

**ADVANCING AMERICAN INNOVATION
AND COMPETITIVENESS**

HEARING

BEFORE THE

**COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE**

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

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MARCH 10, 2010
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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

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ADVANCING AMERICAN INNOVATION AND COMPETITIVENESS

WEDNESDAY, MARCH 10, 2010

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

The Committee met, pursuant to notice, at 2:58 p.m. in room SR-253, Russell Senate Office Building, Hon. Bill Nelson, presiding.

OPENING STATEMENT OF HON. JOHN D. ROCKEFELLER IV, U.S. SENATOR FROM WEST VIRGINIA

Senator NELSON. The meeting will come to order.

Senator Rockefeller. Mr. Chairman.

The CHAIRMAN. Mr. Chairman, I want to apologize to you, to my colleagues, and to our witnesses, but Leader Reid did me a great favor; we were meant to start FAA reauthorization at 2 o'clock, right after the votes, but he knew that I wanted to come and make a statement, at least here, because what this is so—it's all so important. And so, I'm doing that.

But, in the meantime, a coup is taking place, and Senator Nelson has now—with the support of these two, has—I'm out.

[Laughter.]

The CHAIRMAN. Anyway, we're here today to talk about science for research, research for innovation, innovation behind new technologies, and technology development that leads to high-tech jobs. Slow down, Jay. Science-based initiative drives economic growth and helps America compete in the global economy. For centuries, innovation has made this country's global economics at the forefront, from the steam engine driving the Industrial Revolution to computers and networks powering the Internet Revolution. But, we cannot take that leadership for granted, because we see things slipping away from us.

At a time when the economy continues to struggle, our future depends on the investments that we make today to keep our Nation competitive and ensure that our communities' long-term economic security and prosperity will be fine.

Five years ago, the National Academies reported "Rising Above the Gathering Storm" sounded the alarm that U.S. leadership in science and technology was eroding. It was shocking and it was true—and is.

And so, Congress responded in 2007 with the America COMPETES Act, landmark legislation to increase national investment

in research and development; and in science, technology, engineering, and math education, popularly known as STEM.

Dr. Holdren, I want to tell you, one of the best experiences I've had in years, I had last week in West Virginia. And I drove an hour and a half to Parkersburg, in Wood County, and I sat down for 3 hours—no press, nobody knew I was there—with six teachers teaching science, technology, engineering, or math—some cases, two. And this—the whole discussion—why they got into it, why they stay into it, what do they—how do they find the “button” in the student that has it, but doesn't know it, or is inattentive because of problems at home, or whatever. But, just talking with these teachers—one, it gave you the sense of the power of the profession—the power of the profession to change lives—why it is so important, and then, particularly in these areas. It was—I floated back to Charleston, West Virginia, I was so happy and so proud of those folks.

So, I ended on STEM education. Now the legislation is set to expire this year, and, as we know—and as we look toward reauthorization, we need to evaluate our progress since the law was passed.

President Obama began his presidency with a call to, quote, “restore science to its rightful place.” He has followed through on that promise, with proposed funding increases in science, technology, and innovation, and STEM education.

And we also made a significant investment with last year's Recovery Act. Research institutions across the country have received the kind of grants and awards that will allow them to jumpstart new projects and hire new employees.

I know West Virginia colleges and universities have already received nearly \$29 million to continue their important work in West Virginia. That's major money. But, we have a lot more to do, and we need to look even further down the road at the same time.

And in this very difficult budgetary climate, I agree with the President's focus on research investments in STEM education. I do also notice that it's sort of a soft flat line, which always gives me hope.

We may not see the immediate payoff from these budget increases, but the long-term dividends will be immeasurable. A world-class STEM workforce is fundamental to addressing the challenges of the 21st century, from developing clean sources of energy that reduce our dependence on foreign oil, to discovering cures for endless numbers of diseases.

And, very importantly, it also means a lot of jobs. Projections from the Bureau of Labor and Statistics indicate that over 80 percent of the fastest-growing occupations depend on knowledge of mathematics and science. We simply cannot afford to continue jeopardizing our Nation's future by failing to invest today.

So, in closing, this hearing is an opportunity to examine how and where we are making those investments, as we consider the path ahead, and what more needs to be done.

I thank you, Mr. Chairman.

Senator NELSON. Thank you, Mr. Chairman, that you would come here from handling the FAA bill on the floor. We are most appreciative.

Thank you for opening this hearing.

Senator Hutchison.

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

Senator HUTCHISON. Thank you, Mr. Chairman.

I agree with everything that Senator Rockefeller said. I was one of the co-sponsors of the America COMPETES Act and so believe that it was the right thing to do. The “Rise Above the Gathering Storm” report gave us the blueprint to go forward. Today you’re going to be talking about where we are, how it is working, and what we need to do, going forward.

I will have to leave, along with Senator Rockefeller, because the FAA reauthorization bill is on the floor. But, I want to say a couple of things.

I do believe that science and technology are at the core of our ability to compete in an increasingly globalized economy and to solve the challenges that we face in energy independence, biotechnology, and healthcare.

