOHN F. KERRY, Massachusetts, *Chairman*	JOHN ENSIGN, Nevada, *Ranking*
JOHN D. ROCKEFELLER IV, West Virginia	JOHN MCCAIN, Arizona
BYRON L. DORGAN, North Dakota	KAY BAILEY HUTCHISON, Texas
BARBARA BOXER, California	GORDON H. SMITH, Oregon
MARIA CANTWELL, Washington	JOHN E. SUNUNU, New Hampshire
MARK PRYOR, Arkansas	JIM DEMINT, South Carolina
CLAIRE MCCASKILL, Missouri	JOHN THUNE, South Dakota
AMY KLOBUCHAR, Minnesota	

CONTENTS

WITNESSES

APPENDIX

UNITED STATES COMPETITIVENESS THROUGH BASIC RESEARCH

THURSDAY, APRIL 19, 2007

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

The Subcommittee met, pursuant to notice, at 10:04 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. This hearing will come to order.

Good morning, thank you, all of our witnesses, for being here, we appreciate it very, very much.

Everybody here understands what our basic research and innovation means to our economy. Fifty percent of our economic growth in the last half century is due to scientific breakthroughs and technological innovation. And most of our productivity comes from it.

Our competitors know this also, and that's why increasingly, in other countries, they've been dedicating more and more of their resources to compete with us, and some of them are catching up. In Europe, Japan, and China, there's a very specific, intensive dedication to investments in science and engineering.

We're here today because we believe that America can improve our competitiveness posture through basic research, and ensuring that our students remain capable of advancing the fields of technology, science and engineering.

Inexplicably, the Administration has, over the last years, eliminated or cut funding for some of our most successful programs, and I'm not sure why. They have persisted in attempting to cut funds for the highly successful Manufacturing Extension Partnership, and the Advanced Technology Program.

Notwithstanding scores of success stories that have been generated from these fairly modest Federal investments. There's a company in Massachusetts, now the number one exporter of LCD displays to Japan, which used an ATP partnership to create jobs and growth, in fact, an ATP partnership led to the creation of the digital mammogram.

In my judgment it makes no sense to cut a program that retains and creates high-paying, high-tech jobs, when we know that Asian

and the European Community are implementing large-scale, long-range, R&D projects.

The bottom line is that a national budget ought to reflect your values and your priorities, but the choices in the budget today, many of us feel, will have a negative impact on our Nation's ability to innovate and compete.

Over the past years, we have had the opportunity to sustain American competitiveness in the world economy in a number of different ways. But the investments have not supported those opportunities.

I don't suggest that Government policy can or should single-handedly dictate events, or the course of choices in the marketplace. We had that debate, probably in the 1980s here with President Reagan, and we all concluded that we're not trying to pick winners, and we're not trying to create losers. And that's not our role.

But, clearly the impact of Government investment has been proven to make a profound difference to the framework within which private sector choices are made. Perhaps, you know, one of the obvious classic examples of that is the Internet itself, which came out of Government research. The private sector saw the opportunities and took it and ran with it.

There are many other such examples. There are also countless examples of mainstream consumer products that have come out of Government research and programs themselves, the Space Program is a classic example of that.

Personally, I join with those who put their faith in the American entrepreneur and the American worker. But, it is clear that other governments are leveraging, to the greatest degree possible, their opportunities within the marketplace. There is much that we can do.

I know that when I traveled, for instance, to Hong Kong and met with our foreign commercial service personnel, they were really frustrated at the absence of a significant Federal commitment to their ability to go out and compete for the RFPs that were being presented by countries in the region.

And, indeed, many other countries were providing very significant resources, and very significant physical resources, to allow them to meet with different parties, and it was their conclusion, not mine, but their conclusion that we were losing billions of dollars of business as a consequence of our myopia.

We've heard all the alarm bells sound now. Corporate leaders like Bill Gates have called our high schools "obsolete" even when they're working perfectly. I've heard from executives at mid-sized manufacturing firms who say they've cut costs dramatically, but they still can't compete. There are a lot of different ingredients of that, but part of it is this increasing joint venturing that's taking place in a lot of countries in terms of basic research, science, technology, and even bringing products to market.

Norm Augustine and his group from the National Academies say that our Nation risks falling behind, unless we make a comprehensive investment in our scientific eco-system.

This Committee, along with others in the Senate, has responded. Chairman Inouye, and Vice Chair Stevens have worked with other

Committees to craft comprehensive competitiveness legislation. Our Subcommittee Ranking Member, Senator Ensign, has been a leader in this effort as well. I've joined as a cosponsor of this bill, and we expect floor consideration soon.

The bill calls for increased investments in basic research, NSF, at NIST and the Department of Energy. It also addresses the need for better science, technology, engineering, and mathematics education from kindergarten through graduate school, and re-commits the Government to high-risk research.

The purpose of today's hearing is to examine the budgets and programs of our Federal science agencies. Before us are the Nation's preeminent science and technology agencies, and we welcome you here. You have broad expertise, and your programs, from nanotechnology and information technology to climate change and high-tech, provide important opportunities for strengthening the American economy.

Speaking of climate change, the world is finally awakening to the grave threat that climate change poses. When major corporations from IBM to General Electric, Bruce Petroleum, 3M, DuPont, Dow Chemical and others are all calling for a Government response to the need to price carbon, and to begin to move in that direction with greater technology, it's significant.

Rather than sit idly by, as I'm afraid the Administration has done for almost 7 years, other nations have taken significant action, and are reducing their fossil fuel consumption and carbon dioxide emissions. We need to challenge ourselves to do what is important to our own economic future, as well as our health, safety, and security.

There's an enormous economic opportunity staring us in the face, and others are more aggressively pursuing that than we are. Witness what happened with photovoltaic alternative renewables, and the loss of our lead to Japan and Germany, because we basically refused to fuel the research that we committed to in the late 1970s.

Companies that provide greener products, you can see it in General Electric's ecoimagination advertising, you can see it in their revenues, with more efficient batteries, cleaner engines, more efficient appliances, and electronics that consume less, these are going to be the companies that prosper.

Our challenge is to fund research and development that can enable a green product revolution and to educate the students who can invent, manufacture, and service these products.

So, we look forward to hearing from our distinguished panel, Dr. Marburger, the Director of the Office of Science and Technology, thank you for being here, doctor, and Dr. Arden Bement, Director of the National Science Foundation, and Dr. Bill Jeffrey, National Institute of Standards and Technology.

Senator Ensign?

STATEMENT OF HON. JOHN ENSIGN,
U.S. SENATOR FROM NEVADA

Senator ENSIGN. Thank you, Mr. Chairman, for holding this important hearing. I'm very excited that our competitiveness bill will be on the floor, very soon. Although we cannot predict the exact timing, whether it will be later today, tonight, or early next week

sometime, the bottom line is that the full Senate will consider and hopefully pass our competitiveness bill very soon.

A lot of work went into that bill last year. I appreciate Senator Inouye working with Senator Stevens on this Committee, as well as the leaders of the HELP Committee, and the Energy Committees, all working together on this bill. This bill is really one of the more remarkable work products that has come out in a bipartisan fashion in a long time.

I was put in charge by Senator Frist last year, of trying to bring all of those groups together, and trying to just bring three Committees—forget Republicans and Democrats—trying to bring three Committees together to work on the same product and actually come up with something that all three of the Committee chairmen and ranking members would cosponsor, as well as both of the leaders, and then to bring virtually the same product back in this Congress, have both of our leaders cosponsor the bill and bring it directly to the floor so we didn't have to go through more machinations this year, it's very exciting. A big part of the bill is what we are here to discuss today, and that is addressing the basic research needs that we have in the United States.

Anybody who looks at my record knows that I'm one of the most fiscally conservative people in the United States Senate. But there are places where the Federal Government can actually invest strategically, to where you get huge returns in tax revenues in the future, and also huge economic returns. And, there's no better place to look at that, than in high-risk, basic research.

Since the mid-1990s, we have dramatically increased the funding levels in the life sciences, but we have not kept up those increases in funding levels in the physical sciences. That is really a lot of what today's hearing is about, hearing from all of you folks and getting direct testimony on this issue.

Now, we have to make sure that when we're doing this that we are always using taxpayer dollars, in the way that maximizes the benefit. I don't care how much you increase science budgets by, if you don't use the dollars correctly, you will not get the appropriate bang for the buck. So we want to make sure that as we're going through this process that we are investing in those types of research grants that have the potential to yield the most results in the long term. Of course, with any basic research, you never know what's going to be the end result of the research, but you want to have the processes properly set up and in place. I know that a lot of that has been done in the past, but we want to continue to streamline it, and improve it in ways where we invest in the types of research that have the potential to yield the most results.

So, I'm excited about this whole process. Basic research is about keeping America competitive in the world. Basic research produces large amounts of jobs, as we go forward and then let the companies conduct the applied research, and bring exciting products to the market. We're not saying that we know which one of the basic research projects that are being funded today is going to be the next disruptive technology of the future that is going to totally revolutionize the economy.

We just have no idea what specifically will emerge "out of basic" research conducted today. But companies in the private sector can-

not afford to fund that kind of basic research, really, only the Government can. So, I'm excited about today's hearing, and working on this project, and seeing how we can keep America competitive in the 21st century.

And a big part of this—as you've mentioned, Mr. Chairman—is education. You know, it's great to have the research, but if we're not, educating the next generation of engineers, if we're not inspiring young people then we will be in trouble. We have the finest colleges and universities in the world. People from all over the world have wanted to come here. Now, that is changing. Other countries are catching up to us even in the university setting, but we still—at this point in time—have the finest universities in the world.

Unfortunately, in Kindergarten through 12th grade, we do not have the best system for teaching the STEM fields. We're not inspiring our young people to love math and science, and we're not doing a good job of teaching. We've done hearings in the HELP Committee and in this Committee, on some of the things that we're not doing right. We really need to figure out how to improve our STEM education for the future of our American workforce and so that we have those kinds of people that create the jobs for everybody else.

One of the statistics that several experts mention is that 4 percent of the population is going to create the other 96 percent of jobs. A lot of the jobs in both categories are in the science, technology, engineering and mathematics fields, and so we have to make sure that we are providing the kind of educational opportunities, that we need to enable American students to succeed. I agree with Bill Gates, we have to dramatically re-think what we are doing in Kindergarten through 12th grade to get our children on the right paths toward a bright educational future.

So, thanks again, Mr. Chairman, for holding this hearing today.

Senator KERRY. Thank you very much, Senator Ensign. Thank you for your leadership, again, as I said, I know you've been involved, and it's been fun working with you on a lot of this stuff.

We're pleased to have the Chairman of the full Committee here, who has helped lead us to get that bill ready to be on the floor, and Senator Inouye, thank you for that.

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

The CHAIRMAN. I thank you very much, I wanted to be here, Mr. Chairman, to demonstrate my support for the work being conducted by this Subcommittee.

A few weeks ago I read an article that was a bit frightening. It indicated that one-third of fourth graders in the United States performed at or above a level deemed proficient, and about a fifth of eighth graders lacked the competency to perform basic mathematic computations. In this country, only 32 percent of Americans graduate with college degrees in science and engineering, and at the same period, in China, the Chinese graduated more than 600,000 engineers, India, 350,000, and we had less than 70,000.

I think something must be done to change these trends, and I'm here to give my support, sir.

Thank you very much. May I have the rest of my statement included?

[The prepared statement of Senator Inouye follows:]

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

Our economy's strength derives from our competitiveness as a nation in the fields of emerging technologies. The genius and painstaking work of our scientists, and the hard-won government funding for research and development, are investments that have paid dividends not only in world class peer-reviewed scientific papers but also in cutting edge technologies that keep America competitive in the global marketplace.

America's young people are surrounded by an array of these sophisticated technologies. They use these complex gadgets with ease and confidence for both study and play. Unfortunately, we have heard the warnings from Norm Augustine and his National Academy of Sciences panel in *Rising Above the Gathering Storm* that our technologically sophisticated youth are slipping behind their international competitors when it comes to discovering and building the next generation of products.

Although it seems that every month there is a new "best" cell phone or MP3 player that every teenager wants, how many of those teenagers actually understand the science behind wireless communications technology, or what it takes to develop the applications and operating systems that actually make the phone, and the network, for that matter, operational?

This pattern is far more pervasive than simply cell phones and teenagers. Less than one-third of U.S. fourth graders performed at or above a level deemed "proficient" and about one-fifth of eighth graders lacked the competency to perform basic math computations. In the United States, only 32 percent graduate with college degrees in science and engineering.

In 2004, while China graduated more than 600,000 engineers and India graduated 350,000 engineers; the United States graduated less than 70,000 engineers.

We must take action today to turn these trends around if we are to stay competitive tomorrow.

As the researchers of today retire, and reports to Congress indicate that they will be retiring in large numbers during the next few years; there must be a next generation to take their places. That means we need to educate our children so they can do more than talk *about* the science. They need to be able to *do* the science.

Further, scientists, like any other member of our workforce, go to where the jobs are. That means we need to have the world-class laboratories and facilities necessary to tackle a new generation of questions and challenges, and those laboratories and facilities need to be here in America.

These two key issues formed the backbone of this Committee's work on comprehensive competitiveness legislation, S. 761, the America COMPETES Act, and will be the lens through which we view the Fiscal Year 2008 U.S. research and development budget. I look forward to working with you in the year ahead as we make these issues our top priority.

Senator KERRY. Without objection, absolutely. The Chairman can have whatever the Chairman wants.

[Laughter.]

Senator KERRY. Thank you, Mr. Chairman, we appreciate your taking the time to come here and share that with us.

Senator Sununu?

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

Senator SUNUNU. Thank you very much, Mr. Chairman. And let me begin by saying that it really is important to be having this hearing and this discussion. We had at least one similar hearing last year—the more, the better—because of the importance of basic mathematics and science to our economy on the broadest scale. And I think you described that quite accurately in your opening comments.

Second, let me underscore that I appreciate the amount of time and effort spent in developing the competitiveness legislation that is scheduled to be introduced in the Senate, in the coming weeks. I know there was a very sincere effort to make that bill comprehensive, to try to address a number of recommendations that have been put forward by the Administration, by independent groups, and by Members of Congress as well—we all have our priorities.

And, I'll begin by talking about the most important goals of that legislation, which I strongly support, and have supported for some time, and spoken about as far back as 5 or 8 years ago, when I was a member of the House of Representatives. That is, first and foremost, doubling the amount of money committed to the National Science Foundation for peer-reviewed research. It is the best, strongest, most effective vehicle we have for advancing basic science, in the United States and around the world. High-risk basic research has very long time horizons for payback, and the benefits are very widely distributed, and they are not areas that capital markets, or venture capitalists or others in the private sector can really accurately forecast. And that's why the Government has a responsibility in this area.

Second, increasing the Office of Science within the Department of Energy which is also involved in this basic research, from $3.6 billion to over $5 billion in the coming 5 years.

Third, increasing our commitment to the National Laboratories, that are, really, the crown jewels in terms of the physical infrastructure necessary to do this important research. Those are critical, essential goals, extremely valuable achievements that are set out in the competitiveness legislation.

However—and there is a very, very important "however" here—I'm very concerned that—because there were so many hands in it, perhaps, because there are competing interests, because there were four or five Committees in the Senate alone, with jurisdiction—its effectiveness will be diluted. We've seen a proliferation of programs and ideas in there that I am principally concerned will take away from the focused mission in each of these three areas: Office of Science, National Science Foundation, National Laboratories. Instead of maximizing the funding available for peer-reviewed research in physics and chemistry and material science and computational mathematics, this legislation would begin the process of carving out specific fiefdoms for programmatic funding.

And whether it's for education and human resources, or for behavioral sciences—anything that is not geared directly toward that mission of peer-reviewed science, carries the risk of diluting the power and the importance of these institutions, for these important goals we share.

I'm extremely concerned about that, these institutions can provide great axis for educational programs, especially for college and graduate level work in the math and science fields, but their focus needs to remain on the peer-reviewed work. And, I'm very much inclined to try to offer some amendments to make sure we get back to that focus and that emphasis.

Second, as Senator Kerry mentioned, we shouldn't be picking winners and losers in private markets where there are commercial operations and commercial players. And, I suppose there's an hon-

est disagreement, what constitutes picking winners and losers, but I will pick up on the example Senator Kerry gave, and this is an area of disagreement, and I don't want to get bogged down here, I just want to present a slightly different viewpoint on the Advanced Technology Program.

You mentioned an example of an LCD manufacturer, it's a great industry, I'm sure it's a terrific company. But, they are manufacturing commercial products for sale in the United States and around the world, and any time that we provide a grant to a company manufacturing products for commercial sale, we are picking winners and losers, because that means there are some companies manufacturing similar, or even the same products for commercial sale that won't get the grant.

And, at the same time, I recognize the Federal Government does a lot of this. But we need to be very concerned anywhere there are direct grants or subsidies going to people engaged in competitive commercial activity. And that, to me, is picking winners and losers. And, we need to do everything possible to minimize or avoid that kind of intervention in competitive markets—again, anywhere we're doing work—but in this legislation, in particular, there are some programs created in the competitiveness bill, recreated, that would do just that.

And, again, any time we are doing that—intervening in commercial markets—we're diluting resources, and limiting resources that could go to physics and chemistry, computational mathematics and material science—basic peer-reviewed scientific research.

Third, is this issue of education—trying to encourage our educational systems to produce more students interested in science and mathematics and engineering. I don't know if it's a good thing or a bad thing that I speak from some experience, because I'm the only member of the U.S. Senate with a Bachelor's Degree in Engineering. But, maybe that makes me biased, maybe that makes me more knowledgeable, I don't know the answer to that question.

But it is my personal experience that individuals, men and women, pursue education in engineering at college because they are, they find that they are interested in math and science in high school. And that interest in math and science that comes to fruition in high school, or really begins—I shouldn't say comes to fruition, but is inspired in high school—doesn't even begin in high school, it really begins in 5th, 6th, 7th, and 8th grade. That's where a young girl or a young boy realizes, "This is interesting, this is exciting. I enjoy math and science, I'm good at it, and when I get to high school I'll look forward to taking math and science classes." And, if it doesn't happen in 6th or 7th or 8th grade, it's not going to happen when they're a junior or senior in high school.