According to the National Science Board’s Science and Engineering Indicators 2010 report, U.S. leadership in research and development and technological innovation is not growing; it is shrinking. We are still world leaders in R&D, but if this trend continues, a future where we no longer are world leaders in technology development is imminent.

In order to compete, the U.S. needs to not only train the best scientists and engineers in the world, but we must ensure that every student is prepared with a strong proficiency in math and science so we can be competitive for the high-tech jobs of the future.

In my home state of Texas, only 41 percent of the high school graduates are ready for college-level math. Only twenty-four percent are ready for college-level biology. Furthermore, only 2 percent of ninth-grade boys and one percent of ninth-grade girls will go on to attain an undergraduate science or engineering degree.

In contrast to these troubling numbers, 42 percent of all college undergraduates in China earn science or engineering degrees. Furthermore, in 2000, nearly 80 percent of the 114,000 science and engineering doctorates awarded worldwide were from institutions outside the United States, and this situation has only gotten worse in the last 10 years.

I think we can make America even more competitive and innovative than it is today. And we must. To create high-paying, highly-skilled American jobs, we need to increase investment in research by lowering the corporate tax rate, including a permanent extension of the R&D tax credit and we need to encourage student interest in careers in math, science, and technology. Key aspects of the America COMPETES Act are focused on improving academic opportunities available to young Americans, including significant efforts to attract and train teachers qualified to teach courses in science and math, and expanding the availability of advanced placement courses. These are efforts we should continue to build upon as we move forward with efforts to reauthorize the America COMPETES Act.

Thank you for this very timely hearing. I look forward to hearing the testimony of the distinguished panel that we have today.

Thank you.

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

Senator NELSON. And I will just insert in the record an opening statement, and would urge my colleagues to do likewise, so that we can go on and get the testimony.

[The prepared statement of Senator Nelson follows:]

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

I'd like to thank each of our distinguished witnesses for being here today. Science, STEM education, research and development are some of the most important endeavors we undertake as a nation.

Senator Rockefeller would like to be here today but has some business on the floor which is competing for his time. As the floor schedule allows, he will try to come and participate in this hearing.

In 2007, Congress passed the America COMPETES Act—short for “Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science.” This was landmark legislation aimed to increase the Nation’s investment in research and development (R&D), and in science, technology, engineering, and mathematics (STEM) education.

The Act was also a response to growing concerns that the Nation’s ability to compete in the global economy would be hindered by an inadequate science and engineering workforce to drive technological innovation and economic growth.

As an example, my home state of Florida has the fourth largest high-tech workforce in the country. But only one third of Florida’s high school graduates are ready for college-level math, and only one fifth are ready for college science. We need to maintain a strong commitment to Science, Technology, Engineering, and Math education so that we can continue to produce the strong science and engineering workforce that has been so valuable to our economy.

This concern is further highlighted as international competitors adopt the American innovation-driven economic model for the benefit of their own growth.

Authorizations for the America COMPETES Act expire this year and, as we consider a reauthorization and the President’s FY 2011 budget proposal, we need to evaluate the effectiveness of the programs funded by COMPETES in increasing American innovation and competitiveness.

Also, the President’s FY 2011 budget request for NASA creates a new Space Technology program to encourage a broad range of participants to develop next-generation technologies. This renewed focus on innovation is consistent with recommendations from the Augustine Committee and two National Research Council reports from 2009.

In this spirit, and to coordinate technology investments across the agency, NASA also created the Office of the Chief Technologist. The Chief Technologist will need to establish a comprehensive research plan to ensure that the portfolio of early-stage research projects is aligned with long-term mission goals. But I am concerned that the President’s current budget request makes those long-term goals for the agency unclear. I’d like to spend some time exploring that topic today as well.

I look forward to the testimony from each of our witnesses as we explore these important topics.

Witnesses

The Honorable John P. Holdren, Director, Office of Science and Technology Policy, will discuss the overall Federal investment in research and development. Dr. Holdren is Assistant to the President for Science and Technology, Director of the White House Office of Science and Technology Policy, and Co-Chair of the President’s Council of Advisors on Science and Technology (PCAST). Dr. Holdren holds advanced degrees in aerospace engineering and theoretical plasma physics from MIT and Stanford and is highly regarded for his work on energy technology and policy, global climate change, and nuclear arms control and nonproliferation.

The Honorable Arden L. Bement, Jr., Director, National Science Foundation (NSF), will discuss NSF’s leading role in supporting civilian research and development, and training scientists and engineers. Dr. Bement was sworn in as the 12th Director of the National Science Foundation (NSF) on November 24, 2004. As NSF Director, he heads the only Federal agency that funds research and education in all

fields of science and engineering. Dr. Bement earned a doctorate in metallurgical engineering from the University of Michigan.

The Honorable Patrick D. Gallagher, Director, National Institute of Standards and Technology (NIST), will discuss NIST's cutting edge research to advance new technologies. The agency promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology. As Director, Gallagher provides high-level oversight and direction for NIST. Dr. Gallagher received his Ph.D. in Physics at the University of Pittsburgh in 1991.

Dr. Robert D. Braun, Chief Technologist, National Aeronautics and Space Administration, will discuss NASA's new Space Technology program. Dr. Braun was named NASA Chief Technologist by NASA Administrator Charles F. Bolden on Feb. 3, 2010. He serves as the principal advisor and advocate on matters concerning agency-wide technology policy and programs. Dr. Braun received a Ph.D. in Aeronautics and Astronautics from Stanford University in 1996.

Senator NELSON. And what I would like each of you to do—your written statement will be made a part of the record—rather than you sit there and read something to us, I'd rather you just take about 5 minutes and talk to us, and then we will get immediately into the questions. And I will defer to my colleagues for your questions first, before me.

So, let me just tell you what a distinguished panel that Chairman Rockefeller has assembled: The Honorable John Holdren—he's the Director of the Office of Science and Technology, and he's going to discuss the overall Federal investment in research and development, and his credentials are stellar; The Honorable Arden Bement—"Beemit"—Bement, Director of the National Science Foundation, and he's going to discuss the Foundation's leading role in supporting civilian research and development and training scientists and engineers; and The Honorable Patrick Gallagher, the Director of the National Institute of Standards and Technology, NIST, will discuss NIST's cutting-edge research to advance new technologies; and Dr. Robert Braun, Chief Technologist at NASA, and he'll discuss NASA's new Space Technology Program.

So, gentlemen, we'll go in that order.

Dr. Holdren.

STATEMENT OF HON. JOHN P. HOLDREN, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES

Dr. HOLDREN. Well, Chairman Nelson, Chairman Rockefeller, Ranking Member Hutchison, members of the Committee, it's certainly a pleasure to be here to talk about this very important agenda.

I'll be talking about the Obama Administration's response to the America COMPETES Act, to date, our support for reauthorizing that Act, and, of course, about the important investments in research and development and science, engineering, technology, mathematics education that the Administration is proposing in order to continue to fulfill the vision of that Act, going forward.

It was just a little more than half a century ago that Americans, gazing into the night sky, saw the glint of a Russian satellite, the first artificial satellite to orbit the Earth, and we quickly grasped the significance of that event, as a Nation. And we responded aggressively with massive new investments in research and development, and a new commitment to science and math education. We created NASA, we created what was originally our ARPA, now

DARPA—the Defense Advanced Research Projects Agency. We built new labs and manufacturing facilities to tackle the scientific and engineering challenges that suddenly seemed to loom so large.

And I would suggest that today we face another Sputnik moment, if you will, but one that is not so easily recognized, because the indications of it are more diverse and they're more subtle than seeing a Russian satellite overhead when we had none. But, the relevant facts include some that have already been mentioned by Senator Hutchison and others. America has fallen from first in the world in broadband penetration to a place in the middle of the pack of developed nations. In science education, one of the widely used international assessments shows American 15-year-olds ranked 25th in math and 21st in science, among OECD countries.

And again, Senator Hutchison mentioned the Science and Engineering Indicators 2010. That report shows, among other things, that for the first time, in 2008, non-Americans were granted more U.S. patents than Americans were.

We can do better than that. America still can, and indeed must, be an innovation machine. Clearly, technological and economic superiority are not a birthright; it's something that, in the past, we've earned as a result of smart investments in fundamental science and targeted investments in the next big things. And it's something we have to get serious about earning again so that we can continue to lead the world in the next round of modernization and creativity.

That's why the President set the ambitious goal of lifting the sum of public and private research and development in this country to 3 percent of gross domestic product. That would exceed, for the first time, the level of R&D investment at the height of the Space Race. It's why the President is committed to moving American students from the middle to the top of the pack in performance in STEM fields, and to be number one in the world again, when it comes to college graduation rates, as we were just a few decades ago.

The America COMPETES Act has been a very helpful tool in the early stages of attaining these goals and related ones. The President and the Vice President both supported the original COMPETES Act when they were Senators, and the Obama Administration is strongly supportive of Congressional efforts to reauthorize that important Act this year.

But, the Administration has not waited for COMPETES to be reauthorized to continue to pursue the goals of the Act. And specifically, in his first year in office, the President has taken a variety of key steps to move America forward with this agenda by getting the key science and technology agencies—NSF, the DOE Office of Science, the NIST labs—back on track toward doubled budgets, by investing record sums in research and development, through the Fiscal Year 09 and 10 budgets and the Recovery Act, as well as calling for further targeted budget increases for Fiscal Year 2011; in launching a comprehensive strategy for American innovation, which lays out a practical path to rejuvenating American industry and creating millions of high-quality jobs; inaugurating Educate to Innovate, a public-private partnership in STEM education that has already raised more than half-a-billion dollars in commitments of cash and in-kind services to revitalize science and engineering edu-

cation programs in schools; unveiling a new plan for the U.S. space program that will extend the life of the International Space Station, increase investments in game-changing technologies for human exploration of space beyond low-Earth orbit, and with budgets that match the goals; sharply ramping up support for clean energy and energy efficiency research, development, demonstration, and deployment, including standing up the Advanced Research Projects Agency for Energy—ARPA-E.

The America COMPETES Act can and should remain a valuable tool to support these and related strategies for enabling innovation to propel this country into a better future.