So, if you really want to do something about creating engineers, you don't create programs necessarily for post-graduate students in material science—that doesn't encourage more engineers. It might be an important program for a post-graduate electrical engineering student, but if you want to get more post-graduate electrical engineering students, you need to get more electrical engineering undergraduates. And if you want more electrical engineering undergraduate students, you need to get them interested in math and science in 6th and 7th and 8th grade.

So, a huge burden here has to be on our K through 12 system. And whether it's inspiration through the Department of Education in math and science in K through 12, or the corporate leaders that come to Washington that complain that we don't have enough math and science students getting more involved at the local level, to inspire math and science focused curriculum—those are all good ideas, and those ought to be pursued. But, we need to recognize that the inspiration process occurs much earlier.

Senator Inouye had it exactly right—the scary statistics are the proficiency in 4th grade, and proficiency in 8th grade. And if only a third are proficient in 4th or only half are proficient in 8th, you're going to get fewer math and science students in high school, in college. That's just a basic fact. So, for in terms of inspiration, and encouraging more to pursue this field, we have to deal with those numbers that Senator Inouye talked about.

I think we need to remain focused on the basics, we need to act as aggressive as possible at pursuing these goals for doubling NSF funding, Office of Science funding, and National Laboratory funding, and we need to remain true to our mission.

One final thought about the educational effort. The Academic Competitiveness Council put out its initial findings in March. They looked at all of our science, technology, engineering and math education programs in the Federal Government. And, on the one hand, I think we can say we're pleased to find there are lots of them. On the other hand, they're not necessarily—as the Council found—as focused as they should be, there are duplication and overlaps, there is not necessarily the follow-through that there should be.

A dozen in the Department of Agriculture, seven in the Department of Commerce, eight in the Department of Defense, 12 in Education, 34 in the National Science Foundation, six in the Department of Transportation, five in the Department of Health and Human Services and so on—all of these programs focused on science, technology, engineering, and mathematics. And what I don't think we've done in the competitiveness bill is look at these programs, and find out ways to strengthen them and improve them, and make sure they're focused on the goals that we do share, that absolutely come to us across party lines.

So, I hope that we'll do more to look at how those programs are implemented. If we look at the programs in the target areas that they have, of that list of programs, 57 of them focus on under-represented populations, 39 focus on teachers, 60 focus on practitioners, 61 on undergraduate students who are majors, 21 on undergraduate students who are non-majors, 51 on graduate studies. So we can see that there is a lot of duplication, and that's not necessarily a bad thing, but we want to make sure that their efforts are as complementary as possible, where we have multiple programs.

I know that's a tall order, you've been very generous with the time, Mr. Chairman, I just think it's important that we emphasize, even as we pursue the right goals, and the right levels of funding, we want to make sure that we stay as focused as possible. No legislation is perfect, and even when, where we have legislation, we're going to have some disagreement on what you might put in the bill and what I might put in the bill, but I think there's so much agree-

ment here, and so much consensus about the importance of this issue, we ought to be able to improve it before it finally goes to the President.

Thank you very much, you were very, very generous with the time, and I appreciate that.

Senator KERRY. Thank you, Senator Sununu. We do want to get to our witnesses, I want to just make one comment on the ATP, but Senator Thune, do you want to make any comment, or are you—?

STATEMENT OF HON. JOHN THUNE,
U.S. SENATOR FROM SOUTH DAKOTA

Senator THUNE. Mr. Chairman, I thank you for holding this hearing. I think this is an important subject, and it's obviously a tough issue for us to get our arms around because there isn't a single policy that's going to keep us competitive. As the world leader in science, innovation, and entrepreneurship, I think we have to be continually focusing on fostering math, science, and basic research at our schools and universities in order to stay on top, and we also have to ensure that we've got good tax rates, regulatory regimes, and legal environments that aren't so onerous that we lose businesses and jobs to other countries.

We aren't creating our policy in a vacuum, and if we don't get it right, some other country will, and we will lose businesses and jobs to that country.

Again, I appreciate you holding this hearing, I think this is an important subject, I look forward to hearing from our witnesses and I have a couple of questions when that time comes.

Thank you, Mr. Chairman.

Senator KERRY. Great.

Well, we're going to go fairly rapidly to—I do want to just comment on one thing if I can on the ATP, and I don't want to engage in a long, drawn-out debate.

When I was Lieutenant Governor of Massachusetts, I sat *ex officio* on a board called the Mass Technology Development Corporation, and we were specifically charged with allocating certain funding to venture startup efforts using state money for projects that simply couldn't get funded in the private sector—they were very high-risk, they were very long-distant future for returns, but it was a promising field.

And our charge was, specifically, to sort of make a selection between those kinds of projects, which we did, and the minute—if they were successful, that they showed that success, an ability to stand on their own, we withdrew. The Government got out of it, and the normal capital market process would take over.

I'm pleased to say that there are a number of companies today on the big board that have provided enormous job base and significant revenues to our state that would otherwise not have been funded if we hadn't done that. And, I think we did it with a sensitivity to this notion of not picking, you know, specific winner or loser, but taking a project in a sector that couldn't get funded.

Now, ATP has had the very, very similar kind of charge here. It fills a national need, broad-based innovation requirements for the Nation. And, sure an ATP participant benefits from this. But, they

put up the majority of the funding. And, they're taking huge risk, which otherwise the private sector won't fund.

Now, it's good and well to sit here and say, "Well, the private marketplace ought to do this," but they don't. Everybody knows it. There's only so much private capital, there's a capital pool that goes out there, there's a certain risk they're willing to take. The fact is that we have repaid, in the tax base of our country, more times over, many times, what we've put up.

So, if you want to talk about return on investment, and smart leverage, this has been about as smart a leverage program as there is. And the ATP selection criteria require that the potential benefits of projects be broad-reaching, not narrow, incremental improvements, but broad-reaching improvements that spill out into the rest of the economy. And significantly, it's been extensively reviewed since its inception.

There have been more—there have been the General Accounting Office has conducted 14 studies, 10 studies have been completed by the Department of Commerce's Inspector General former Secretary of Commerce Bill Daly sponsored a 60-day study, the National Academy of Science's National Research Council published *ATP Challenges and Opportunities* in 1999, and *ATP Assessing Outcomes,* in 2001.

In addition, 25 studies have been conducted by ATP's Economic Assessments Office and they have all—all—revealed that the ATP does not, does not fund projects that otherwise would have been financed in the private sector. Rather, the ATP have funded the so-called Valley of Death projects, those that just couldn't find the financing otherwise.

And in June of 2001, the National Academy of Science, National Research Council completed its comprehensive review, and they found that it's an effective Federal partnership, funding new technologies that contribute to important societal goals.

I could go on and on and on—I'm not going to now, but I really think that given that kind of a record, and we can get into this a little bit, it's hard to understand why somebody would zero-fund it. Measured against the unbelievable successes that we've had.

So, you know, it's worthy of a debate—all of these things are worthy of debate, but the facts are facts, and the record is the record, and it's pretty darn hard to ignore, sort of, the sensitivity with which it's been constructed, the requirements are very rigorous for who can participate and how, and what the benefits have been.

I know we wanted to try to get here, Senator Pryor, did you want to make any quick comment, because we do want to try to, you know, thanks, very much.

Dr. Marburger, if you'd lead off, we'd appreciate it very much.

And your full testimonies can be placed in the record, if you want to summarize, we can get to have a good dialogue here, and that'd be helpful.

STATEMENT OF DR. JOHN MARBURGER III, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT

Dr. MARBURGER. Thank you, I will do that.

And thank you very much, Chairman Kerry, and Ranking Member Ensign, members of the Subcommittee for inviting me to present the President's Fiscal Year 2008 research and development budget.

And I also want to thank the Committee on behalf of the Administration for the good working relationship that it has established with the science agencies, and with my office. And I look forward to working together on the important task of fostering innovation and competitiveness. We agree on the thrust of the principles, I believe.

As you know, President Bush has proposed a Federal budget that will balance in 5 years. By continuing strong pro-growth economic policies, and by holding non-security discretionary spending below inflation. And that requires establishing priorities, and allocating resources to achieve the greatest impact.

Winning the war on terror, securing the homeland, strengthening the economy remain the President's top priorities, and this year's budget, once again, proposes investments in America's future competitiveness through research and development.

The President is proposing a $142.7 billion Federal R&D budget, that's another record-breaking budget, an increase of $5.5 billion over his 2007 proposal. And within this record-breaking top line amount, are increases in categories of funding that are important for broad national goals, including innovation and competitiveness.

In this budget, non-defense research increases at a higher rate than the rest of the discretionary budget, expanding once again, this year, the science share of available funds to 13.9 percent, it's unprecedented.

Growth in non-defense R&D, important for civilian productivity, during this Administration has been substantial, and there's a chart in my written testimony in the record.

The basic research category, which includes Department of Defense 61 funds, also grows in this budget, by nearly a billion dollars, from $27.5 billion to $28.4 billion. The indicator called Federal Science and Technology, which includes DOD 61 and 62 funds, increases by $1.5 billion, relative to the President's 2007 proposal.

Many of these increases come from follow-through on the President's American Competitiveness Initiative last year, and further commitments to R&D this year to diversify America's energy supply.

The ACI does set education as well as research priorities, and it focuses funds accordingly. The overarching research priority in the ACI is innovation-enabling basic research in physical science and engineering. Multi-year funding targets are set for NSF, NIST research, and DOE's Office of Science, which has been mentioned here. The Fiscal Year 2008 budget calls for a 7.2 percent increase for these agencies, on top of the 9.3 percent increase the President requested in Fiscal Year 2007. This additional $764 million would bring the two-year ACI research incremental investment to $2.6 billion.

Unfortunately, the Fiscal Year 2007 Continuing Resolution process only provided half of the first year ACI budget increase requested, $452 million short of the President's request. And, I do hope we can catch up this year.

This program responds to a very strong call from the Nation's high-tech community, as you've noted, Mr. Chairman whose recent American Innovation Proclamation—a very nice summary, I would say of our mutual goals—summarizes exactly the principles of the President's initiative. The Proclamation has been endorsed by hundreds of American business and higher education leaders, and it preserves the focus and the priorities that are so important to the American Competitiveness Initiative.

This budget contains substantial investments in research and other important areas that are described in more detail in my written testimony. It sustains budgets for climate change and science and technology, it includes funding to improve Earth observations capabilities in areas such as ocean observing, earthquake monitoring and prediction, tsunami warnings. It provides funds for the Landsat Data Continuity mission, the Global Precipitation Measurement Mission, launches a new Ocean Initiative, with over $80 million.

The Advanced Energy Initiative in this budget, that, Department of Energy is increased by 26 percent, to $2.7 billion, accelerating clean electricity generation technologies. This year the AEI includes over $700 million in basic research at DOE's Office of Science, a 32 percent increase, to overcome major technical barriers, the use of solar, biomass, hydrogen and fusion.

We have other initiatives—the National Nanotechnology Initiative continues to grow, biomedical research would receive $431 million in new funds over the 2007 request, and so forth.

Let me just finish this rapid and incomplete overview by expressing a concern about NASA, and the budget danger that lies ahead for this agency.

The President's Fiscal Year 2008 budget includes a 3.1 percent increase for NASA in 2008, on top of the 3.4 percent the President requested for 2007. But, unfortunately, once again, the CR held NASA more than a half a billion dollars below the President's request, which causes great stress on that agency, and we're concerned about that.

Mr. Chairman, I believe that this year's R&D budget proposal does provide robust levels of investment that will allow America to maintain its leadership position in science, and move ahead in selected priority areas.

I'd like to thank you for the opportunity to address the Committee on these points.

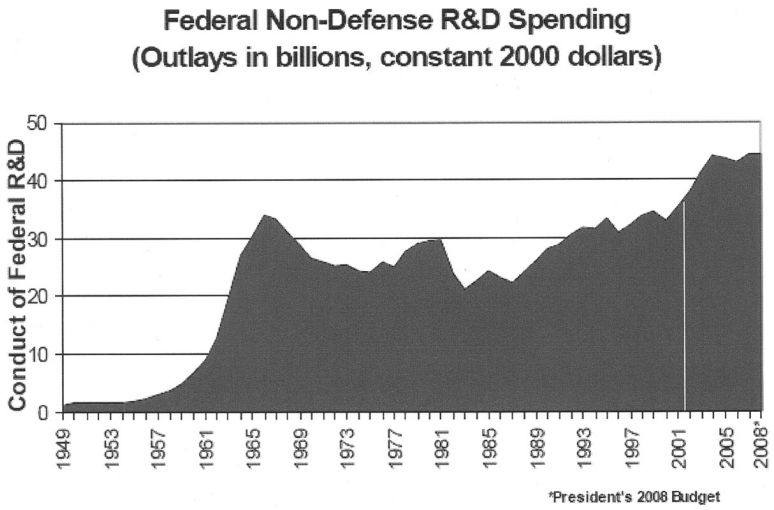
[The prepared statement of Dr. Marburger follows:]

PREPARED STATEMENT OF DR. JOHN MARBURGER III, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT

Chairman Kerry, Ranking Member Ensign, and Members of the Subcommittee, I am pleased to appear before you today to present the President's Fiscal Year 2008 research and development (R&D) budget. Although this is my first appearance before the Committee under the new Congressional leadership, I am aware that this Committee has expressed bipartisan support for science funding in the past, and values scientific research and its applications for the benefits it brings to every part of our society. On behalf of the Administration, I thank the Committee for the good working relationship it has established with the science agencies and with my office, and look forward to working together in the future to advance American innovation and competitiveness.

This year, President Bush presents a Federal Budget that will balance in 5 years. The President proposes to do this by continuing strong pro-growth economic policies and by holding non-security discretionary spending below inflation. This strategy inevitably requires establishing priorities and allocating resources to achieve the greatest impact. Winning the war on terror, securing the homeland and strengthening the economy remain the President's top priorities, and this year's budget once again emphasizes investments in America's future competitiveness through research and development. The President is proposing a record $142.7 billion 2008 Federal R&D Budget, an increase of $5.5 billion over his 2007 Budget. And the American Association for the Advancement of Science (AAAS) estimates that 2008 non-defense Federal R&D is increased by over 2.1 percent in the President's Budget, much better than overall non-defense discretionary spending. The President's commitment to the government's R&D enterprise is strong, and the advancement of science remains among his top budget priorities.

While significant increases have occurred for defense-related development—most of the "D" in R&D—it is important to be aware of the very significant growth during this Administration in non-defense research spending, as shown in the accompanying chart.



Non-defense R&D has continued on a significantly upward trajectory. In fact, with President Bush's 2008 Budget, *real* growth in outlays for the conduct of non-defense R&D—*i.e.* corrected for inflation—is up 26.5 percent during the 7-years of this Administration.

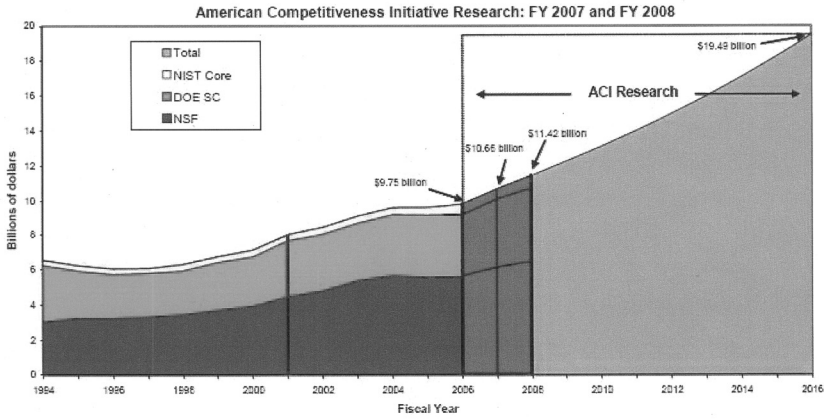
The 2008 Budget also raises funding for the category of Basic Research almost $1 billion above the most currently calculated level of 2006: $28.4 billion compared to $27.5 billion. This is a direct indication of the Administration's strong focus on fundamental research and the discovery of new knowledge as a leading mission of the Federal Government. It is notable that this favorable treatment of Basic Research is occurring in a year of belt-tightening for many other domestic programs, indicating the high priority this Administration places on the importance of this activity.

Basic Research, by itself, however, is not the complete measure of investment activities that drive future innovation. The accounting category known as the Federal Science and Technology Budget emphasizes both basic and applied science and engineering research short of development, and thus captures other important activities underpinning competitiveness. The Federal S&T Budget advances $1.3 billion in 2008 relative to 2006 funding levels, and when only civilian S&T agencies are considered, it represents a 4 percent increase. If Congress fully supports the President's 2008 request, Federal science and technology investment will increase $1.5 billion from the President's own 2007 Budget.

These very positive historical trends directly reflect the launch of the American Competitiveness Initiative (ACI) last year and further commitment to the importance of research and development to diversify America's energy supply in this

year's State of the Union address. This focus on research and development, science and math education, and advanced energy solutions directly supports our National goals of protecting the homeland, educating our children and making the economy strong.

The American Competitiveness Initiative establishes clear research and education priorities and focuses increased funding accordingly. The overarching ACI research priority is innovation-enabling physical science and engineering research. As the next chart illustrates, ACI funding increases under this priority are targeted to three science agencies, including two under the jurisdiction of this Subcommittee—the National Science Foundation and the laboratories of the National Institute of Standards and Technology—as well as DOE's Office of Science. The 2008 Budget calls for a 7.2 percent increase on top of 2007's 9.3 percent requested increase. This additional $764 million brings the total two-year ACI Research incremental investment to $2.6 billion. I want to note that the recently released "American Innovation Proclamation—a package of consensus recommendations by American business and higher education leaders—calls for the doubling of the ACI research agencies.



Unfortunately, the 2007 Continuing Resolution only provided 50 percent of the first-year ACI budget increase. That was $452 million short of the increase in the President's request. I know this Committee is as disappointed as I am at this shortfall for science. This is not sufficient to meet America's competitiveness challenge, and falls short of the aforementioned doubling path that is the key component of the Initiative. A year of enhanced and expanded high-impact innovation research is diminished and a $1.2 billion increase is now required in 2008 to "catch up" to the President's commitment. Achieving this in 2008 is critical to sustaining momentum necessary to complete the doubling Initiative in the outyears.

Before turning to other specifics of this year's research budget, I want to comment on S. 761, the America COMPETES Act, which I understand Senate leadership may be considering for floor time. While I commend this Committee and the entire Senate for its leadership and efforts on the issue of competitiveness, I must share with you concerns I have regarding the specific provisions of this legislation. These concerns, which I raised in a letter (appended) to the Committee when nearly identical legislation was considered last year, largely center on the many new programs created in the bill, and how their focus and cost would divert resources available for priority basic research in the physical sciences at the key ACI agencies (for example, the Administration estimates the legislation creates up to 20 new programs and could cost over $8.6 billion more than projected Administration budgets over 4 years). I hope the Senate will give strong consideration to these concerns, in Committee or otherwise, before it commits to floor consideration of any competitiveness-related legislation. I believe we share a common interest in working to strengthen America's capacity to innovate and retain its leadership position in the global economy, and I look forward to working with you toward this goal.

Another major concern I must address is the serious, deleterious impacts of earmarking on the Federal science budget in the past. Earmarks circumvent the scientific merit-review process for identifying and funding the best research. That process has been the bedrock of our Nation's scientific leadership. On January 3, 2007, President Bush called on Congress to cut the number and cost of earmarks by at

least half this year. To help establish a clear and transparent benchmark for accurately measuring the President's goal, OMB developed a database on FY 2005 earmarks. As we discuss the importance of pursuing the best science to contribute to U.S. competitiveness, I hope the new Congress will reject research earmarks in FY 2008, as it so commendably did in a spirit of reform in the Continuing Resolution for the current Fiscal Year. We would like to work with the new Congress to achieve the President's goal.

While future competitiveness is a national priority that is reflected in the Federal R&D budget request, there are additional national goals that are similarly well-served by the FY 2008 Budget. Since 2002, the Administration has spent approximately $9 billion on climate change science research through the multi-agency Climate Change Science Program (CCSP), and the President's 2008 Budget sustains that level of effort. I should note, however, that some of the research projects included in earlier CCSP totals have now advanced to operational missions which are no longer included in CCSP totals, but which certainly contribute significantly to advancing climate science research. Further, between 2003 and 2006, the President has committed nearly $3 billion annually to the climate change technology research and deployment programs that constitute the multi-agency Climate Technology Program. The U.S. leads the world in advancing climate science and technology, with expenditures on the order of $35 billion in climate-related science, technology, international assistance, and incentive programs during this Administration.

Undoubtedly, previous investments in advanced energy science and technology have put the U.S. well on track to meet the President's goal of reducing greenhouse gas intensity 18 percent by 2012. In addition, the 2008 Budget includes funding to improve our Earth Observations capabilities in areas such as ocean observing, earthquake monitoring and prediction, and tsunami warnings. The Budget request also provides funding to continue the Landsat Data Continuity Mission, to move forward with the Global Precipitation Measurement mission, and to launch a new Ocean Initiative with over $80 million in new funding for ocean science research at the National Oceanic and Atmospheric Administration, NSF and the U.S. Geological Survey. This Ocean Initiative is based on priorities set forth in the *Ocean Research Priorities Plan: Charting the Course for Ocean Science in the United States,* a report of the National Science and Technology Council's Joint Subcommittee on Ocean Science and Technology, written with significant input from the external scientific and resource management communities.

Biomedical research is supported in the 2008 NIH Budget with an increase of $431 million over the 2007 request. The FY 2008 request of $28.7 billion will allow NIH to maintain many priorities including awarding over 9,400 new and competing research grants. The NIH Director's Roadmap Initiative is increased in 2008 to enhance this interdisciplinary incubator for new ideas that will accelerate the pace of discovery across the NIH's 27 Institutes and Centers.

The Advanced Energy Initiative (AEI) at DOE is funded at $2.7 billion in the 2008 Budget, which is a 26 percent increase over the President's 2007 request and almost $1 billion more than 2006. The AEI will develop technologies that could help contribute to the President's goal of cutting gasoline use by 20 percent in 10 years through legislative and regulatory actions. AEI will help by accelerating the technical and cost viability of plug-in hybrids, hydrogen-powered fuel cells, and "cellulosic" ethanol derived from biomass, which are all technologies that could help meet the President's twenty in ten goal. AEI will also accelerate clean electricity generation technologies such as solar, wind, nuclear, and clean coal. Perhaps most critically, the 2008 AEI includes over $700 million in basic research at DOE's Office of Science, a 32 percent increase, to overcome major technical barriers to the use of solar, biomass, hydrogen and fusion. With the 2008 Budget, the Presidential commitment to invest $2 billion on clean coal research is fulfilled, as is President Bush's commitment to propose a five-year, $1.2 billion Hydrogen Fuel Initiative.

This Administration's National Nanotechnology Initiative also strongly continues with $1.45 billion in 2008 for this multi-agency, highly-coordinated investment in fundamental research, multi-disciplinary centers of excellence, and development of focused cutting-edge research and education infrastructure. The NNI also supports activities addressing the societal implications of nanotechnology, including those related to human and environmental health and methods for managing potential risks. With the 2008 request, over $8 billion will have been spent on nanoscale R&D in 7 years.

Finally, let me finish by expressing a concern regarding NASA and the budget danger that lies ahead for this agency. The President's FY 2008 Budget includes a 3.1 percent increase for NASA in 2008 on top of the President's 3.4 percent requested increase for 2007. However, the FY 2007 CR held NASA $545 million below the President's request. That leaves NASA at its 2006 level (hurricane

supplementals removed) with no increase and puts at risk the Vision for Space Exploration and priority Earth and space science missions. Certainly at risk is the timely development of a new, much more capable U.S. human spacecraft to follow the Space Shuttle which will be retired in 2010.

Budget Highlights of Agencies of Jurisdiction

National Science Foundation (NSF)

Funds are requested to increase the budget for NSF to $6.43 billion in FY 2008, 45 percent above 2001's $4.43 billion level. Similar investments in the past have yielded important scientific discoveries, which boost economic growth and enhance Americans' quality of life.

The centerpiece of the American Competitiveness Initiative is President Bush's plan to double investment over a 10-year period in key Federal agencies that support basic research programs emphasizing the physical sciences and engineering. NSF is one of the three key agencies, as it 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.

NSF has central roles in 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, proposed at $390 million in FY 2008, a 5 percent increase over the 2007 request and 160 percent 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 $994 million in 2008, up $90 million over 2007 and 56 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.

The 2008 NSF Education and Human Resources (EHR) budget will advance efforts to prepare U.S. students for the science and engineering workforce with a 7.5 percent increase (+$53 million) over the level in FY 2007 CR, adjusted for the movement of EPSCoR to the Research and Related Activities account. To further strengthen NSF's emphasis on increasing the quality and quantity of the science and engineering workforce and ensuring that undergraduate students are well prepared for an increasingly technological global society, EHR will increase funding for its undergraduate education portfolio by $13.4 million. This total includes $3.5 million for the Course, Curriculum, and Laboratory Improvement (CCLI) program and $5.1 million for the Advanced Technological Education (ATE) program to improve technician training at community colleges. The FY 2008 EHR budget also provides an increase of $8.9 million for the Graduate Research Fellowship program, an amount that will support an additional 200 graduate students, and $4.53 million for the Centers of Research Excellence in Science and Technology, a program designed to broaden participation in the science and engineering workforce. The FY 2008 request provides increased support for K–12 STEM education including $30 million for new awards under the Math and Science Partnerships program. The increases in funding for the ATE and CCLI programs also benefit K–12 students, in the case of the former by providing support for high school students who participate in dual-enrollment or articulated technician education programs, and the later which aims to improve undergraduate STEM education to all students, including those who will become K–12 teachers. Similarly, since many research projects and centers include education and outreach activities for K–12 students and teachers, the increased funding for research also benefits K–12 education.

National Institute of Standards and Technology (NIST)

The Department of Commerce's NIST "core" research and facilities receive $594 million in 2008, an increase of 21 percent from the level in the FY 2007 CR, which is $42 million below the President's 2007 ACI request. In 2008, the American Competitiveness Initiative proposes NIST funding increases of $69 million for new initiatives in research and measurements in high-leverage areas such as the Disaster-Resilient Structures and Communities Program, the interagency Climate Change Science Program, and the interagency National Earthquake Hazards Reduction Pro-

gram. Support continues for high-leverage, broad impact research in quantum information processing, nanotechnology, and new and expanded capabilities at the NIST Center for Neutron Research and at its Boulder, Colorado, high-performance labs.

National Aeronautics and Space Administration (NASA)

The President's 2008 Budget for NASA is $17.3 billion, a 3.1 percent increase over the President's 2007 request, reflecting a strong commitment by the Administration to the continued pursuit of the Vision for Space Exploration. The FY 2007 CR, however, reduces the 2007 Budget by $545 million to $16.2 billion.

In 2008, NASA requests $3.92 billion for exploration systems including the Orion Crew Exploration Vehicle (CEV) and the Ares I launch vehicle that will carry astronauts to the Moon. Having already initiated the acquisition process for certain elements of this architecture during 2006, NASA anticipates that all Orion CEV and Ares I elements will be under contract by the end of 2007, with the first crewed-flight planned to occur no later than 2014.

The 2008 Budget requests $5.52 billion, almost a third of NASA's total budget, to continue operating the 59 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 develop seven new Earth observing space missions, including the Landsat Data Continuity Mission and the Global Precipitation Measurement mission, which will launch no later than 2013. 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 also support studies of the Earth-Sun system using data from the STEREO mission and the upcoming Solar Dynamics Observatory. A new Lunar Science Research program will conduct robotic investigations of the Moon as a part of the Vision for Space Exploration. Following up its missions to Mars and Saturn, NASA is sending ever-more capable spacecraft to Mars, Mercury, the asteroids, and Pluto. NASA also will continue its vibrant astronomy program through its Great Observatories, and will upgrade Hubble in 2008 to provide five more years of productive on-orbit life, while planning new spacecraft, such as Webb and Kepler, that will search for planets around other stars and peer deep into the universe. Funding for the Beyond Einstein program is increased in FY 2008 to act on the forthcoming recommendation from the National Research Council regarding a strategy to unlock the secrets of the fundamental physics of the universe.

In December 2006, the President approved the Nation's first National Aeronautics R&D Policy. Consistent with this Policy, the 2008 NASA aeronautics budget prioritizes fundamental aeronautics research, the improvement of aviation safety, and research that will help support the development of the Next Generation Air Transportation System. In addition, NASA will address infrastructure upgrades and maintenance requirements for aeronautical test facilities across NASA centers that are of vital importance to the Nation. The 2008 Budget requests $554 million for NASA aeronautics, an almost 5 percent increase over the 2007 request after adjusting for NASA's implementation of simplified full-cost accounting.

National Oceanic and Atmospheric Administration (NOAA)

For NOAA in the Department of Commerce, the FY 2008 Budget provides $358 million for Oceanic and Atmospheric Research (OAR), a $20 million increase over the 2007 Budget. OAR provides for ongoing research on climate, weather, air quality, and ocean processes.

The 2008 NOAA budget supports a new interagency oceans initiative to implement the President's U.S. Ocean Action Plan including $60 million in new funding over the 2007 Budget to advance oceans science and research (of which $13 million is in OAR). Of this $20 million will address four near-term ocean research priorities established by the *Ocean Research Priorities Plan and Implementation Strategy* (ORPPIS), published in January (with another $20 million from NSF and USGS). The NOAA Budget also proposes $40 million to develop an operational ocean monitoring network, to delimit the extent of the U.S. Continental Shelf, for technology and other infrastructure to support ocean science, for International Polar Year activities, and for research on protected species and commercial fisheries.

Department of Transportation (DOT)

The FY 2008 Budget request for highway-related research is $430 million, 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. These research programs include the investigation of ways to improve safety, reduce congestion, improve mobility, reduce lifecycle construction and maintenance costs, improve the durability and longevity of highway pavements and structures, enhance the cost-effectiveness of high-

way infrastructure investments, and minimize negative impacts on the natural and human environment.

The 2008 Budget request for Federal Aviation Administration (FAA) Research, Engineering, and Development is $140 million, including $63 million focused on the advancement of the Next Generation Air Transportation System led by its Joint Planning and Development Office.

In addition, the 2008 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.

Budget Highlights of Other Important Science Agencies

Department of Energy (DOE)

The Office of Science in DOE (DOE–SC) is one of the three priority research agencies in the President's American Competitiveness Initiative, supporting scientific studies and infrastructure for a wide range of basic research related to potentially significant innovations. The 2008 Budget provides $4.4 billion for DOE–SC, an increase of 16 percent over the level in the 2007 House-passed full-year Continuing Resolution (CR), which is $306 million below the President's 2007 ACI request. The Budget includes funding for priorities such as nanotechnology ($286 million), materials science research facilities ($699 million), basic research in support of the Hydrogen Fuel Initiative ($60 million), the Advanced Energy Initiative ($713 million), and high-end computing facilities and research ($340 million). The Budget also completes funding ($45 million) for project and engineering design 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—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 funding for the project and engineering design for the upgrade of the Continuous Electron Beam Accelerator Facility.

DOE implements the President's Advanced Energy Initiative (AEI), highlighted above. The 2008 AEI Budget proposes:

- $217 million for the solar R&D to accelerate development of cost-effective photovoltaic materials;
- $292 million for the biomass R&D, including $179 million for the Biofuels Initiative and an additional $113 million in supporting basic research, to help enable cellulosic ethanol to become practical and competitive;
- $42 million for development of high-energy, high-power batteries for hybrid-electric and "plug-in" hybrid vehicles;
- $40 million for wind energy research to help improve the efficiency and lower the costs of wind technologies, and to help overcome technical and regulatory barriers to more wide-scale deployment of wind technologies;
- $108 million for the FutureGen project to develop technologies for a coal gasification plant with near-zero atmospheric emissions; and
- $309 million for the Hydrogen Fuel Initiative, a crosscut of activities at DOE that includes AEI activities to accelerate development of hydrogen production, storage and infrastructure technologies that can help make possible the use of hydrogen-powered fuel cell vehicles and infrastructure to support them.

The 2008 AEI budget also proposes $395 million for the Global Nuclear Energy Partnership (GNEP) in Nuclear Energy with the goals 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 $160 million for the U.S. contribution to the ITER international fusion energy project is included as well.

Department of Defense (DOD)

DOD's FY 2008 R&D budget is almost $79 billion. This level of funding will support the Department's commitment to transform 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 will advance novel technologies to detect and neutralize improvised explosive devices, mines, rockets and mortars. DOD pro-

vides the largest share of NITRD program funding, over $1 billion, to address IT needs for the Nation's defense. Likewise, DOD will invest $375 million under the National Nanotechnology Initiative, emphasizing development of materials, devices and systems that address the national security mission.

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 $10.8 billion in the FY 2008 Budget, DOD S&T exceeds the 2001 enacted level by 21 percent, or $1.8 billion. From 2000 to 2007, Congressional earmarks to DoD S&T quadrupled. For 2007, there were over 1,200 of these adds (totaling $2.8 billion), most of which must be identified and tracked down, advertised in a way specific to the Congressional mark, evaluated, negotiated and awarded, in some way 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 should be cause for concern to Congress as well as to the Administration.

A total of $1.43 billion is provided for DoD 6.1 basic research in 2008. This is a nominal increase over the 2007 Budget and represents 13.3 percent of the DoD S&T Budget, more than last year's 12.8 percent share.

Department of Homeland Security (DHS)

The President's FY 2008 request includes $799 million for the DHS Directorate of Science and Technology and $562 million for the Domestic Nuclear Detection Office. R&D continues to play a key role in securing the Nation against the terrorist threat. The President's 2008 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: $100 million in transformational R&D aimed at enhancing our ability to detect, identify, and attribute nuclear and radiological materials; $68 million for explosives countermeasures research; and $15 million to fund cyber security and information assurance R&D.

United States Geological Survey (USGS)

The President has proposed a budget of $975.0 million for USGS in the Department of the Interior in Fiscal Year 2008. The proposed budget includes an increase of $3 million for the new oceans initiative activities, including $1.5 million in the Coastal and Marine Geology program to begin implementation of the Oceans Research Priorities Plan and Implementation Strategy. This involves conducting observations, research, and sea-floor mapping and developing forecast models. The budget also includes $1.5 million in the Hydrologic Networks and Analysis program to begin implementation of an interagency National Water Quality Monitoring Network that will integrate watershed, coastal waters, and ocean monitoring based on common criteria.

The FY 2008 USGS budget continues funding for operations and maintenance of Landsats 5 and 7 at $16 million. The Budget also includes $24 million to fund efforts with NASA and the Landsat Science Team to continue development of the Landsat Data Continuity Mission.

Environmental Protection Agency (EPA)

The FY 2008 Budget for science and technology funding at EPA is $755 million. Research priorities include supporting the agency's risk assessment programs including Air Quality Science Assessments (formerly called the Air Quality Criteria Documents) and the Integrated Risk Information System (IRIS), and the Science to Achieve Results (STAR) program of extramural research and graduate fellowships in areas of environmental science and engineering; $69 million is requested to fund new and ongoing research in water security, including monitoring and surveillance of terrorist threat agents, and post-incident decontamination.

Conclusion

Making choices is difficult even when budgets are generous, but tight budgets require priorities to be focused, and program management to be strengthened. 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 American Competitiveness Initiative and Advanced Energy Initiative properly focus R&D investments in areas that will increase our economic competitiveness, decrease our dependence on foreign oil, and accelerate development of clean energy technologies.

America currently spends one and a half times as much on federally-funded research and development as Europe, and over four times as much as either Japan or China, the next largest investors. 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.

We lead not only in science, but also in translating science to economically significant products that enhance the quality of life for all people.

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 initiatives advanced in the President's proposal. I would be pleased to respond to questions.

OFFICE OF SCIENCE AND TECHNOLOGY POLICY
EXECUTIVE OFFICE OF THE PRESIDENT
Washington, DC, May 17, 2006

Hon. TED STEVENS,
Chairman,
Senate Committee on Commerce, Science, and Transportation,
Washington, DC.

Dear Mr. Chairman:

I am writing to thank you for your strong and steadfast leadership on issues of importance to America's science and technology enterprise, and to comment on legislation (S. 2802) that I understand your Committee may be considering for markup.