Both the America COMPETES Act and the 2007 “Rising Above the Gathering Storm” report, again, already mentioned here, emphasized the need for enhanced Federal efforts in science, technology, engineering, and math education. As I noted earlier, President Obama is committed to bringing American students back to the top in this domain. His Fiscal Year 2011 budget would put a billion dollars into improving math and science achievement among K-through-12 students, and \$3.7 billion into STEM education, overall. And that Educate to Innovate Initiative has already attracted, as I mentioned above, an extraordinary amount of corporate and philanthropic support for improving STEM education facilities, practices, and teacher preparation. Reauthorization of COMPETES is a clear opportunity for Congress to reinforce these efforts, going forward.

Let me note briefly, before closing, that among the responsibilities the America COMPETES Act assigned to the Office of Science and Technology Policy in the White House was a requirement that the director, in consultation with others, develop an overarching set of principles to ensure the communication and open exchange of research data collected by Federal scientists, and to prevent the suppression or distortion of such research findings.

The Act also required that OSTP develop specific policies and procedures regarding the public release of data, consistent with the principles established in the Act, a task that the last Administration did not, in fact, fulfill.

President Obama initiated the remedy in March of last year, issuing a Presidential memorandum that promulgated six principles to, quote, “restore scientific integrity in government decision-making,” close quote, and tasked me, as OSTP’s Director, with making recommendations for how to ensure scientific integrity throughout the Executive Branch.

A substantial effort has ensued, as described in my written statement, but the task has proved more challenging than expected, and the work is not yet complete. I do expect to have those recommendations completed shortly, and I expect that they will more than satisfy the remaining responsibilities in this domain, under the COMPETES Act.

In conclusion, I know this committee shares with me, and, of course, with the President, the important goal of advancing America’s standing in the world as a leader in innovation and competitiveness. It’s a goal I think you’ll all agree transcends partisan politics because it is so important and so central to this Nation’s well-being.

I look forward to working with all of the members on this committee toward reauthorization of the COMPETES Act, and, more broadly, on all that we can do together to achieve the potential of science, technology, innovation, and STEM education, to strengthen our country and improve our world.

I thank you for your attention, and I'll be happy to try to answer your questions.

[The prepared statement of Dr. Holdren follows:]

PREPARED STATEMENT OF HON. JOHN P. HOLDREN, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES

Chairman Rockefeller, Ranking Member Hutchison, and members of the Committee, it is my distinct privilege to be here with you today to discuss the Obama Administration's responses to the America COMPETES Act to date, my support for the Committee's interest in reauthorizing the Act, and the important investments in R&D and science, technology, engineering, and mathematics (STEM) education the Administration is proposing in order to continue to fulfill the vision of the Act going forward.

A little more than a half a century ago, Americans gazed astonished into the night sky at the glint of a Russian satellite arcing overhead—the first artificial satellite to orbit the Earth. As a nation, we quickly grasped the significance of that signal event, and responded aggressively with massive new investments in research and development (R&D) and a new commitment to science, technology, engineering, and mathematics (STEM) education. We created NASA and DARPA, and we built laboratories and manufacturing facilities—some as small as classrooms and others larger than football fields—to tackle the scientific and engineering challenges that suddenly loomed large.

Hardly more than a decade after that blinking wake-up call, Americans were walking on the surface of the moon, having leapfrogged Russia and every other advanced nation with a technological tour de force that laid the foundation for a solid 50 years of economic superiority. That burst of activity led to the creation of the Internet, microchips, the Global Positioning System (GPS), revolutionary improvements in medical technologies, and much more; created enormous entrepreneurial opportunities and countless jobs; and enabled a standard of living never before available to such a broad swath of any nation.

Today we are at another such moment in history, again faced with a fundamental innovation challenge. China, South Korea, India, and other nations are focusing increased attention on advanced manufacturing, renewable energy, and other technologies of the future, even as America's scientific and technological dominance has eroded.

The challenge we face may not be obvious at first glance. Last year, as they have in so many years, Americans won the vast majority of Nobel Prizes in the sciences. Not only that, but more so than in many other years it was easy to see how these winners' achievements had changed our lives for the better.

One won his prize for seminal work in fiber optics, the field of science at the heart of today's national broadband networks, which are streaming this hearing live to millions of Americans who cannot be here in Washington to see their government at work—networks that today support \$900 billion of the American economy and will continue to prime this Nation's economic pump in ever greater degrees as this Administration, through the Recovery Act and our soon-to-be-released national broadband plan, races to lay thousands of miles more of cable every year.

Another Nobel winner was honored for having invented the charged coupled device or CCD, which is at the heart of the digital cameras that are embedded in our cell phones as well as every Flickr picture on the web, and the YouTube videos viewed more than a billion times on the Internet every day.

But these Nobel winners and, for the most part, their fellow awardees, did their work decades ago—based on investments America made in the 1950s, 1960s, and 1970s.

Today we face a new Sputnik moment, albeit one not so easily recognized because the indications are more diverse and subtle than seeing a Russian satellite overhead when we had none. But consider:

- America has fallen from 1st in the world in broadband penetration to the middle of the pack among developed nations.¹
- In science education, one widely used international assessment shows American 15-year-olds ranked 25th in math and 21st in science among OECD countries.²
- For the first time, in 2008, non-Americans were granted more U.S. patents than Americans.³

We can do better. America still can, and indeed must, be an innovation machine. Clearly, however, technological and economic superiority is not our birthright. It is something that in the past we have earned—earned as a result of smart investments in fundamental science and targeted investments in the next big things—and it is something we must get serious about earning again, so we can continue to lead the world in the next round of modernization and creativity, just as we have in the decades following Sputnik.

That is why the President has set the bold and ambitious long-term goal of lifting the sum of public and private investments in research and development in the United States to 3 percent of Gross Domestic Product (GDP)—to exceed, for the first time, the level of R&D investment at the height of the space race. Investing in innovation is not a luxury today—it is a necessity.

That is also why the President is committed to moving American students from the middle to the top of the pack in STEM education, and to be number 1 in the world once again when it comes to college graduation rates, as we were just a few decades ago.

And it is why—for reasons ranging from economic growth to environmental protection to enhanced national security—this Administration is determined to stoke the fires of American ingenuity, to support the workforce of today as well as the entrepreneurs and industries of tomorrow, to keep the pipeline of American productivity fully pressurized and provide the jobs, the security, and the position of global leadership that previous generations worked so hard to attain.

The America COMPETES Act has been a helpful tool in the early stages of attaining these goals. And the Administration is strongly supportive of congressional efforts to reauthorize this important Act this year. But the time has come to refine that initial approach—to strengthen the parts that have the most capacity to leverage the American economy and secure America's future and perhaps to trim some parts that have proven to be less valuable.

Meanwhile, this Administration has not waited for COMPETES to be reauthorized to continue pursuit of the goals the Act was created to achieve. In his first year in office, the President has taken key steps to move America forward by:

- Getting key science and technology agencies (NSF, DOE Office of Science, and the NIST laboratories) back on track toward doubled budgets;
- Investing record sums for R&D through 2009 and 2010 appropriations and the Recovery Act, as well as calling for further targeted budget increases in 2011;
- Launching a comprehensive Strategy for American Innovation that lays out a practical path to rejuvenating American industry and creating millions of high-quality jobs;
- Inaugurating Educate to Innovate—a public-private partnership in STEM education that has already raised more than half a billion dollars in cash and in-kind donations to revitalize science and engineering programs in schools;
- Unveiling a new plan for the U.S. space program that extends the life of the International Space Station and increases investments in game-changing technologies for human exploration of space beyond low Earth orbit, with budgets that match the goals;
- Sharply ramping up support for clean-energy and energy-efficiency research, development, demonstration, and deployment, including standing up the Advanced Research Projects Agency for Energy, or ARPA-E.

The America COMPETES Act can and should remain a valuable tool to support these and other strategies for propelling America into a better future.

¹OECD, OECD Broadband Portal, *Data on Broadband Subscribers per 100 inhabitants*, 2009 Q2 data.

²U.S. Department of Education, National Center for Education Statistics, Program for International Student Assessment, *Highlights from PISA 2006: Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context*, December 2007.

³NSF, *Science and Engineering Indicators 2010*, Chapter 6, based on U.S. Patent and Trademark Office data.

Reauthorization of the America COMPETES Act

The Obama Administration believes that the America COMPETES Act should be reauthorized this year so that the Nation can continue to build on the achievements of the original Act. The President and the Vice President, who supported the original COMPETES Act when they were Senators, share my belief that the COMPETES Act provides a valuable roadmap to guide Federal policies in innovation, competitiveness, and STEM education. We are supportive of this committee's efforts to reauthorize this landmark act this year, and we very much look forward to working with the Committee to make the reauthorization a reality during this session of Congress.

The original COMPETES Act identified three key science agencies—the National Science Foundation, the DOE Office of Science, and the National Institute of Standards and Technology laboratories—as essential to our Nation's future prosperity and to preserving America's place as the world leader in science and technology. Last April, in a speech at the National Academy of Sciences, President Obama announced his President's Plan for Science and Innovation, which would place these agencies' budgets on the doubling path that Congress called for in COMPETES. Although the previous Administration supported an effort to double these agencies' budgets between 2006 and 2016, the appropriated budgets fell short in 2007 and 2008. But last year, this Congress and this Administration worked together to finally put these agencies on a doubling trajectory, and the 2011 Budget maintains that trajectory with a 6.6 percent increase for their combined budgets, totaling \$13.3 billion.

The reauthorization of the COMPETES Act is an opportunity for Congress to sustain the vision of doubling the budgets of these three agencies. The authorizations in the original COMPETES Act extend through Fiscal Year (FY) 2010. For FY 2011 and beyond, the Administration supports authorizations for NSF, DOE Office of Science, and the NIST laboratory programs at the budget levels outlined in the 2011 Budget, which would achieve the President's vision of doubling these budgets by 2017.

I would also like to call attention to the 2011 Budget's strong support for NIST's external programs. The 2011 Budget requests \$130 million for the Hollings Manufacturing Extension Partnership (MEP), a \$5 million increase over the 2010 enacted level consistent with the Administration's plan to double funding by 2015. The 2011 Budget also requests \$80 million, a \$10 million increase over 2010, for the Technology Innovation Program (TIP), created and authorized in the America COMPETES Act. These NIST programs are important components of *A Framework for American Manufacturing*, the comprehensive strategy for supporting American manufacturers announced in December.