First, I want to commend you for your efforts to highlight the paramount importance of basic research to America's long-term economic competitiveness. Your commitment to this issue is greatly appreciated. Your support now for the President's American Competitiveness Initiative (ACI) specifically will be crucial to the ultimate success of this domestic agenda priority.

As you know, the centerpiece of the ACI is a commitment to double, over 10 years, funding for the three key Federal agencies that support high-leverage fields of physical science and engineering: the National Science Foundation, the Department of Energy's Office of Science, and the National Institute of Standards and Technology labs within the Department of Commerce. The focus on these priority agencies was born out of an extensive and growing recognition that increasing the support for the basic research these agencies fund in the physical sciences is of critical importance to ensuring America maintains its competitive edge.

The proposed American Innovation and Competitiveness Act endorses our common goal of strengthening U.S. competitiveness through science and technology. However, I must raise very serious concerns with regard to the specific provisions of the legislation. While the President's ACI proposal is a targeted effort to focus increased funding on existing peer-reviewed research at the three priority agencies, the draft bill creates a multitude of new programs at many agencies, which, if enacted, would undermine and delay this very research. The Administration is strongly opposed to the creation of new bureaucracy. Many of the draft bill's provisions would duplicate or complicate existing education and technology programs. Others would put the government in the position of competing with private investment and influencing market decisions in potentially inefficient and counterproductive ways.

While we understand that the draft legislation is still a work in progress, the Administration is especially concerned about the authorization levels currently under consideration; excessive authorization levels may discourage and divert resources available for basic research in the physical sciences, thereby jeopardizing our shared goal to double funding for basic research at the key ACI agencies.

I hope you will give strong consideration to these concerns as your Committee begins consideration of any competitiveness-related legislation. I believe we share a common interest in working to strengthen America's capacity to innovate and retain its leadership position in the global economy, and I look forward to working with you toward this goal.

Thank you again for your leadership on these issues.

Sincerely,

JOHN H. MARBURGER III,
Director.

Senator KERRY. Thank you very much, doctor, I appreciate that. Dr. Bement?

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

Dr. BEMENT. Chairman Kerry, Ranking Member Ensign, and Members of the Committee, thank you for this opportunity to testify on the National Science Foundation's importance to U.S. competitiveness.

NSF's commitment to the science and engineering enterprise comes from an abiding belief that knowledge is a powerful force for progress.

NSF works at the frontier of knowledge, where high-risk, high-reward research can lay the foundation for revolutionary technologies, and tackle complex problems that challenge society.

Quite simply, our investments in fundamental research and education aim to improve the quality of people's lives, and to keep the Nation safe and growing. The NSF budget for 2008 reflects this vital agenda and is detailed in my written testimony.

For over 50 years, NSF has been a strong steward of the Nation's scientific discovery and innovation process that has been crucial to increasing America's economic strength, global competitiveness, national security and overall quality of life. Despite its small size, NSF has an extraordinary impact on scientific and engineering knowledge and capacity.

While NSF represents only 4 percent of the total Federal budget for research and development, it accounts for 50 percent of non-life science basic research at academic institutions. In fact, NSF is the only Federal agency that supports all fields of basic science and engineering research, and the education programs that sustain them across the generations.

NSF relies on a merit-based competitive process that is critical to fostering the highest standards of excellence and accountability, standards for which NSF is known all around the world.

Not only do we provide funding to the best of the best, we prioritize the research funding based on principles that have proven to be both robust and visionary over the years. The proof of its effectiveness lies in the outcomes.

NSF-funded results permeate our society—examples include Doppler radar, MRI scans, nanotechnology, the Internet, web-browsers, search engines, bar codes and computer-aided design systems. NSF investments have had a profound effect on our quality of life and on American competitiveness. Just these examples alone have added hundreds of billions of dollars to the U.S. economy over the past 15 years.

I would like to point out just a few other recently funded developments with equal promise, some of which illustrate the accelerating convergence between the physical and the life sciences. NSF's support for cutting-edge research projects often serve as bell weathers for solutions to a myriad of complex issues facing society.

For example, implantable generators, with advanced drug delivery systems, illustrate nanotechnology's increasing contribution to understanding and treating disease. An injectible gel to treat spinal cord injuries is the result of NSF-supported polymer research. The Lasik eye correction procedure has emerged from high-precision laser research, funded by NSF.

On the environmental front, thin film technologies and power plastics sufficiently generate power from light, offering viable renewable energy resources. Meanwhile, the production of plastics from atmospheric carbon dioxide puts the damaging greenhouse gas to good use, helping to sustain the environment.

NSF programs traditionally integrate research and education, fast-tracking innovation excellence via hands-on learning. For example, NSF-supported Advanced Technology Education centers offer industry-sanctioned technician education programs. The centers respond directly to industry's workforce needs, and graduate technicians who immediately enter the high-tech workforce.

It is important to note that in our efforts to advance the frontier, we also aim to enhance developments of the Nation's talent pool of scientists, technologists, engineers and mathematicians, otherwise known as STEM. The world class STEM talent pool, trained through NSF-sponsored research, transfers new scientific and engineering concepts from universities directly to the entrepreneurial sector as they enter the workforce. This may be basic research's most profound and lasting impact. This capability is a strong suit in U.S. competitiveness, and one of NSF's greatest contributions to the Nation's innovation system.

Another significant contribution is NSF-supported coupling programs between universities and the private sector. NSF centers programs, such as our Engineering Research Centers and Science and Technology Centers, directly invite private sector partners to engage in and sponsor related cutting-edge research in education that can lead to high-leverage innovations.

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

Today I've only touched on the variety and richness of the NSF portfolio. NSF research and education efforts contribute greatly to the Nation's innovation economy, and help keep America at the forefront of science and engineering. Extraordinary discoveries coming from NSF-funded researchers and initiatives enrich the entire science and engineering enterprise, and make education fun, exciting, and achievement-oriented. NSF and the National Science Board looks to the future, committed to these important considerations, and we have crafted our 2008 budget to address them.

Mr. Chairman, and members of the Committee, I look forward to working with you in the months ahead, and would be happy to respond to any questions that you may have.

[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 Committee, thank you for this opportunity to testify on the importance of basic research. It is a pleasure to appear before you again on this important topic. I would like to thank the Members of this Committee for their support for NSF over the years and specifically for your support for NSF in the 2007 Continuing Resolution, the 2008 budget and the America COMPETES legislation.

I am especially pleased to emphasize once again the role the National Science Foundation (NSF) plays in sustaining America's competitiveness in the global economy. As you are well aware, the President's request for NSF represents an 8.7 per-

cent increase over the appropriated levels, and will keep NSF on the course set by the President's American Competitiveness Initiative (ACI) to drive innovation and sharpen America's competitive edge. This year's budget reinforces the Administration's firm commitment to doubling overall funding for the NSF, the Department of Energy's Office of Science, and the Department of Commerce's National Institute of Standards and Technology labs over the next 10 years.

For over fifty years, NSF has been a steward of the Nation's science and engineering enterprise, with a track record of producing results. 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.

Despite its relatively small size, NSF has an important impact on scientific and engineering knowledge and academic capacity. While NSF represents only 4 percent of the total Federal budget for research and development, it accounts for fifty percent of non-life science basic research at academic institutions. 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 for which NSF is known all over the world.

We provide funding to the best of the best. Of the 513 individuals who have received the Nobel Prize since NSF first awarded research grants in 1952, 174 or 34 percent received NSF funding at some point in their careers.

NSF-funded research has led to social benefits. Examples include Doppler radar, MRI scans, nanotechnology, the Internet, web browsers, search engines, bar codes, and computer-aided design systems. NSF investments have played an important role in American competitiveness and innovation. The economic returns from these technologies alone have added hundreds of billions of dollars to the U.S. economy over the past 15 years.

As you well know, investments in fundamental research often yield unexpected benefits. One example I like to use is NSF's support of abstract auction theory and experimental economics. NSF-supported researchers provided the FCC with its current system for apportioning the airwaves. Since their inception in 1994, FCC "spectrum auctions" have netted over $45 billion in revenue for the Federal Government and more than $200 billion in worldwide revenues. Although the payoff was unexpected at the time NSF started supporting game-theory research, the payoff is many times greater than the total investment NSF has made in social and behavior sciences over our fifty year history.

In our efforts to advance the frontiers of knowledge and spur innovation, NSF also aims to develop of the Nation's talent pool and create a highly skilled workforce. This may be NSF's most profound, and lasting, impact.

Perhaps even more important than the breakthroughs I have described above, are the students that have been educated and trained along the way, including as participants in prize-winning research. The scientists, technologists, engineers, and mathematicians trained through the integration of research and education transfer new scientific and engineering concepts from universities directly to the entrepreneurial sector as they enter the workforce. This capability is a strong suit in U.S. competitiveness, and one of NSF's greatest contributions to the Nation's innovation system.

Opportunities to advance the frontiers of research and education are more promising than ever before—across every field of science, mathematics and engineering. No matter what field of science one chooses—from studying the smallest particles of matter, to exploring the formation of the cosmos, to understanding dynamic interactions among humans or unraveling the complexity of life on Earth—ground-breaking research is on the horizon. The NSF budget for FY 2008 sets an ambitious agenda for capitalizing on this potential to discover new knowledge that can help boost the Nation's economic vitality and improve our quality of life.

NSF's commitment to the science and engineering enterprise comes from an enduring belief that knowledge is a powerful force for progress. NSF works at the frontier of knowledge where high-risk, high-reward research can lay the foundation for revolutionary technologies and tackle complex societal problems.

Quite simply, our investments in fundamental research and education improve the quality of people's lives and contribute significantly to our Nation's prosperity. The NSF budget for 2008 reflects this vital agenda, and I'm pleased to present it to you today.

Let me begin with the numbers. Overall, in his FY 2008 Budget Request, the President is requesting $6.43 billion for the NSF. That's an increase of nearly $513 million, or 8.7 percent above the 2007 appropriated amounts. Funding at this level in FY 2008 will keep us on the course set by the President's American Competitive-

ness Initiative. The ACI aims to expand Federal research investments over the next 10 years to drive innovation and sharpen America's competitive edge. Our task in this ambitious undertaking is to energize the Nation's leadership in fundamental research and education that keeps America at the leading edge of innovation.

Funding levels increase for every major NSF appropriations account. Investments in Research and Related Activities increase by 7.7 percent, and our Education and Human Resources account by 7.5 percent. Rapid progress in these areas will generate new concepts and tools with far-reaching applications, lay the foundations for next-generation tools and technologies, and develop educational strategies to engage students and prepare them for the fast-changing, global environment. The budget includes increases for every Directorate and Office of NSF.

Our budget priorities for 2008 are based on the long-term investment strategies identified in the new NSF Strategic Plan. They are focused squarely on the future.

Discovery Research for Innovation

The first priority is Discovery Research for Innovation. In nearly every field of science and engineering, we are moving toward new knowledge that will contribute to the resolution of some of society's most stubborn problems—in areas such as energy, security, health and the environment. And we are on the threshold of technological innovations that will power the economy well into the future.

Today, the most fertile ground for discovery is often at the interface among disciplines, where insights from one field inform our understanding of another. To explore that territory, our strategy must be to keep all fields and disciplines of science and engineering healthy and strong. We continue to address that objective in 2008.

At the same time, we must be constantly alert to research that has the potential to overturn accepted paradigms and open entirely new fields for exploration. Below I will highlight several of these emerging frontiers. But it is important to note that the power of transformational research is ubiquitous today across the social, physical and life sciences, and engineering.

Cyber-enabled Discovery and Innovation

The power of new information and communications allows us to investigate phenomena of increasing complexity, scale and scope. But researchers are finding it increasingly difficult to cope with the flood of data from improved observational tools, to assimilate different data formats and ontologies—atomic to the cosmic—and to find ways to store and archive petabyte-sized databases.

In 2008, NSF will invest $52 million in a new initiative we call Cyber-enabled Discovery and Innovation, or CDI. CDI will explore a new generation of computationally-based discovery concepts and tools at the intersection of the computational world and the physical and biological worlds.

In every discipline, we need new techniques that can help scientists and engineers uncover fresh knowledge from vast amounts of data generated by sensors, telescopes, satellites, or even the media and the Internet. Understanding complex interactions in systems ranging from living cells to binary star systems, or from computer networks to societies, also present challenges.

We need improved simulation and other dynamic modeling techniques to support experiments with complex systems—from earthquakes to brains—that are not feasible to perform in the physical world.

Finally, virtual environments have the potential to enhance collaboration, education, and experimentation in ways that we are just beginning to explore. CDI educational research efforts will center on a combination of virtual environments and advanced cyberinfrastructure. CDI will tackle all of these challenging research problems.

Ocean Research Priorities Plan

Understanding the interactions between society and the oceans is of vital importance for ensuring a clean, healthy, stable, and productive ocean environment. The Ocean Research Priorities Plan (ORPP) lays out, for the first time, a national effort to link ocean research to societal issues ranging from the stewardship of ocean resources to the ocean's role in climate.

A new NSF investment of $17 million will support fundamental research and technology development in four areas identified in the Plan as near-term priorities.

One area of investigation will look at the complex dynamics that control and regulate marine ecosystem processes—knowledge that is absolutely essential to improve the management of marine resources. A second explores variability of the Meridional Overturning Circulation in the Atlantic Ocean. This is one element of global ocean circulation that is responsible for long-term climate variations along the Eastern Seaboard. Research will also address the response of coastal ecosystems to events ranging from non-point source pollution to hurricanes.

A fourth priority is the development of new marine sensors. This is also an important objective of the Foundation's Ocean Observatories Initiative (OOI). OOI—together with other observatories such as NEON, NEES, and GEON—will make an important contribution to GEOSS—the Global Earth Observation System of Systems (GEOSS). This research complements a much more extensive, ongoing program of ocean research and education at NSF.

National Nanotechnology Initiative

Nanotechnology is an emerging field of immense promise, with ramifications for manufacturing, medicine, and next-generation computing. With the promise of nanotechnology, we can anticipate systematic programs to identify or design a broad spectrum of materials with just the right properties for the application in mind.

We are increasing our investment in the interagency National Nanotechnology Initiative by nearly $17 million, to a total of $390 million, to support fundamental nanoscale research and the development of nanomaterials.

A critical focus of this investment will be a new multidisciplinary effort to better understand the environmental, health, and safety impacts of nanomaterials. This research will explore the interactions between nano particles and materials and the living world at all scales. The development of innovative methods and tools to detect, characterize, and monitor nano materials in the environment, is an important feature of these activities.

International Science and Engineering

International partnerships are now an abiding feature of the global science and engineering landscape. U.S. scientists and engineers must remain connected with researchers around the globe to detect movements at the frontier and capitalize on new concepts. This is essential if we wish to be the first nation of choice for scientists, engineers, and students from abroad.

Moreover, in this era of globalization, international experience is fast becoming an essential element in the training of U.S. undergraduate and graduate students.

NSF will support agency-wide activities to expand international partnership opportunities for U.S. scientists, engineers and students, with an increase of nearly 11 percent for the Office of International Science and Engineering, for a total of $45 million.

Preparing the Workforce for the 21st Century

Creating a strong science and engineering workforce for the future is vital to maintaining the Nation's competitive edge. NSF will continue to fund a portfolio of highly successful programs.

You will recognize all of them: CAREER, aimed at junior faculty; Advanced Technological Education (ATE) to train skilled technicians and technologists; Broadening Participation in Computing, designed to train the future IT workforce; Noyce Scholarships, which promote the development of a world-class math and science teaching corps; The STEM Talent Expansion Program (STEP) and the Centers for Research Excellence in Science and Technology (CREST), both of which aim to broaden participation of underrepresented groups and engage a broader spectrum of institutions, two objectives of vital importance to maintaining America's global competitiveness.

In coordination with the Department of Education, NSF will continue funding for the Math and Science Partnership program, aimed at improving K–12 science and math education and teaching. Although the 2008 Request for MSP remains at the FY 2007 level of $46.0 million, approximately $30 million will be available for new awards in 2008.

The budget request also includes funding for an additional 200 Graduate Research Fellowships (GRF). Together with other NSF graduate fellowship, that brings the total number of graduate students supported to about 5,375.

Transformational Facilities and Infrastructure

World-class tools and facilities are every bit as essential for discovery. Our strategy is to invest in tools that promise significant advances in a field and to make them widely available to a broad cross-section of investigators.

For FY 2008, NSF proposes one new start in the Major Research Equipment and Facilities Construction account (MREFC): Advanced LIGO (AdvLIGO), a gravitational wave observatory that will improve by a factor of 10 the sensitivity of current earth-based facilities. Observations made with this instrument could revolutionize the field of theoretical physics.

Scientific breakthroughs that are just over the horizon will require speeds and abilities that even today's supercomputers cannot produce. The development of a petascale computing capability will continue to be an important priority for NSF.

Our commitment to support cyberinfrastructure remains equally steadfast. These investments will optimize high-end computing and cyberinfrastructure for science and engineering applications—and contribute to the Nation's competitiveness in many other ways.

Funding for the Major Research Instrumentation (MRI) program increases by about $24 million to a total of $114 million. In addition, we will raise the maximum level of funding within MRI from $2.0 million to $4.0 million. These funds support the design and acquisition of mid-size instruments that are every bit as essential as their big brothers.

International Polar Year (IPY)

As the lead agency supporting Polar research, NSF will provide U.S. leadership for IPY activities through support for an intense research and public education effort. The budget request includes nearly $59 million for these activities.

In the Polar Regions, we are discerning the outlines of environmental change, from sea ice extent, retreating glaciers, shifting patterns in flora and fauna, to environmental observations by Arctic natives. Such change—whether environmental, biological or social—has implications for the rest of the globe. Polar change ripples across the planet on a spectrum of time scales, through the atmosphere, oceans, and living systems.

We do not yet fully understand the causes of what we are observing. Now is the time to change this, for new tools make possible the needed observations and synthesis of knowledge. They range from satellites to ships to sensors, and from genomics to nanotechnology, information technology, and advances in remote and robotic technologies.

For these reasons, climate change research and environmental observations will be a major focus for NSF IPY activities. Much of this research will support the goals of the U.S. Climate Change Science Program. Because the scope and scale of climate change is global, U.S. scientists will collaborate with scientists from around the world.