The President's FY 2011 Budget proposes \$300 million for the Advanced Research Projects Agency-Energy (ARPA-E), created and authorized in the America COMPETES Act and first funded in the Recovery Act. ARPA-E supports high-risk, high-reward research to yield revolutionary changes in how we produce, distribute, and use energy. ARPA-E announced its first set of grants last October and in 2010 will make additional awards with Recovery Act funds. The proposed allocation in the 2011 Budget would allow ARPA-E to make additional awards next year.

I would also like to call the Committee's attention to the 2011 Budget's strong support for other Federal agencies whose investments in science help underpin this country's economic competitiveness, environmental quality, and national security. For example:

- The Budget proposes in FY 2011 \$5.0 billion for NASA's science portfolio and \$1.15 billion for NASA's Aeronautics and Space Research and Technology portfolio, increases of more than \$500 million in Science and about \$400 million for Space Technology compared to 2010 (Space Technology includes the Innovative Partnership Programs (IPP) budget, which was funded at \$175.2 million in FY 2010). The Science increase is primarily in Earth Science to enable continuity of key climate observations and accelerate Earth observing science missions recommended in the National Research Council's (NRC's) decadal survey, which defines the priorities of the Nation's earth science community.
- The NOAA budget of \$5.6 billion is an increase of \$806 million over the 2010 enacted level to allow NOAA to strengthen the scientific basis for environmental decisionmaking, improve weather and climate services that protect life and property, invest more heavily in restoring our oceans and coasts, and ensure satellite continuity.
- The Defense Advanced Research Projects Agency (DARPA) would receive \$3.1 billion for longer-term breakthrough research.

- The 2011 Budget sustains DOD's basic research ("6.1") with a record commitment of \$2.0 billion, and provides increases for research in high priority areas such as night vision, cybersecurity, enhanced GPS, deployable force protection, nano-manufacturing, and advanced distributed learning.
- And the 2011 Budget provides \$32.1 billion for NIH, an increase of \$1.0 billion, or 3.2 percent above the 2010 enacted level, to support the discovery of knowledge and therapies that will lead to better health outcomes for all Americans through a robust program of intramural and extramural research, education, and training.

The Administration would encourage the Congress to provide the requested growth for these programs.

Let me offer here a few thoughts on how Congress might strengthen the parts of the COMPETES Act that have the most capacity to leverage the American economy and secure America's future. A major strength of the original COMPETES Act was its authorizations of Federal policies to encourage innovation and competitiveness. Just as the original COMPETES Act authorized the creation of ARPA-E and laid the foundation for its eventual launch in April of last year, the reauthorization of the COMPETES Act is an opportunity for Congress to lay the foundations for other innovative approaches to addressing the challenges we face.

For example, Congress has the opportunity to authorize DOE's Energy Innovation Hubs. The 2011 Budget includes support for four Energy Innovation Hubs to accelerate cross-disciplinary R&D for transforming advances in energy science into commercially deployable materials, devices, and systems: three appropriated by Congress last year to advance fuels from sunlight, modeling and simulation for nuclear reactors, and energy-efficient building systems design; and one new Hub to conduct R&D on batteries and energy storage. Congress also has the opportunity to authorize NSF's proposal for \$12 million in the 2011 Budget to support a new Innovation Ecosystem where universities will partner with other institutions to increase the impact of the most promising innovations through commercialization, industry alliances, and start-up formation.

Science, Technology, Engineering, and Mathematics (STEM) Education

Both the America COMPETES Act and the 2007 *Rising Above the Gathering Storm* report produced by the National Academies called attention to the need for enhanced Federal efforts in STEM education. And the President has been emphatic about his commitment, which I share, to increase the participation and the performance of American students in STEM subjects and to raising the international ranking of our students from the middle to the top of the pack over the next decade. Over the past year, OSTP has been working with the White House Domestic Policy Council, the Department of Education, and a number of science and technology agencies to identify and promote concrete actions to help meet these ambitious goals.

The 2011 Budget invests \$3.7 billion in STEM education programs across the Federal Government, including an historic \$1 billion commitment to improve math and science achievement among K-12 students—that latter figure an increase of more than 40 percent over the FY 2010 level. The impact of these investments will be magnified by "Educate to Innovate," an initiative launched by the President to motivate and inspire young people to excel in STEM subjects. This campaign has already mobilized more than \$500 million in financial and in-kind support from companies, foundations, philanthropies, universities, non-profit organizations, and grassroots volunteers.

In addition to these leveraged investments, the Administration has made great strides in integrating STEM education into broader education programs. For example, the \$4.35 billion Race to the Top fund in the Recovery Act provides a competitive advantage to states that commit to a comprehensive strategy to improve STEM education. The 2011 Budget, by providing an additional \$1.35 billion in funding for Race to the Top, builds on these historic investments to create state capacity, focus on student achievement, and help prepare America's students to graduate ready for college and careers.

The Administration's vision for STEM education includes improving student outcomes by using the latest educational technologies and cognitive and learning research results, but we also want to ensure that we are addressing the very basic issues that limit student access to high-quality STEM education. Reauthorization of COMPETES is an opportunity for Congress to reinforce our efforts to improve access to high-quality, cutting-edge STEM equipment and infrastructure in K-12 classrooms, as well as access to well trained teachers and counselors. (Both of these ele-

ments were part of the historic investments made in R&D and STEM education through the National Defense Education Act of 1958.)

The Obama Administration is committed to investing in and scaling up what works in STEM education, while improving coordination and minimizing duplication among Federal STEM education programs. The Department of Education and the NSF are leading an effort, with active OSTP participation, to increase the impact of the Federal STEM investments I've outlined above by: (1) developing an aligned strategy that emphasizes key agency capacities and takes advantage of the new energy and interest at the Department of Education in partnering with science agencies that have both expertise and substantial investments in STEM education; (2) clarifying evidence standards used to evaluate program impact and aligning our work on evidence and evaluation so that we can compare the effectiveness of programs across Federal agencies and Departments and identify the most promising STEM efforts for further validation, testing, and suitability for scale-up; (3) a locus of resources at the agency level, in particular within the Department of Education, to allow effective interagency coordination and coherence on STEM education; and (4) specific strategies and efforts to ensure opportunities in STEM education for traditionally underrepresented groups, such as women and girls, minorities, and students with disabilities, realizing that the diversity of our Nation is a strength as we look for innovative design solutions to compete in an increasingly demanding global marketplace.

Scientific Integrity

Among the responsibilities that the America COMPETES Act bequeathed to OSTP was a requirement that the Director, in consultation with the Director of OMB and others, develop an overarching set of principles to ensure the communication and open exchange of research data collected by scientists employed by Federal civilian agencies and to prevent the suppression or distortion of such research findings. The Act also required OSTP to develop specific policies and procedures regarding the public release of data consistent with the principles established in the Act, a task that the last Administration did not fulfill.

In March 2009, President Obama released a Presidential Memorandum that iterated six principles "to restore scientific integrity in government decisionmaking" and tasked the Director of OSTP with making recommendations for Presidential action designed to guarantee scientific integrity throughout the executive branch, based on those principles. In response to that call, OSTP organized a comprehensive strategy for developing such recommendations, including creation of an interagency working group and the launch of a blog-based public forum to gather input from stakeholders. Based on a summary report by that working group, which incorporated public comments and a review of policies at various agencies, OSTP has been crafting recommendations on this topic that will be delivered to the President for his approval and, after that, released for implementation by relevant agencies. OSTP anticipates that these recommendations will more than satisfy the remaining responsibilities under America COMPETES.

Conclusion

I know this committee shares with me, and with the President, the important goal of advancing America's standing in the world as a leader in innovation and competitiveness. It is a goal that I think you will all agree transcends partisan politics because, in fact, it is so important and so central to this Nation's well-being.

I look forward to working with all of the members on this committee toward the reauthorization of the COMPETES Act and, more broadly, on all that we can do together to achieve the potential of science, technology, innovation, and STEM education to strengthen our country and improve our world.

Senator NELSON. Dr. Bement, see if you can confine it to 5 minutes so we can really get into the give-and-take on these questions.

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

Dr. BEMENT. Chairman Rockefeller, Ranking Member Hutchison, and Senator Nelson, I'm pleased to appear before you.

The essence of the President's 2011 budget request for the National Science Foundation is to reaffirm the agency's roots as the

Nation's wellspring of new, transformative concepts through scientific innovation.

NSF's research and education agenda is both multifaceted and well rounded. It is designed very deliberately to support the Administration's plan for making innovation a centerpiece of economic strength and future well-being.

The main driver for this investment is a national innovation strategy. Nothing speaks more to what NSF is and does than the Administration's commitment to fundamental research. That's emphasized throughout the budget. When you talk about the building blocks of innovation, you talk about NSF.

You will also see at the forefront of educating the next generation of 21st-century knowledge and skills, NSF is present. It's through the integration of education with research that we prepare the talent that goes into academia and also into the private sector to be the innovators and the entrepreneurs of the future. This is NSF's greatest contribution to the Nation's innovation system, and it's a priority that the Administration has placed on the agency, and one that we take quite seriously.

The Advanced Technological Education Program supports new and enhanced 2-year college programs that educate technicians for the high-technology workforce. The Graduate Research Fellowship and Faculty Early Career Development program supports students and early career investigators to foster the Nation's next generation of scientists and engineers. Climate-change education addresses learning at all levels; it is designed to stimulate careers in climate science. NSF's programs also support next-generation information technology and secure cyberspace. The agency will support the interagency Networking and Information Technology R&D Program, at \$1.17 billion.

Overcoming challenges inherent in today's great scientific questions will require a new computer revolution to overcome the physical restrictions of today's silicon chip-based technology. So, there are some innovation activities and initiatives within the budget that will lead to new technologies and new capabilities for information technology, especially NSF's Science and Engineering Beyond Moore's Law program, which is a multidisciplinary research program designed to enhance our Nation's economic competitiveness.