Another IPY research effort will explore how life functions and survives in the extremes of the polar regions. A surprising diversity of life flourishes in the McMurdo dry valleys of Antarctica, for example. Research will focus on microorganisms at various scales, but will include a diversity of organisms. Research on humans in polar environments will advance our understanding of our species' place in the complexity of polar phenomena.

IPY offers an excellent opportunity for outreach and education to raise public understanding of science and engineering and NSF will continue to support such efforts.

Stewardship

Also among our 2008 priorities is Stewardship—our commitment to support excellence in science and engineering research and education by maintaining a capable and responsive organization. I would be remiss if I didn't mention that the success of our post—award and pre—award oversight and merit review process depends entirely on our program officers and program directors. They all know that the optimal use of limited public funds relies on two conditions: Ensuring that research is aimed—and continuously re-aimed—at the frontiers of understanding; and certifying that every dollar goes to competitive, merit-reviewed, and time-limited awards with clear criteria for success. When these two conditions are met, the Nation gets the most intellectual and economic leverage from its research investments.

Our 2008 Budget request would provide adequate funding for operations and award management *i.e.,* salaries and expenses), particularly in the information technology field, which is critical to the agency functioning as efficiently as possible. We need to maintain our investments in productivity-enhancing tools, including cybersecurity, and modernization of information technology as well as continue to provide post-award oversight. I applaud Members of this Committee for their support for full funding of our FY 2008 budget request.

NSF has just completed a new strategic plan for 2006–2011. As a direct result of the strategic planning process, NSF has established eight new multi-year objectives for stewardship. We will strengthen our traditional partnerships and develop new collaborations with other agencies and organizations. We will also expand efforts to broaden participation from underrepresented groups and institutions in all NSF activities.

NSF leads Federal agencies in funding research and education activities based on competitive merit review, with over 88 percent of its research and education funding going to awards selected through a competitive merit review process. Improving the

transparency, consistency, and uniformity of the merit review process is a priority for 2008 and into the future.

An objective for 2008 is establishing the *Research.gov* portal site—a one-stop website for grantees seeking Federal funding. The portal will also help research agencies share grants management best practices as part of the Grants Management Line of Business.

Conclusion

Mr. Chairman, I've only touched upon some of the variety and richness of the NSF portfolio. NSF research and education efforts contribute greatly to the Nation's innovation economy and help keep America at the forefront of science and engineering. At the same time, NSF-supported researchers produce leading edge discoveries that serve society and spark the public's curiosity and interest. Extraordinary discoveries coming from dozens of NSF programs and initiatives are enriching the entire science and engineering enterprise, and making education fun, exciting and achievement-oriented.

Scientists can now peer back in time to the early years of the universe, from its explosive formation to its dark ages, to its first stars and mini-galaxies. Seeing this far into the past is a remarkable feat of science and engineering creativity and imagination. It is imperative that we also use our knowledge to illuminate the future. The ultimate reason for the science and engineering enterprise is to put knowledge to work for the growth of the economy and the well being of society.

At the beginning of the 21st century, America has the world's best cadre of scientists and engineers. We have some of the finest academic institutions anywhere. And maybe most importantly, we have a half century of experience working to perfect what is commonly acknowledged as the most successful system for supporting research, coupled with educating our scientists and engineers.

As this century plays out, there will be an increasing number of competent players in the global competition for ideas, talent, and innovation. 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. The nation needs bold efforts, at the most demanding levels of creative enterprise, to sustain a leadership role in the global economy.

In these shifting sands, I believe that America can continue to be on the leading edge of ideas and research that can chart the global path for the next half century. We want our universities and businesses to continue leading the world in discovery and innovation. That means cultivating our strengths—U.S. 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. These strategies can help us reinvent American competitiveness in the 21st Century.

But make no mistake. Staying at the forefront of discovery and innovation will require sustained investments. In a science and technology based world, to retreat from the frontier is to put the Nation at peril.

NSF is committed to cultivating a science and engineering enterprise that not only unlocks the mysteries of the universe but that addresses the challenges of America and the world. The National Science Foundation looks to the future with these important considerations in mind, and we have crafted our 2008 budget to address them.

Mr. Chairman and members of the Committee, I hope that this brief overview conveys to you the extent of NSF's commitment to advancing science and technology in the national interest. I look forward to working with you in months ahead, and would be happy to respond to any questions that you have.

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

Dr. Jeffrey?

STATEMENT OF DR. WILLIAM A. JEFFREY, DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, U.S. DEPARTMENT OF COMMERCE

Dr. JEFFREY. Chairman Kerry, Ranking Member Ensign, and Members of the Subcommittee. I'm pleased to present the President's 2008 budget request for NIST.

This is a strong budget that will further enhance our ability to support the measurements and standards needs of U.S. industry and universities.

NIST has a long history of being at the forefront of new innovations through our measurements and standards. In 2003, the National Academy of Engineering identified the greatest engineering achievements of the 20th century. NIST measurements and standards were integral to the successful development and adoption of virtually every one.

Nineteen retrospective studies of economic impact show that, on average, NIST labs generated a benefit to cost ratio of 44 to 1 to the U.S. economy. The high rate of return results from the fact that new measurements or standards benefit entire industries or sectors of the economy, as opposed to individual companies.

For example, NIST researchers recently developed new measurement techniques that cut up to 80 percent of the cost and time for industry to develop advanced materials. As one industry scientist put it, "NIST scientists are re-awakening a major element of creativity that analytical science almost lost." NIST also operates world-class user facilities. Last year, approximately 2,000 researchers from 60 different industries leveraged the NIST Center for Neutron Research or the NCNR. A National Academy of Sciences report describes the NCNR's capability to image an operating fuel cell as, "A considerable achievement, and one of the most significant analytical advances in the fuel cell realized in decades." Industry scientists have stated that the research performed at the NCNR has allowed them to jump 5 years ahead in fuel cell development.

To prepare for the future, NIST is working with industry to identify critical measurement barriers to innovation, evaluating its physical infrastructure, forming new and strengthening existing partnerships, and updating the way it stimulates the knowledge transfer from its labs to industry and academia.

The increased funding provided through the budget 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.

For example, the research initiatives will speed the development, and foster the adoption of nanotechnology products, and provide the physical measurements to ensure their safety, accelerate the revolutionary economic potential, in exploiting the unique properties of the quantum world, provide confidence and reduce uncertainty in measurements supporting global climate change models, reduce the risk to communities as they encroach on hurricane-prone coasts and fire-prone wild land urban interface regions, and enhance safety of new and existing structures from the catastrophic impact of earthquakes.

To meet the demands for measurements at ever-smaller scales, at faster rates, and with more accuracy requires excellent laboratory and user facilities. The budget request, therefore, includes capacity and capability improvements at both our Boulder campus and the NCNR.

The budget request for MEP is identical to last year's request, and is a reduction of $58.3 million from the 2006 enacted. I recognize the difference in priority between the Administration and Congress, regarding the Federal funding level for the MEP program. One thing you can be certain of, regardless of the final appropria-

tions, NIST will execute the program in the most effective manner possible to support the Nation's small manufacturers.

No funds for ATP are requested in the President's 2008 budget, the 2006 enacted budget was consistent with the phase-out of the program. Since the 2007 Continuing Resolution, however, included funding for ATP, we have initiated a new competition.

In summary, recent NIST measurements and standards research have enabled innovations now embedded in the iPod, body armor, saving the lives of domestic law enforcement officers and our service men and women overseas, and diagnostic screening devices for cancer patients, making their treatment more targeted and accurate. The results of NIST research can be found in virtually every manufacturing and service industry.

For more than a century, NIST research has been critical to our Nation's competitiveness. The increased funding requested for NIST will directly support innovations in broad sectors of the economy that will, quite literally, define the 21st century.

Thank you, and I would be happy to answer any questions.

[The prepared statement of Dr. Jeffrey follows:]

PREPARED STATEMENT OF DR. WILLIAM A. JEFFREY, DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, TECHNOLOGY ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Chairman Kerry, Ranking Member Ensign and Members of the Subcommittee, I am pleased to appear before you today to present the President's FY 2008 Budget request for the National Institute of Standards and Technology (NIST). This is a strong budget for NIST and it will further enhance NIST's ability to support the measurement and standards needs of U.S. industry and universities. The FY 2008 request of $640.7 million includes $594.4 million for NIST's core (encompassing NIST's research and facilities) and $46.3 million for the Hollings Manufacturing Extension Partnership. The budget for the NIST core represents an 11 percent increase over the President's FY 2007 request and a 21 percent increase over the FY 2007 Continuing Resolution (P.L. 110–5). This funding supports NIST's mission *to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards and technology in ways that enhance economic security and improve our quality of life.*

NIST's Impact on Innovation and the Economy

NIST has a long history of being at the forefront of new innovations through our high-impact measurements and standards. In 2003, the National Academy of Engineering identified 20 of the greatest engineering achievements of the 20th century—including automobiles, aircraft, lasers, computers, and the Internet. NIST measurements and standards were integral to the successful development and adoption of virtually every one. Now NIST is paving the way for the greatest achievements of the 21st century which are still yet to be imagined.

NIST's measurement science and standards form part of the foundation upon which innovation is built. Just as the Nation's physical infrastructure (*e.g.,* roads or power grid) define the Nation's capacity to build and transport goods—the Nation has an innovation infrastructure which defines the Nation's capacity to innovate. And investment in long term basic research like that done at NIST is an integral component of the innovation infrastructure. As stated in the National Academy of Sciences' *Rising Above the Gathering Storm, "The power of research is demonstrated not only by single innovations but by the ability to create entire new industries."*

NIST researchers are world leaders in their fields. They frequently arrive at the "cutting edge" of science before anyone else. And once there, they partner with industry and academia to identify and overcome barriers that can slow or even halt the progress of new innovations. With the proposed FY 2008 budget, NIST will continue developing the measurement and standards tools that enable U.S. industry to maintain and enhance our global economic competitiveness.

NIST continues to meet the Nation's highest priorities by focusing on high impact research and investing in the capacity and capability of our user facilities and labs. This emphasis is validated by the high rate of return to the Nation that the NIST

labs already have demonstrated. Nineteen retrospective studies of economic impact show that, on average, NIST labs generated a benefit-to-cost ratio of 44:1 to the U.S. economy. The high rate of return results from the fact that new measurements or standards benefit entire industries or sectors of the economy—as opposed to individual companies.

NIST supports U.S. innovation and economic competitiveness primarily through its measurements, standards, and national user facilities. Recent NIST successes highlight the importance of each of these critical components and illustrate how NIST's labs are able to return such a large benefit to the nation:

Measurements—NIST researchers recently developed new measurement techniques that allow for rapid and cost-effective assessments of advanced materials that are used in a range of products from new detergents to improved adhesives for next-generation electronics. Previously, it could cost industry $20 million to develop and understand the characteristics of one new material. With this NIST measurement advance, the cost and time are estimated to have been cut by 80 percent. To facilitate the transfer of this technique to industry, NIST organized an open consortium now consisting of 23 members that are learning to use and adapt these new measurement techniques. As a scientist from Honeywell International put it, ". . . *NIST offers an invaluable resource to show what can be done, and how to go about it. NIST Combinatorial Methods Center scientists are reawakening a major element of creativity that analytical science almost lost.*"

Standards—Nanotechnology has the potential to revolutionize manufacturing. And one of the most promising nanomaterials is the carbon nanotube. Carbon nanotubes have unique electronic and mechanical properties that lend themselves to a variety of applications, ranging from the development of stronger and lighter materials to nanowires and transistors for miniature electronics. Regardless of the potential application, the quality of the materials is paramount. Unfortunately, current production techniques for carbon nanotubes result in products with high levels of uncertainty in their quality and uniformity. To address this concern, NIST is currently developing a carbon nanotube reference material. This reference material, when deployed, can be used by any nanotube manufacturer to validate their product's quality, purity, and consistency and accelerate the adoption of carbon nanotubes into more sophisticated devices.

National User Facilities—NIST operates world-class user facilities that benefit the entire U.S. research community. Last year, approximately 2,000 researchers from 60 different industries across the country leveraged the NIST Center for Neutron Research (NCNR). One recently developed application of the NCNR was to image the interior of operating fuel cells to help improve the efficiency and durability of these devices. Large and small companies involved in the manufacture or use of hydrogen fuel cells, including General Motors, Daimler-Chrysler, Dupont, and PlugPower, have benefited from this new capability. The NCNR is the premier facility in the world providing this capability. A National Academy of Sciences report describes the NIST efforts in regards to fuel cell technologies as ". . . *a considerable achievement and one of the most significant analytical advances in the membrane fuel cell realized in decades. The NIST facility offers the entire fuel cell community unique research opportunities that previously eluded them.*" Industry scientists have stated that the research performed at the NCNR has allowed them to jump 5 years ahead in terms of fuel cell development.

The President recognized NIST's critical role for the Nation as part of the American Competitiveness Initiative (ACI). The ACI describes NIST as: ". . . *a high-leverage Federal research agency that performs high-impact basic research and supports the successful technical translation and everyday use of economically significant innovations* . . ." Under the ACI, overall funding for NIST's core, the National Science Foundation, and the Department of Energy's Office of Science is together slated to double by 2016.

Preparing for the Future

The 21st century will be defined by technology innovations that fundamentally change the products and services available, the way they are manufactured and provided, and the impact on our quality of life. These advances will arise from basic research now beginning in, for example, nanotechnology, quantum science, and alternative energies—all areas in which NIST has a strong and increasing focus with its investments.

The goal of increasing physical sciences research at NIST (along with that supported by the National Science Foundation and the Department of Energy's Office of Science) provides a unique opportunity to strategically establish the programs,

plans, and infrastructure that will more than double the impact that NIST has on the economy. To prepare for the future, NIST is working with industry to identify critical measurement barriers to innovation, evaluating the capacity and capability of NIST's physical infrastructure, forming new and strengthening existing partnerships, and updating the ways it stimulates the knowledge transfer from its labs to industry and academia.

For example, over the past year, NIST worked with over 1,000 experts from industry and universities to identify measurement barriers to innovation in a number of critical industry sectors. Over 700 technical barriers were identified, analyzed, and documented in a report. NIST is now in the process of working with industry, universities, and other government agencies to address many of these identified barriers over the coming years.

In terms of facilities, NIST has conducted a rigorous evaluation of its laboratory capacity and capabilities on its Boulder, Colorado, campus. This review found facilities' shortfalls in our ability to meet both current and projected industry and university needs in a number of important areas. Examples include the high-speed and high-frequency measurements required for electronics, defense, and homeland security; measurements and tests at the single atom level; and improved methods for measuring time, an area expected to vastly improve navigation and positioning systems. Each technical area was evaluated in terms of necessary laboratory conditions (to include stability of temperature, vibration, and humidity, as well as air cleanliness). As a result of this assessment, new laboratory space to meet the Nation's needs well into the 21st century is proposed in the FY 2008 budget (Boulder Building 1 Extension).

NIST also serves industry and academia by being a steward of world-class user facilities. As part of the ACI, NIST identified two important opportunities first called out in the FY 2007 budget and enhanced in the FY 2008 budget—increased capacity and capability of the NIST Center for Neutron Research and creation of the NIST Center for Nanoscale Science and Technology. Both of these facilities are designed to stimulate progress in support of our Nation's economic competitiveness.

The ACI provides NIST the opportunity to further promote U.S. innovation and industrial competitiveness. With focused, world-class research and facilities, NIST will have a greater impact on the 21st century economy than it did even over the past century.

FY 2008 President's Budget

The increased funding provided through the FY 2008 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 following table summarizes the proposed FY 2008 budget. In this table we show both the FY 2007 President's budget and the FY 2007 Continuing Resolution (P.L. 110–5) for comparisons as different baselines.

Budget Summary Showing Both FY 2007 President's Request and P.L. 110–5 as Baselines

[$ million]

	FY 2007 President's Request	FY 2007 Continuing Resolution (P.L. 110–5)[1]	FY 2008 President's Request	Change Between FY 2008 and FY 2007 Request	Change Between FY 2008 and P.L. 110–5
STRS (Labs)	467.0	432.8	500.5	33.5	67.7
CRF (Facilities)	68.0	58.7	93.9	25.9	35.2
Core Subtotal:	535	491.4	594.4	59.4	102.9
ITS (MEP + ATP) Subtotal:	46.3	183.6	46.3	0	(137.3)
TOTAL:	581.3	675.1	640.7	59.4	(34.4)

[1] Totals for FY 2007 do not include the 50 percent of the pay raise that was included in P.L. 110–5.

The FY 2008 budget was formulated with the FY 2007 President's request as the baseline. Since P.L. 110–5 provides a smaller budget for the NIST core (STRS and CRF) than the FY 2007 President's request by $43.6 million, some proposed initiatives in FY 2007 that will not receive full funding are implicitly contained within the President's FY 2008 request. New initiatives and program increases are described in more detail below:

Scientific and Technical Research Services (STRS)

Enabling Nanotechnology from Discovery to Manufacture (+$6 million)

The potential market for products containing nanomaterials is estimated at over $1 trillion by 2015. Because of their small size—a thousand times thinner than a human hair—nanoscale products require entirely novel ways to characterize their physical properties and fully exploit their unique characteristics in the manufacture of new products.

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.

The research initiatives proposed in FY 2008 will build on recent NIST advances by:

- Developing 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
- Producing the measurement techniques required to address the interagency efforts to characterize nanotechnology impacts to our health, safety, and environment.

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

The climate is changing. Determining how fast it is changing, and understanding the complex relationships between all the environmental variables is a critical objective of the U.S. Climate Change Science Program. Many different climate monitoring systems in space, in the air, and on the ground are currently monitoring solar output as well as trapped and reflected heat by the Earth's atmosphere. These systems are operated by many countries and research groups. Establishment of absolute calibration and standard references will allow accurate intercomparisons of these systems, will help identify small environmental changes occurring over many years, and will reduce uncertainties in the data input to global climate change models.

With the proposed FY 2008 funding, NIST will, working in coordination with other agencies, 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-based irradiance measurement systems;
- Techniques for generating specific types of aerosols in the laboratory, measuring aerosol optical and physical properties, and for 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.

Enabling Innovation Through Quantum Science (+$4 million)

Unlike the laws of physics that govern our "every day" world, the laws of physics that govern the quantum world of atoms, electrons, and light particles are fundamentally different. These quantum particles are able to interact in ways that according to human experience would seem impossible. For example, a quantum particle can actually be in two different places simultaneously.

Conceptualizing these phenomena is difficult to say the least, but developing ways to exploit them for the development of technologically significant innovations is even more challenging. NIST, however, has world-class scientists who are leaders in the emerging field of quantum information science. Three NIST scientists have won Nobel Prizes in the last 10 years based on their work in this 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 revolutionized the 20th century.

The proposed FY 2008 initiative will build upon NIST's significant expertise in this area, and leverage the collaborations established in the recently created Joint Quantum Institute between the University of Maryland, NIST, and the National Security Agency. NIST proposes to accelerate the potential of the quantum world for enhancing our Nation's competitiveness through research into:

- Quantum "wires" that use "teleportation" techniques to reliably transport information between the components of a simple quantum computer;
- Quantum memory analogous to the random access memory of today's computers to allow more complex logic operations;
- Quantum conversion processes that transfer information from one form of quantum information to another (for example, ways to transfer information about the quantum characteristics of an atom to a photon); and
- Quantum based measurement tools such as optical clocks and single electron counters.

Disaster Resilient Structures and Communities (+$4 million)

The past few years have reminded us that both natural hazards—including extreme winds, storm surge, wildland fires, earthquakes, and tsunamis—as well as terrorist actions, are 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 codes, standards, and practices used when they were built. Many of these legacy codes, standards, and practices—which have evolved over several decades—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.

The proposed FY 2008 initiative will, working in coordination with other agencies, develop:

- Standard methods to predict losses, evaluate disaster resilience, and estimate cost-to-benefit of risk management strategies at the community and regional scales that local officials can use to evaluate and mitigate risks via land-use planning and practices;
- Decision-support tools to modernize codes, standards, and practices consistent with the risk;
- A validated "computational wind tunnel" for predicting extreme wind effects on structures; and
- Risk-based storm surge maps for the design of structures in coastal regions.

National Earthquake Hazards Reduction (+$3.25 million)

Many earthquakes strike without warning. Within the U.S., more than 75 million people are located in urban areas considered to be of moderate to high risk of 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. To address this threat Congress has provided longstanding support for the National Earthquake Hazards Reduction Program which NIST coordinates across the Federal Government.

This initiative will enhance the safety of:

- *New structures* by establishing and promoting performance-based standards for entire building designs and by accelerating the adoption of basic research into the model building codes, standards, and practices; and
- *Existing structures* through research on actual building performance in earthquakes; developing structural performance models and tools; and establishing cost-effective retrofit techniques for existing buildings.

Construction of Research Facilities (CRF)

Building 1 Extension (B1E)—Enabling Sustained Scientific Advancement and Innovation (+$28 million)

When President Eisenhower dedicated the NIST facilities in Colorado in 1954, no one imagined that half a century later scientists would be manipulating matter atom-by-atom. Such technological advances require increasingly complex and difficult measurements—to be able to observe, characterize, and create structures at ever smaller spatial scales. As the structures shrink in size, small fluctuations in temperature, humidity, air quality, and vibration begin to distort the results. We are now at the point where laboratory conditions are inhibiting further advances in some of the most promising areas of research for the 21st century.

The $28 million proposed in the FY 2008 budget will leverage previously proposed funds ($10.1 million) in the FY 2007 budget to construct state-of-the-art laboratory space that will meet the stringent environmental conditions required for 21st century scientific advances. An additional $38.1 million will be needed in FY 2009 to complete the project. With a total cost of $76.2 million, 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.

NIST Center for Neutron Research (NCNR) Expansion and Reliability Improvements (+$19 million)

The NCNR is widely regarded as the most scientifically-productive and cost-effective neutron facility in the U.S., and serves more scientists and engineers than all other U.S. facilities combined. Neutron scattering techniques, in which beams of neutrons are used as probes to see the structure and movements of materials at the smallest scales are critical in a wide range of applications that will define the 21st century including nanotechnology, alternative energies, and understanding the structure of biological molecules. Because of the unique properties of neutrons for probing materials and their applications to some of the most advanced technologies, a significant shortage of neutron beam capacity and capability exists in the U.S. to satisfy the demands of industry and academia.

This initiative begun in FY 2007 is the second-year of a planned five-year program to expand significantly the capacity and capabilities of the NCNR. The program includes the development of a new neutron cold source together with a new hall to house the guide tube, modernization of the control system, and five new world-class neutron instruments. The specific FY 2008 funding will complete construction of the new guide hall.

Industrial Technology Services

Hollings Manufacturing Extension Partnership (MEP) ($46.3 million—no change from FY 2007 President's request; –$58.3 million from P.L. 110–5)

The MEP program is a partnership between the Federal Government and local officials to provide assistance to small and medium sized manufacturers around the country. Surveys taken of companies 1 year after receiving MEP assistance indicate a significant financial benefit accrued to the individual company.

The Federal Government is an important partner in the MEP program. Specifically, the Federal Government:

- Develops new services and programs in response to the evolving manufacturing environment and propagates them throughout the network;
- Evaluates and ensures high-quality performance of every member of the network; and
- Ensures that small manufacturers remain the focus of the effort.

The above Federal role can be accomplished within the requested budget. The reduction 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.

Advanced Technology Program (ATP) ($0—no change from FY 2007 President's Request)

No funds for ATP are requested in the President's FY 2008 budget. The FY 2006 enacted budget and the 109th Congress' House mark and Senate Appropriations committee mark were consistent with the phase-out of the ATP program. The last new awards were made in 2004 and sufficient funds were available in the carryover to complete all awards and provide government oversight.

The FY 2007 Continuing Resolution (P.L. 100–5) includes funding for the ATP program. NIST will work with Congress to ensure the funds are executed in the most effective manner to promote U.S. industry's competitiveness.

Summary

Measurements and standards are the bedrock upon which any economy stands. Our founding fathers recognized this. The Constitution assigns the Federal Government responsibility to both issue money and to "*fix the standards of weights and measures.*" The two are actually more similar than they might seem at first glance.

All economic transactions rest fundamentally on trust—trust between two parties that a given amount of something is worth a given amount of something else. Helping to create that trust for innovative new technologies is the common theme that runs through all of NIST's proposed FY 2008 research initiatives. Each helps build a missing or inadequate measurement base—a rigorous, accepted way of quan-

titatively describing something—that improves confidence in scientific results or improves the quality, reliability or safety of innovative products. Recent NIST measurements and standards research have enabled innovations now embedded in the iPod, body armor currently saving the lives of domestic law enforcement officers and our service men and women overseas, and in diagnostic screening devices for cancer patients making their treatment more targeted and accurate. The results of NIST research can be found in virtually every manufacturing and service industry.

For nearly 106 years, NIST research has been critical to our Nation's current and future competitiveness. The increased funding in the President's FY 2008 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.

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

Thank you, all of you, I appreciate it.

I guess we'll do a loose 5-minute round, and try to, since there are only three of us here now, see what happens, four of us.

Each of you has come before the Committee and obviously articulated what you think you can do, these programs are very important, and we obviously respect and appreciate what you're doing. And we all understand that you have to operate within constraints.

You're the top science standards/research spokespeople for the Nation but, as I listen to you say, in a very direct way, and albeit, the President's budget for 2008 has a request of $143 billion for the R&D funding. Analysis by the American Association for the Advancement of Science shows that 58 percent of that budget, $83 billion, is going to defense-related R&D, $60 billion or 42 percent for non-defense, and the request is very heavy on development, about $82.8 billion totally.

Even after the proposed increase in the ACI agencies, NSF, NIST, DOE Office of Science, funding for basic and applied science research overall would fall 2 percent. R&D at NASA and ACI would, for the new space vehicle, rises, but the request for domestic R&D at other agencies would also fall, with cuts of 10.8 percent for the Department of Agriculture, 9.5 percent for NOAA, and a continued decrease in R&D funding for the Department of Homeland Security.

How do we reconcile this sense that you come in and say, "Well, this is overall increase," in fact, here's a chart—I wish I had it blown up, I apologize that I don't, you can't really see if from there, but maybe you can see some colored lines. This is 2001 here, you see the high line for NIH when we did the doubling, and the trend line has been downward since then. These are in inflation-adjusted dollars, now inflation-adjusted dollars are what everybody has to deal with, the reality of what can you purchase and what do you get, even though the dollars may go up.

Likewise if you look in other sectors, NSF goes slightly up, and down in USDA, and very much down in DoD S&T. The bottom line is, we're not growing in the basic and applied research areas. Isn't that dangerous for our long-term competitiveness?

Dr. MARBURGER. There's no question that basic research is a primary Federal obligation, Federal role, and that the ACI and similar initiatives have a focus on basic research.

Regarding the specific numbers and the details of the budgets for this year, and the budget behaviors, there's no question the President has attempted to restrain spending, and within the existing resources has set priorities that do emphasize basic research in

areas that have been historically underfunded, relative to their importance to——

Senator KERRY. Such as what, doctor?

Dr. MARBURGER. Such as physical sciences and mathematics, computer sciences, in particular, which have been underfunded with respect to some other areas of science. And the ACI specifically calls out these three priority agencies, which have been mentioned here today, for special treatment.

That is not to say that the other areas do not also enjoy priorities, I believe that the—that the expenditures through the Department of Defense are extremely important to maintain our competitiveness in technology, and I also believe that the expenditures for things like climate change, and environmental studies, Earth observations are extremely important, and this budget attempts to identify priorities in those areas and fund them at levels that maintains our leadership in precisely these areas.

Senator KERRY. If I could just interrupt you for a second. We had already agreed, Congress and the President, on a NSF authorization in 2002 that promised a 5-year doubling effort by 2007. In effect, the 2007 request fell nearly $4 billion short of the previous doubling target. So it's not sufficient, it seems to me, to come in and say, "We're going up," when we're actually not meeting the goal we set.

Dr. MARBURGER. I believe this budget does request appropriate amounts for the National Science Foundation. We would like to see us on a doubling track, as the Initiative very clearly states, and we're disappointed that——

Senator KERRY. Why are we not? What's the precedent of priority, in your judgment, that we're not doing that?

Dr. MARBURGER. The—I'm sorry, I don't understand——

Senator KERRY. You said, "There are priorities here, the reflection of priorities." Does this reflect the request that you put in? Did you ask for the full doubling?

Dr. MARBURGER. The, the—I'm sorry, the ACI has a doubling for these agencies over a period of 10 years on a schedule that we've circulated in the policy documents for this Initiative. The President has funded the National Science Foundation at above-inflation rates, during the previous several years. Now under the ACI, which clearly responds to a number of reports and expert committees and advice, the President is requesting funding on a doubling track. And that's, that's very clear. We're disappointed that Congress has failed to enact the ACI through the Continuing Resolution, falls short by nearly a half a billion dollars, and we'd like to get that back on track, and move ahead.

Senator KERRY. What I'm trying to wrestle with here is the disparity between the discussion about where the priorities ought to be, and then where the funding is. Because the overall budget for NSF, I can see, increases, that I understand. But, the education and human resource budget, which seems to be central to the goals that we've talked about, decreases. I'm trying to figure out how you reconcile that.

Dr. MARBURGER. The President has requested increases for those areas in this budget, and we believe that those increases are appropriate for the goals and the existing programs within the National

Science Foundation. We think that it is appropriate for the National Science Foundation to have programs in this area, and the President has requested funds for them, commensurate with the aims of those programs.

Senator KERRY. Well I seem to see here that there's a NSF Education and Human Resource decrease of 5.8 percent, from $797 million in 2007, down to $750 million in 2008, despite the fact that the President, as you said, is promoting STEM education, and Congress has authorized new education programs. The money itself is going down.

Dr. MARBURGER. My understanding is that the President has requested increases in key programs in the National Science Foundation for these—we have the Director of the National Science Foundation here, he might be able to clarify the details of this. But, the President is committed to improving both K through 12 education, and education in other sectors that lead to STEM workforce increases.

Senator KERRY. Well, let me ask this——

Dr. MARBURGER. Not only through the National Science Foundation, but also through the Department of Education as well, and other appropriate agencies.

Senator KERRY. Dr. Bement, maybe you can help us here. Some of the most effective programs within NSF, aside from the scientific discovery, are the education and human resource programs, you'd agree with that?

Dr. BEMENT. Fully agree.

Senator KERRY. And those programs are specifically designed to try to attract students to science, technology, engineering, mathematics, which we've all heard from each of the Senators is a critical focus, a priority.

But the 2008 budget, if you exclude the Experimental Program for Competitive Research, the EPSCoR Program, which was transferred to the Director's Office last year, if you set that aside, the fiscal year funding for the core EHR Programs has declined, from $844 million to, a request now of $750 million. I'm trying to see how you reconcile that.

Dr. BEMENT. Senator, most of that decline is in one program, that's the Math and Science Partnership Program——

Senator KERRY. And what's the judgment about that program?

Dr. BEMENT. I'm sorry?

Senator KERRY. What is the judgment about that program that would bring about a decline?

Dr. BEMENT. I think the program has been very effective——

Senator KERRY. Then, isn't that a priority, according to what we've said, to get more students capable in math? The Chairman was here a moment ago, he talked about math, science performance, the numbers of engineers, et cetera?

Dr. BEMENT. Well, since the beginning, the Math and Science Partnership Program has been a partnership with the Department of Education, and it was a matter of judgment what that balance should be over time. The role of the National Science Foundation has been to carry out research and development in terms of pedagogy and instructional materials and so forth, that would meet the goals of No Child Left Behind, and would stimulate performance

against those goals. And we have demonstrated that we have improved performance in the programs that we have funded, all of which have been peer-reviewed, they're all competitive.

Now, the question is, in terms of scalability, and in terms of transferability, in building up the impact of those programs, it requires resources well beyond what the NSF can provide, and it would be inappropriate for the NSF to do the scalability and the transferability, that ought to be a partnership with the states. And we do partner with the State Math and Science Partnership Program, funded by the Department of Education, so that's been a very close partnership, and those—those priorities have changed over the last 4 or 5 years, the net result has been a decrease in the NSF part of the overall program.

Dr. MARBURGER. But an increase in the Department of Education programs that fund similar STEM-oriented teaching improvements.

Senator KERRY. Do you know how much, by how much?

Dr. MARBURGER. I don't have the details, I'll be glad to provide them.

Senator KERRY. We'll look forward to, maybe we can——

[The information previously referred to follows:]

Department of Education Funding for the Math and Science Partnerships Program:

FY 2008 (requested): $182.1 million
FY 2007: $182.2 million
FY 2006: $182.2 million
FY 2005: $179.5 million
FY 2004: $149.1 million
FY 2003: $100.3 million
FY 2002: $12.5 million

Department of Education Funding for other programs supporting related STEM-oriented teaching improvements at the K–12 level (Math Now, Advanced Placement, Adjunct Teachers):

FY 2008 (requested): $397 million
FY 2007: $37 million
FY 2006: $32 million
FY 2005: $30 million
FY 2004: $24 million
FY 2003: $23 million
FY 2002: $22 million

Dr. MARBURGER. But, the idea is to continuously increase investment in No Child Left Behind, and the Math and Science Partnership, in particular.

Senator KERRY. Thank you. My time is up.

Senator Sununu?

Senator SUNUNU. Thank you very much. Let me at least start by talking about a very different subject—invention. And, in particular, I want to call your attention to language in the House competitiveness bill, and this gets at one of the concerns that I was raising about dilution of mission from investment in basic science and mathematics. There is a provision in the House bill that called for research on innovation and inventiveness. And, I would like each of you just to comment on how this kind of initiative can be defined, and whether or not you think National Science Foundation money ought to be carved out for this purpose.

It says, "In carrying out its research programs on science policy, and the science of learning, National Science Foundation may support research on the process of innovation, and the teaching of inventiveness." Now, again, my personal experience here is limited, although I worked for 4 years in a manufacturing capacity for a gentleman named Dean Kamen, who I honestly believe is the most gifted inventor I've ever met. Dean has some weaknesses, he has a very limited wardrobe, for example, for those that have met him——

[Laughter.]

Senator SUNUNU.—but he is a brilliant inventor. He's also a college dropout. And, it's my experience that it's very difficult to really characterize where this gift comes from. And, in fact, the only common denominator I think you can find among great inventors is—especially on the technology side—an interest, an interest in technology, in science, in mathematics. I get back to the basic concern I raised earlier, that that is driven, that's inspired in 5th grade and 6th grade and 7th grade and 8th grade, and I know it was in Dean.

And, it's a great concern to me to start carving out resources at the National Science Foundation to try to characterize or quantify the unquantifiable.

And, I'll offer one other example, before I ask you each for a comment, and that is, one of the other great inventors of our time, and, in a slightly different area of technology, that is, software development, is a gentleman named William Gates, some of you may have heard of him——

[Laughter.]

Senator SUNUNU. He is also a college dropout. Now, there are some people, maybe, without a great technical background, and some people I know with a great technical background that would love to take those data points, extrapolate, and start encouraging kids to drop out of college, because that's obviously a determining factor in becoming a great inventor, but that's not the case. That's obviously not the case.

The point is, it's so hard to characterize the gift, but again, both of them—whether you're Bill Gates or Dean Kamen, the key is an interest in technology, an interest in science, an interest in what makes things work, and that didn't start when they were freshmen in college, just prior to dropping out, it didn't start when they were seniors in high school. It started much earlier than that. Comments? Dr. Marburger?

Dr. MARBURGER. As a matter of policy, we have no complaints about, or concerns about NSF investing in researchers to study issues like this, about what is it that leads to innovation, we think that's important. The concern would be to, a carve-out, or some limitation on NSF's ability to direct, or not to direct, funding in that area. We think that the National Science Foundation does support useful research on what it takes to do innovation on social sciences that are relevant to innovation and competitiveness, but we would like not, to see them not constrained to spend a fixed portion of their budget on any area, but rather to leave it up to the judgment of the community that does the work.

Dr. BEMENT. Thank you, Senator, for that question.

Now, this is indeed a focus of NSF's investment in education, to teach creativity and innovation through hands-on learning, through inquiry-based learning, and also to couple informal education with formal education so that children have experiences in and outside the classroom that stimulate their curiosity and inventiveness.

I can tell you that we're seeing this now happen in pre-school, in early grades—I've attended some classes in 6th grade where they're teaching engineering, for example. And this is, what I think, will stimulate inventiveness.

We also, through our social science program, are looking at what constitutes creativity and inventiveness, and that will couple into our education programs.

A lot has to do with cognition, child development, learning what science children can learn early, and also how to evaluate their learning in those subjects.

Dr. JEFFREY. Thank you. Obviously, I have nothing to add over my two colleagues who I agree with completely, so——

Senator SUNUNU. Thank you.

Getting back to the issue of the carve-out, though, and that is my principle concern, is that Congress not start directing the National Science Foundation where to put its money, how much and in what time sequence. And again, in the House bill there are 3.5 percent of the funds required to go to early career awards for science and engineering researchers.

I know this is a program that you value, but not only is there a requirement that 3.5 percent go to those career grants, but there's also 1.5 percent that has to go to the graduate education and research grant program, there's a minimum award size set at $80,000 for 5 years, would you like to speak to this issue of micro-management, and whether or not the limitation on your flexibility is a cause for concern?

Dr. BEMENT. Yes, I would, and thank you for that question.

Prioritization within the Foundation is an organic process, it's a daily process. Some of our priorities are handed down by the Congress, by the Administration, and our job is to put together the best programs and the best science to address those priorities.

In addition to that, we get priorities from the community, in terms of what science is worthy of supporting, where the frontier is moving forward, and in many cases, where opportunities far exceed the available resources, they also have to help us in prioritizing where those resources go.

Those priorities are reviewed by the National Science Board, by the Office of Science and Technology Policy, and by the Office of Management and Budget. Along with setting priorities is balancing our program. Balance between support for Education and Human Resources versus Research and Related Activities. Balance between support for young investigators versus more senior investigators. Balance between instrumentation and tools, and discovery research.

That balance can very easily be upset. And when we get carve-outs and when we get language that sets dollar amounts or dollar limits, it under-optimizes, if you will, the overall program at the NSF, and the effectiveness of the overall investment.

Senator SUNUNU. Thank you.

One final question, Dr. Marburger, I mentioned the 34 different Science, Technology, Engineering, and Math Programs, supported by the National Science Foundation, dozens of others in different parts, and at different Departments and agencies within the Federal Government. There's also a proposal in our Senate competitiveness bill to have the Department of Energy work to establish specialty schools for science, math and engineering. Could you comment on both of these issues? One, what is the Administration's perspective on the number of Science, Technology, Engineering, and Math Programs, education programs, what can be done to better coordinate their activities? And second, do you think the Department of Energy is the best agent for working to develop and create specialty schools for math and science?

Dr. MARBURGER. Senator, thank you for the question—there's no question that there are too many of these programs, and they really need to be consolidated and optimized, and the Administration is beginning to do that through a process that's jointly sponsored by the Office of Management and Budget——

Senator KERRY. When you say too many of these programs, too many within various agencies, government-wide?

Dr. MARBURGER. There are approximately 100 of these programs, and multiple programs within each agency and they have not been uniformly assessed or coordinated in the past. And, we're just beginning to do that.

This Committee will be pleased to note that the National Science Foundation comes out rather high on the ratings, they know how to do these programs and they're pretty effective. Not every agency is set up to do this. Specifically, with respect to the Department of Energy, there are assets in the Department of Energy, the National Laboratories are fascinating places, they provide mentoring for science projects and so forth, teacher training, but I believe that the most important mission of the Department of Energy is the basic research and the operation of the facilities that they provide—these missions are essential to the future competitiveness and innovation of our Nation, and they need to be funded more than they are today.

And, when it comes to priorities, that would be our first priority—getting the money back into the Office of Science laboratories and programs, and letting them respond to the science community regarding the priorities for funding.

Education would not be my first choice as a function or a mission for the Department of Energy. It's an ancillary function that needs to be managed very carefully in the context of their overall program. I believe that the new programs that are proposed for the Departments of Energy and Education have the potential for diffusing any new resources that we have available to put into that agency.

Senator KERRY. Thank you very much, Senator.

Senator Pryor?

Senator PRYOR. Mr. Chairman, please let Senator Thune go, he was here before me, and I can stay for a few more minutes, so please let him go.

Senator THUNE. I thank the gentleman for yielding.

Thank you, Mr. Chairman.

I'm particularly interested in—our Nation's energy policy. I come from a state that's rich in renewable energy sources such as bio-fuels and wind, but it's not simply a parochial issue for me. I think energy research and energy policy are very much connected to our national security, and I guess I would ask whether or not the U.S. is doing enough basic research today to get us to energy independence, via clean, renewable sources during my lifetime, and if not, what more or what else should we be doing.

Dr. MARBURGER. Let me just venture a short response to this. One of the reasons that we would like to see the budget of the Department of Energy Office of Science increase, is that they have a lot to offer on basic research for materials and processes that feed into energy independence and climate change issues. And this is why it's so important to maintain the pace of the President's American Competitiveness Initiative. Unfortunately, we did not maintain that pace for the Department of Energy Office of Science this past year, and I hope we can catch up again this year. They have a very important role to play there. Obviously, we're not investing as much as we should be in that area, the President has requested funds to correct that.

Dr. BEMENT. I would say that more attention needs to be given to basic research. Certainly the efficiency of solar cells could be improved. It may be a point of diminishing return, but we're seeing opportunities for improving their overall effectiveness.

We're seeing science being applied to how to make plants more susceptible to cellulose breakdown for ethanol production, through modification. We're also seeing breakthroughs in fuel cell technology, where you could begin to match power cycles, which has been illusive in the design of fuel cells.

Energy is an important enough area where basic research from more than one agency is critically important. The research that the NSF supports goes to support graduate students at universities, those will be the people who will take that knowledge into the private sector, and be very innovative in taking new concepts, new ideas, and developing whole new approaches to renewable energy generation, and energy sustainability in general. Not only how to generate energy, but how to conserve it, as well.

Dr. JEFFREY. If I could just add a few words to that, of course, there are a number of programs, for example, that are under the ACI that are very high priority. I mentioned in my opening statement, some of the work at the NIST Center for Neutron Research and the impact that being able to use neutrons to image fuel cells have made a huge increase in their efficiency and productivity. That's a major priority for us under the ACI and we did get adequate funding under the 2007 Continuing Resolution to stay on track on that program.

Another is supporting a hydrogen fuel initiative, to allow for hydrogen to actually be used as a portable fuel. There's a lot of work that needs to be done there, that we're doing in conjunction with the Department of Energy, that was not fully funded, unfortunately, under the 2007 Continuing Resolution, but again, we hope to be back on track in 2008.

I'd like to add and follow up on a thought of Dr. Bement's, as well, that in addition to some of the bio-fuels work and hydrogen

work, there's also energy reduction work—how do you actually have more efficient lighting? How do you actually have better insulations to reduce the demand, as well as to increase the supply of alternative energies? These are all areas that, I know, all of the agencies mentioned under ACI are heavily involved in.

Senator THUNE. Well, I just don't think we can hardly do enough in that area. And I know that there have been estimates that there is enough wind generated in my State of South Dakota alone to meet the electricity needs of 10 percent of the people in the entire country. And so, we are obviously very interested in pursuing some of those things, but as I said, it's not a parochial issue, I think it's an issue that has a bearing on our energy independence, the energy needs that we have as a Nation, and the need for good, clean, renewable energy.

Some people might argue there's probably enough wind in Washington, D.C. to meet the needs of 10 percent of the people. But, my point is, we have to stay ahead in that area, and we have so many reasons for doing it. I would appreciate your continued dialogue with us about some of the things that are going on in areas that I see, as great opportunities for our country in terms of renewable energy.

Mr. Bement, I just—in your written testimony, you mentioned that National Science Foundation leads Federal agencies in funding research and education activities based on competitive merit review, with over 88 percent of it's research and education funding going to awards selected through a competitive merit-review process.

We've seen this merit-review process in competition, up close, in South Dakota recently, there's a—as you know—an NSF selection process ongoing to develop a deep underground science and engineering laboratory. A decision on that particular project is due out very soon and as much as I'd like to, I won't lobby you for South Dakota's location——

[Laughter.]

Senator THUNE. I respect very much the merit-based and peer-review process that you use and undertake for this project and for others.

But, I did want to ask you a question about it, because you mention in your testimony that you want to continue to improve on the selection process in 2008, by enhancing transparency and uniformity to the merit-review process. And, I would just ask you what types of improvements you're considering, and how would those changes impact projects that are currently receiving funding, or already selected for future funding?

Dr. BEMENT. I think with regard to transparency, it's a question of making sure that the community knows well what our criteria stand for in merit review, and that we have an ongoing dialogue so that they meet those requirements in their proposals. We put much of that information on the website, but we have to communicate it in many more ways so that there's a clearer understanding of what it takes to be successful.

We also have what we call NSF days. As a matter of fact, when I leave this hearing, I'll be going down to Oak Ridge to meet with principal investigators from universities, as well as representatives

from the private sector to provide outreach in how to be successful in working with the National Science Foundation through our merit-review process.

With regard to consistency, we need to continue to work on consistency across the Foundation. Our program officers do have the responsibility of recommending awards. Program officers from different directorates have different viewpoints on what constitutes an outstanding or excellent merit review. We need to share those practices and that information across the Foundation so that we can lift the quality of our merit review generally.

Senator THUNE. I appreciate that response.

And, Mr. Chairman, I thank my colleague from Arkansas for his forbearance, and I yield back my time.

Senator KERRY. Thank you very much, Senator Thune.

Senator Pryor?

STATEMENT OF HON. MARK PRYOR,
U.S. SENATOR FROM ARKANSAS

Senator PRYOR. Thank you. Thank you, Mr. Chairman.

If I may, Dr. Marburger, I'd like to start with you and talk about nanotechnology. I just have two or three quick questions for you on nanotechnology.

I notice that Nobel Laureate Rick Smalley has talked about how nanotechnology could enable a sustainable world of clean energy, water, agriculture, et cetera. Do you see nanotechnology as an important part of the future when it comes to clean energy and the environment?

Dr. MARBURGER. Yes, sir, Senator. Nanotechnology promises improvement of many materials and processes that are related to energy, not only on the energy conservation side, for example, in making chemical reactions and the production of chemical products, more efficient, but also in connection with increasing battery storage capacity, and other characteristics of fuel cell, primarily through the materials enhancements, and products that use less energy, and use it more efficiently.

Senator PRYOR. OK, great. Given that, do you think that Congress should direct more Federal agencies to focus their nanotechnology resources, if you will, to working on energy, water, et cetera, environmental issues? Or, do you think that, just allowing things to work the way they are now that the resources will find their way to the problems?

Dr. MARBURGER. Nanotechnology is such a broad field that there are very many opportunities and it's difficult to see, sometimes, from which part of this field you will get the results. So, for example, people working on biomass, are working with molecular-level machinery, that may turn out—serendipitously—to have an influence on some other application.

So, when it comes to basic research, I favor letting the science community determine the direction and the course, I don't favor top-down direction. We try to avoid it ourselves, in the Executive Branch. This is one area that has such a broad impact that we want the scientific community to let us know.

Senator PRYOR. Great, that's helpful.

There's something called the Nanotechnology Environmental and Health Implications Working Group, and as I understand it, I think that you may call it the NEHI Working Group, the NEHI Working Group is developing research strategy, with priorities, timelines, budgets, et cetera. When can we expect to have the benefit of that work product?

Dr. MARBURGER. My understanding is that that's a high-priority project, and I don't want to commit to a time, because I haven't asked them, specifically, where they are, but my understanding is that they're working aggressively on this, and I expect something, certainly, during this calendar year, and almost certainly well before that.

Senator PRYOR. OK, great.

Dr. Bement, let me turn to you, if I may, in looking at the geography when it comes to R&D and EPSCoR, things like that, when looking at the map, the geography, I notice that there are clusters of research that are done on the East Coast, West Coast, Upper Midwest, but there are areas in the country that don't have much of that.

Is geographical diversity—is that a worthy goal? In other words, do you think that good ideas really don't have any geographical boundaries, or do you think it makes sense to have them concentrated in certain clusters around the country?

Dr. BEMENT. Absolutely, I agree with you, Senator. There seems to be a misconception that all of the talent in the world exists in a few, top research universities, but one has to keep in mind that the Ph.D. graduates from those universities go elsewhere in the country to teach, and many of them go to places in the United States where they want to be located, some want to go to smaller institutions, because they have more freedom and flexibility. So you'll find talent broadly distributed throughout the United States.

And more to the point of your question, the National Science Foundation could not meet its obligations under the American Competitiveness Initiative without involving every state in the initiative.

Senator PRYOR. And I would welcome your thought on how we should have the EPSCoR Program and others to try to improve, you know, some sort of geographical diversity——

Dr. BEMENT. Yes.

Senator PRYOR.—I don't know if you have thoughts today or if you just want to get back to us.

Dr. BEMENT. Well, I do have thoughts today, I'd be glad to get back with you, and——

Senator PRYOR. That'd be great.

Dr. BEMENT.—discuss it more broadly.

Senator PRYOR. I'd like to, because that is probably a longer discussion than we really have time for today, but I'd love to visit with you about it.

The last thing I have is really a question that in some ways is off the subject, but I think is very relevant, and if I may, Dr. Jeffrey, I'll start with you since I haven't picked on you yet. The Congress, once again, will soon enter a discussion on immigration policy. Before this very distinguished panel leaves, I'd like to get each one of your thoughts on things that we need to be looking for when

we are evaluating America's immigration policies and things we need to have in our minds as we listen to this debate. So, if you want to start, and if all three could answer.

Dr. JEFFREY. Thank you very much. I believe that there are definitely aspects of the immigration policy that directly impact our ability as a Nation to remain competitive. And, when you look at the history of a lot of the science within this country, a lot of the Nobel Prize winners—many of these were immigrants coming into this country.

One of the things for me to be able to do my job at NIST, as well as others, we try to bring in the best and the brightest from around the world. And, it would be great to be able to make that an easy access, and to then encourage retention of some of the best and the brightest talent within the United States, helping to support missions that are important to the U.S.

And, so as the immigration debate goes forward, remembering the goals, also, of attracting and retaining the best and the brightest around the world, I think, is an incredibly important part of our competitiveness.

Dr. BEMENT. Yes, with regard to collaborating with the very best scientists around the world, and tapping the best talent for a graduate education in this country, it's important that we keep the barriers low, not only for visas, but also for immigration. I think that expresses my point of view.

Dr. MARBURGER. The President's American Competitiveness Initiative has a specific provision for improving the immigration environment for highly trained people in the technical areas that are important for our competitiveness.

Senator PRYOR. Thank you, Mr. Chairman.

[The prepared statement of Senator Pryor follows:]

PREPARED STATEMENT OF HON. MARK PRYOR, U.S. SENATOR FROM ARKANSAS

For the past half century, the United States investment in basic research has been the engine that drives our economy. In 1945, Vannevar Bush submitted his report *Science—The Endless Frontier* to President Franklin Delano Roosevelt that spurred the creation of a system of public support for university research that endures to this day.

The connection between basic research and the economy is straightforward. Basic research produces the discoveries that through innovation and manufacturing become the products that transform and strengthen our economy.

The goal of basic research is not to publish the most scientific papers, receive the most patents, or win awards. The goal is to discover new scientific ideas, principles, and theories. In a global economy, with instantaneous access to information, the United States runs the risk of other nations innovating faster that we do and ending up with the "commercial fruits" of our "scientific labor."

I support the recommendations of the National Academies report *Rising Above the Gathering Storm* and I am a cosponsor of the America COMPETES Act. I hope that this legislation will begin to restore our science research infrastructure and competitive edge. At the same time, I am concerned about our ability to rapidly translate scientific discoveries through innovation into new commercial products and technologies.

I thank the witnesses for joining us today and Senator Kerry for chairing this hearing.

Senator KERRY. Thank you very much, Senator, I appreciate it.

I'm a little pressed here because I have to get over to a Finance Committee meeting momentarily, but I want to try, if I can, to cover a couple of questions, and see where we are.

Dr. Bement, in 2005, the National Research Council of the National Academy of Sciences issued *America's Lab Report, Investigations into High School Science.* And they found, "the quality of current laboratory experience is poor for most students," and then "A revision in lab activities would help students to better develop skills and cultivate an interest in science." It referred to the declining condition of schools, and their science facilities. Can you share with me what NSF's response has been to that report?

Dr. BEMENT. We're very favorable to the report, and agree with all of the recommendations and findings in the report, and through our programs, we try to respond to that. Not only in trying to upgrade laboratories, but also to provide training to teachers, and how best to teach in the laboratory, to get the best benefit from the investment.

Clearly, we can provide supplements to many of our grants that can go, not only to improving laboratories, but also explore where laboratories can be more cost-effective using modern technology, information technology for example.

Senator KERRY. Do you have a specific, or is there a targeted program based on that, that's trying to really lift people's focus, and focus energies on it.

Dr. BEMENT. I don't know that we have—we do have one targeted program, and that's the program we call ITEST, which is to bring information technology into the classroom. It meets many of the requirements that would also be necessary for effective use of laboratory resources, as well.

But, I guess I would have to say, that's the only example I can think of.

Senator KERRY. I've been in some of these schools, and I've had science teachers sort of point out to me, you know, "Senator, it's really hard to do what we're trying to do, this is not state-of-the-art," and so forth. And I think it's pretty tough to encourage kids around the country to be serious about science, and think we're serious, if these are the facilities that they're operating in. I think that your input on this can be particularly persuasive to our colleagues here in terms of expenditures and otherwise. I'd urge you to——

Dr. BEMENT. Senator, it does also occur to me that we are working with the National Governor's Association in trying to deal with some of these issues, and most of our Math and Science Partnerships deal with this issue in partnership with the states. So, hopefully, as a partnership, we can begin to address many of these issues. It's certainly high on our agenda, it is something we discuss regularly with State officials, and I agree with you entirely, it's important.

Senator KERRY. Thank you.

Dr. Jeffrey, with respect to the Manufacturing Extension Program, everybody in the country knows what's happened to certain states, the manufacturing base, the jobs. During the period that the Bush Administration has repeatedly tried to cut it, we've actually used it to add or retain more than 12,000 manufacturing jobs in Massachusetts alone.

The Fiscal Year 2008 budget proposes very dramatic cuts to this program, from $104 million down to about $46 million. Why, given

its benefits and contribution to competitiveness is it repeatedly under assault?

Dr. JEFFREY. Well, thank you Senator.

The program we view as an effective program, it's a question of priorities. As mentioned—one of the core priorities that we have is increasing the basic science research, which creates new industries, supports new industries—the Manufacturing Extension Partnership works at a company by company level, it does that effectively. We believe that the Federal Government, the role that we play in that, is really to help ensure that new skills are generated that can get propagated throughout the centers; that there's a quality control to ensure that the centers operate effectively; and that there is enough of a focus that is kept on a small manufacturing base, which is a critical component.

We believe with the budget that was proposed, we can do that from the Federal Government. And then, it gets into the prioritization, where the other funds are necessary, where we believe there's greater leverage from the Federal investment in the basic science.

Senator KERRY. Well, I understand your drawing that distinction. But, I think there's a fairly strong base of support here, and obviously each year we've had a different point of view in the Congress, bipartisanly.

What about with respect to the Massachusetts program, there was a policy difference between NIST, you folks and the IG, has that been resolved, on the audit?

Dr. JEFFREY. If you're referring to the 2003 audit——

Senator KERRY. Right.

Dr. JEFFREY.—that has been resolved, and Massachusetts MEP has been notified.

Senator KERRY. We should be able to proceed forward with that?

Dr. JEFFREY. Yes.

Senator KERRY. Great. Well, I appreciate it. There are a few other questions, I want to leave the record open for a couple of weeks, just to follow up if any colleagues also have questions or weren't able to be here.

We appreciate it, I know these are complicated budget times. I might just comment that there was a revision on the budget done by CBO which suggests that we will not, in fact, be in balance by 2012, just for the record so you're aware of that, we obviously have to operate within that. But, I hope that we can continue the cooperation which we've obviously appreciated. We do consider these entities that you represent among the most important in our Government, and really vital to our economic future. I know you know that, and as a committee we know that. We look forward to working with you, and we appreciate the job you're doing under obviously constrained circumstances.

Thank you for being here today, we stand adjourned.

Thank you.

[Whereupon, at 11:40 a.m., the hearing was adjourned.]

A P P E N D I X

Response to Written Question Submitted by Hon. Mark Pryor to Dr. William A. Jeffrey

Question. It appears that NIST has been slow to market the user facility to industry. When will the user facility be available to outside users? Will NIST researchers help companies improve their nanoscale materials or merely provide a characterization service? Has NIST developed a standard agreement that clearly defines fees and intellectual property ownership?

Answer. The Center for Nanoscale Science and Technology (CNST) exemplifies NIST's core mission to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life, The CNST endeavors to provide science and industry with the necessary measurement methods, standards, and technology to facilitate the development and productive use of nanotechnology from discovery to production. In this way, we hope to drive innovation in nanotechnology and the related frontier areas of science and technology.

To achieve this mission, the CNST contains the Nanofab, a state-of-the-art facility that provides advanced nanofabrication and measurement instrumentation on a fee-based, shared use basis. It includes tools for patterning semiconductor and other materials via photolithographic, electron beam, ion beam, or nanoimprint lithographic methods as well optical, electron, and ion based measurement tools. It is located in both a 16,000 square foot clean room (which includes 8,000 square feet of class 100 space) and in an adjacent laboratory building (216) of NIST's Advanced Measurement Laboratory (AML) complex.

The CNST Nanofab has recently opened to all users. It currently has in excess of 150 internal NIST users who are taking advantage of the state-of-the-art Nanofab on a fee-based, shared use basis. CNST staff is actively reaching out to potential external users to facilitate the growth in external use over the next year. The CNST staff has created a range of standard agreements that clearly define fees as well as issues related to intellectual property rights. Under at least one of the arrangements, external users may maintain sole ownership of their intellectual property rights.

Finally, the CNST provides a flexible menu of services to the external research community, which can be leveraged to best meet their individual needs. As discussed above, external users can have access to the CNST Nanofab user facility on a fee-based shared use basis. This would include access to the Nanofab's technical staff that can assist the users in taking full advantage of the capabilities of the laboratory space and equipment. In addition, users can, if they choose, partner with CNST researchers in joint research teams, focused on areas of common interest related to improving nanostructures and devices.

Response to Written Questions Submitted by Hon. Mark Pryor to Dr. John Marburger III

Question 1. The United States competes with other countries for ideas, talent, and resources. Emerging economies are rapidly increasing their R&D investment. As a percentage of GDP, the U.S. Federal investment in physical sciences and engineering research has dropped by half since 1970. In 2005, the U.S. high technology industries employed 5.6 million people. Starting in 2001 the U.S. has run a high-tech trade deficit that continues to widen.

In many fields, what was once viewed as a linear process of innovation from basic research, through scale-up, to commercialization is now much more complex. Scientific discoveries reported in the literature or patents are instantaneously available around the globe. The U.S. needs to be more nimble and faster in translating these scientific ideas and discoveries into new products and technologies before our com-

petitors do so. Do we have a good understanding of the innovation process and the barriers to innovation?

Answer. There is a great deal of on-going research aimed at gaining a better understanding of the conditions that foster, drive and enable innovation. Despite some progress in describing the innovation process in limited areas, it remains a field of inquiry with a great deal of potential.

Question 2. What implications would a better understanding of how innovation occurs have on science and technology policy?

Answer. Innovation is a hallmark of successful research and development and a trait that should be fostered. If a solid, scientific basis for innovation could be established it would allow us to formulate science and technology policy with more focused goals and give us tools to better evaluate the outcomes.

Question 3. What new models, pilot programs, or experiments for accelerating the innovation of high risk/high reward R&D would you suggest the Federal Government try?

Answer. An important long term goal of the American Competitiveness Initiative is to foster innovation by ensuring that basic physical sciences are appropriately funded thereby increasing the chances that fundamental discoveries will fuel innovation. The decision to undertake specific programs and experiments is best left to agency leadership in consultation with scientists.

Question 4. An important aspect of U.S. efforts to maintain and improve economic competitiveness is maintaining a capable scientific and technological workforce. Science and engineering occupations are projected to grow by 21 percent from 2004 to 2014, compared to a growth of 13 percent in all occupations during the same time period.

The increased presence of foreign students in graduate science and engineering programs is a concern to some in the scientific community. Enrollment of U.S. citizens in graduate science and engineering programs has not kept pace with that of foreign students. Also, a significant number of university faculties in the scientific disciplines are foreign, and foreign doctorates are employed in large numbers by industry. Do you think the United States should be concerned that our universities are educating foreign students who then go back to their home countries and compete with the U.S.?

Answer. The U.S. system of higher education, the best in the world, will continue to attract high quality students from around the world. Some of these students will stay in the U.S. after receiving their degree, some will return to their home country and some will seek opportunities elsewhere. The U.S. should make every effort to retain the best of these students while accepting the fact that many of them will not stay. Many of those who go elsewhere will use their American education to build better trading partners and allies for us.

Question 5. Do you have recommendations for policy changes so that the United States can retain the best and brightest foreign students to work in America?

Answer. The American Competitiveness Initiative recognizes the importance of retaining qualified foreign students with sections that focus on education, workforce training and immigration. These complex issues should continue to be addressed by Congress and the Administration.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. KAY BAILEY HUTCHISON TO DR. JOHN MARBURGER III

Question. Please provide a summary of the manner in which the National Aeronautics Research Policy established pursuant to P.L. 109–155 contributes to and enhances the Nation's competitive posture through an emphasis on basic research.

Answer. The National Aeronautics Research and Development Policy approved by President Bush on December 20, 2006 and effectuated by Executive Order 13419 "National Aeronautics Research and Development", provided the Nation with the overarching goal "to advance U.S. technological leadership in aeronautics by fostering a vibrant and dynamic aeronautics R&D community that includes government, industry, and academia." The Policy will contribute to U.S. competitiveness by providing lasting, long-term policy guidance to the Federal Government's aeronautics R&D activities which will cultivate an R&D environment that enables a globally competitive U.S. aeronautics enterprise. Consistent with this, Executive Order 13419 states that "continued progress in aeronautics . . . is essential to America's economic success and the protection of America's security interests at home and around the globe." Hence, both the statutory Policy and Executive Order

clearly recognize the link between the Nation's interests and the need for advancing—not merely maintaining—its technological leadership in aeronautics.

The Policy's inclusion of basic research activities are captured primarily through its clarification of roles and responsibilities of the departments and agencies conducting aeronautics R&D in a section devoted to "stable and long-term foundational research". While foundational research does consist of basic research, it also encompasses many aspects of applied research that require continued long-term scientific study in order to advance a strong technology base in aeronautics that will not only benefit Federal departments and agencies, but also the Nation's broader aeronautics enterprise.

Lastly, it should be noted that the Policy does not place an emphasis solely on foundational research. Of interest to the topic of the Nation's competitive posture, the Policy includes general guidelines for the interaction between the Federal Government and the commercial sector. The Policy also lays out guidelines to Federal departments and agencies for advanced aircraft systems development and air transportation management systems—key elements that will allow our Nation to maintain its mobility through the air that is vital to economic stability, growth, and security.

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

Question 1. Please provide a detailed summary of actions taken by the Foundation which would increase its focus on basic research in response to the American Competitiveness Initiative.

Answer. The American Competitiveness Initiative (ACI) sets out a bold challenge, calling for expanded Federal investment to drive innovation and sharpen the Nation's competitive edge. NSF's investments in research and education encompass all of the ACI's goals.

For the 2007 Fiscal Year NSF has set priorities that will strengthen the science and engineering enterprise through investments in frontier research, the workforce, education, and cutting-edge research tools. Examples include:

- *Cyberinfrastructure*—Cyberinfrastructure is likely to be a key factor determining research excellence for many years to come. NSF has increased funding for cyberinfrastucture research and will begin the acquisition of a leadership-class high performance computing (HPC) system optimally configured to enable an orderly progression toward petascale level science and engineering computation and data processing. This investment is critical to NSF's multi-year plan to provide and support a world-class computing environment that will make the most powerful HPC assets broadly available to the science and engineering community.
- *Sensors for the Detection of Explosives*—NSF is investing in fundamental research on new technologies for sensors and sensor systems to improve the detection of explosives, including Improvised Explosive Devises (IEDs). Related research will target advances in the analysis, interpretation, and evaluation of data gathered from sensors, as well as the integration of this data with information available from a wide variety of other fields and sensing systems.
- *Advanced Materials*—Fundamental research in advanced materials underpins competitiveness across the spectrum of technologies on which society depends, ranging from communications and computers to medicine, energy, transportation, civil infrastructure, security and national defense. NSF's advanced materials investments include new materials in electronics to reduce the need for internal cooling fans, polymer gels to power tiny machines and sensors to detect leaks from hydrogen-fueled vehicles.

Fiscal Year 2008 priorities target investments in concrete scientific, engineering, and educational challenges of major significance to the Nation and the world. Rapid progress in these areas will generate new concepts and tools, with far-reaching applications, lay the foundation for next-generation tools and technologies, and develop educational strategies to engage students and prepare them to excel in a fast-changing, global environment. One targeted investment is Cyber-enabled Discovery and Innovation (CDI). This is a new NSF-wide investment to broaden the Nation's capability for innovation by developing a new generation of computationally based discovery concepts and tools to deal with complex, data-rich, and interacting systems. The rapidly emerging world of peta-scale computers, massive data flows, and databases pose exceptional challenges that require capabilities well beyond those available today. CDI aims to explore radically new concepts, approaches, and tools at the

intersection of computational and physical or biological worlds to address such challenges. New means of computational discovery will augment the traditional discovery-innovation loop with novel computational concepts to aid knowledge discovery, analysis, and experimentation. This will accelerate the discovery of knowledge buried in massive datasets, creation of models to understand complex phenomenon, and understanding of rare events.

NSF's commitment to the ACI is further underscored in its Strategic Plan for FY 2006 to FY 2011, which outlines key steps and new investments at the forefront of discovery, learning, and innovation. The four strategic outcome goals established in the plan shape the overall investment strategy of the NSF:

- *Discovery*—Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the Nation as a global leader in fundamental and transformational science and engineering.
- *Learning*—Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.
- *Research Infrastructure*—Build the Nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure, and experimental tools.
- *Stewardship*—Support excellence in science and engineering research and education through a capable and responsive organization.

The plan charts an ambitious course for the future, stressing investment opportunities that promise to stimulate innovation, contribute to economic growth, and provide exceptional returns on America's investment in frontier research and education.

Question 2. Has the NSF undertaken any effort to better focus its consideration of grants and awards toward addressing the Nation's challenges in the fields of science, technology, engineering and mathematics? Please provide details of those efforts.

Answer. The cornerstone of NSF's organic act is "to promote the progress of science, the national health, prosperity and welfare, and to secure the national defense." The NSF Strategic Plan for FY 2006–2011 views this mission in the context of current challenges facing the Nation, and it specifically identifies investment priorities under the agency's four strategic goals: Discovery, Learning, Research Infrastructure, and Stewardship. These priorities are based on a range of inputs, including Congressional interests, Administration priorities, and interagency initiatives to address national needs. These are given further focus through NSB studies, community workshops, and NSF's budget formulation processes. Current research efforts address some of the Nation's most critical challenges such as nanotechnology, climate change, earthquakes, and hazard reduction.

Question 3. I understand NSF has recently taken steps to enable unsolicited proposals for support of research aboard the International Space Station. Please provide details about this initiative.

Answer. NSF is part of a task force of seven Federal agencies which has developed a strategy for using the International Space Station National Laboratory as a venue for further inspiring teachers and students in the areas of science, technology, engineering, and mathematics. The basic idea is that young people of the Nation in various settings will devise experiments, talk with astronauts, and monitor space station events that will inspire and educate them and their teachers across the country. The task force's education development concept looks at ways to use the Space Station's U.S. segment to support future projects and develop partnerships for education payloads, or experiments, with other Federal agencies.

Question 4. The National Research Council recently, recommended that the Federal Government establish a program of Innovation Inducement Prizes similar to the DARPA autonomous vehicle grand challenge or the privately funded Ansari X-Prize. Earlier this year, the National Academy of Engineering awarded the $1 million Grainger Challenge Prize for Sustainability to Professor Hussam of George Mason University for an inexpensive, easy to-make system for filtering arsenic from well water.

Designed properly, Innovation Inducement Prizes could be a new way to stimulate innovation on hard to solve societal and technological problems. Many universities and companies compete for these prizes and the overall body of knowledge grows. Do you think Innovation Inducement Prizes could be a useful experimental model to try as a pilot program to stimulate innovation on some very specific, hard to solve problems?

Answer. Not for the NSF. In Fiscal Year (FY) 2006 NSF awarded a grant to the National Academy of Sciences (NAS) to study the concept of developing an NSF Innovation Inducement Prize. Discussions held by the NAS Board on Science, Technology, and Economic Policy and Global Affairs were completed in August 2006 with a resulting report published in January 2007.

While the report was supportive of the concept of inducement prizes for applied research and areas of research that had a clear target, the report recognized the challenges of this type of effort to the NSF mission and traditions. NSF focuses its energies on supporting research frontiers of all types and thus supports those people who attack the frontiers of knowledge. Moreover, the report concluded that, "the agency is seen as working primarily through the competitive award of grants to academic scientists and engineers for self-initiated proposals about how to advance basic knowledge of natural and social phenomena. It has limited experience in supporting innovations intended to solve societal problems and no experience in administering innovation prize contests."

While the NAS report attempted to list some possible candidates or targets for a prize, it also recognized the challenge to NSF to initiate the management of such an activity. Considering these issues and budgetary constraints, the NSF has elected not to pursue a prize program.

Question 5. If not the NSF, what agencies would be best suited to sponsor and manage an Innovation Inducement Prize program?

Answer. The agencies that might be suited to sponsor and manage an Innovation Inducement Prize program would be those in whose domain the specific applied research target area falls, such as defense, energy, or space.

Question 6. The *Rising Above the Gathering Storm* report sounded the clarion call for the need to improve our graduation numbers in science, technology, engineering, and math (STEM) across all grade levels from kindergarten through graduate school. The United States has allowed our competitive advantage to erode by not supporting K through college STEM education. In 2003, U.S. tenth graders ranked 18th in mathematics and 24th in science out of the 30 OECD countries. Only 17 percent of U.S. undergraduate student are studying science and engineering. The comparable numbers for China are 52 percent, South Korea 41 percent, and Taiwan 38 percent.

The America COMPETES Act authorizes substantial increase in STEM funding at all levels of our education system. This funding must be applied wisely and strategically. Has the NSF analyzed the STEM initiatives in the America COMPETES Act and do you believe that these new and bolstered programs will result in more students going into science, engineering and math programs and a reversal in our worldwide rankings?

Answer. NSF's programs in education emphasize the importance of recruiting and retaining U.S. students into STEM fields. In accordance with the recommendations from the recent report from the Academic Competitiveness Council, we are currently working to ensure our efforts in STEM education work in concert with similar programs in other agencies and also with those of state and local entities. Key to these efforts will be the development of critical evaluation tools so that programs can be assessed and effectiveness measured.

Question 7. How do we get students interest in STEM? Do we need to change the curriculum or how we teach science and math? Are we creating enough scholarships, fellowships, and young faculty research grants to attract and retain the best and brightest students into these scientific fields?

Answer. We believe that improving the curriculum and reaching students at an early age in order to encourage their interest in science, especially before middle school, is a promising strategy for attracting students to the STEM fields and increasing interest in STEM careers (Fadigan & Hammrich, 2004; National Research Council, 2007; Tai, Liu, Maltese, & Fan, 2006) There is evidence that a relationship exists between early engagement and the pursuit of careers in science (*e.g.*, Tai et al., 2006). Further, there is accumulating evidence that instructional materials focusing on experimental inquiry rather than stressing fact memorization can create and sustain interest in science and mathematics (see National Research Council, 2007).

References

Fadigan, K.A. and P.L. Hammrich (2004). A longitudinal study of the educational and career trajectories of female participants of. an urban informal science education program. *Journal of Research in Science Teaching* 41(8): 835–860.

National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K–8.* Committee on Science Learning, Kindergarten Through

Eighth Grade. Richard A. Duschl, Heidi A. Schweingruber, and Andrew W. Shouse, Editors. Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Tai, R.H., Liu, C.Q., Maltese, A.V., & Fan, X. (2006). Planning early for careers in science. *Science,* 312, 1143–1144.

○