NSF must continue to innovate in tackling the large-scale scientific and engineering challenges of our age, including understanding the nature and scope of changes in the Earth's climate. NSF contributes multiple resources to support the U.S. Global Change Research Program and other interagency initiatives that are helping us understand and confront the global challenge of a changing climate.

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

With an investment of \$19 million, NSF will jointly fund RE-ENERGYSE with the Department of Energy to prepare as many as 8,500 highly trained young scientists and engineers for clean en-

ergy careers by 2015. Additionally, RE-ENERGYSE will provide training of technicians for clean energy industries.

One project that is very important is the NEON project, which is in our budget, for \$20 million, under our Major Research, Equipment, and Facilities Construction account. Now, this facility will collect data on the effects of climate change, changes in land use, and invasive species, over a period of decades, rather than centuries, and over the span of regions—on a regional basis, rather than on a global basis. NEON will be the first observatory network designed to detect and enable forecasting of ecological change at the continental scale, over multiple decades.

Mr. Chairman and members of the Committee, as this will likely be the last time I testify before you, before my June 1st departure from the Foundation, I want to make certain you are aware of how deeply appreciative I am of your support over the past 9 years, as Director of NSF and NIST.

Thank you very much. I'd be glad to answer your questions.
[The prepared statement of Dr. Bement follows:]

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

Chairman Rockefeller, Ranking Member Hutchison, and members of the Committee, I am pleased to appear before you this afternoon.

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

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

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

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

While the United States still far outpaces the world in its level of public and private R&D investment and research output, our counterparts around the globe are well aware of the importance of funding R&D. As is highlighted in the just released 2010 Science and Engineering Indicators, the world's R&D expenditures have been on an 11-year doubling path, growing faster than total global economic output. While the growth of annual U.S. R&D expenditures averaged around 6 percent, China, for example, has invested in R&D at an annual growth of over 22 percent during the same period of time.¹

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

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

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

With its relatively small size, NSF delivers an enormous “bang for the buck” of Federal Government research and development (R&D) investment. NSF represents just 4 percent of the total Federal budget for research and development, but accounts for over sixty percent of Federal support of non-life science basic research at academic institutions. For example, NSF’s share of Federal support for basic research in computer sciences at academic institutions in FY 2008 was over 80 percent. NSF is the research funding lifeline for many fields and emerging interdisciplinary areas at the frontiers of discovery. In fact, NSF is the only Federal agency that supports all fields of basic science and engineering research.

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

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

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

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

2011 Budget Request Highlights

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

Let me begin with the big picture. As noted earlier, the President is requesting \$7.42 billion for the NSF in FY 2011. That’s an increase of almost \$552 million, or 8 percent above the current 2010 appropriated amount. While it seems like a large increase, this level is necessary to fulfill the President’s vision for doubling the National Science Foundation’s budget. This increased investment will reinforce NSF’s leadership in basic science and engineering and allow us to preserve America’s pre-eminence in the global technology economy.

In this year’s proposed budget, funding levels increase for every NSF appropriations account. Research and Related Activities investments increase by 8.2 percent, and our Education and Human Resources account is increased by 2.2 percent. We need rapid progress in these areas to stimulate the discoveries in research we need to maintain our standing in the global marketplace, and to keep our students engaged and ready to perform in the global workforce. Our budget includes increases for every Directorate and Office within NSF. But, as with any budget, the FY 2011 Request reflects tough choices and clear priorities. It recognizes NSF’s unique na-

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

tional responsibility for supporting basic research, our catalytic role in education, and the ongoing need for investments in stewardship.

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

National Innovation Strategy

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

Maintain American Leadership in Fundamental Research. Since innovation depends on the foundation of earlier investments, NSF's foremost responsibility in innovation is to continue to support fundamental research and education in all fields of science and engineering. The President's Plan for Science and Innovation aims to double the Federal investment in three key basic research agencies over FY 2006 levels. This investment will be vital to the effort to increase national R&D investments to 3 percent of Gross Domestic Product.

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

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

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

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

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

Partnerships for Innovation (PFI), (108.8 percent increase to \$19.19 million). PFI brings together colleges, universities, state and local governments, private sector firms, and nonprofit organizations. Initiated in FY 2000, PFI connects new knowledge created in the discovery process to learning and innovation, while broadening the participation of people and institutions in NSF activities. PFI activities include research, technology transfer, building infrastructure for innovation, and workforce

education and training. In FY 2011, \$12.0 million will be invested in a new “NSF Innovation Ecosystem” component, which aims to: increase the engagement of faculty and students across all disciplines in the innovation and entrepreneurship process; increase the impact of the most promising university innovations through commercialization, industry alliances, and start-up formulation; and develop a regional community that supports the “innovation ecosystem” around the university. It will draw on the individual entrepreneurial spirit of university faculty and students, as well as on the proven strengths of established technology centers such as Science and Technology Centers, Engineering Research Centers, Industry University Cooperative Research Centers, and others that link higher education institutions with investment and industry sectors. The Innovation Ecosystem initiative will focus on ways to maximize the innovation potential of scientific and engineering discovery in the university system and accelerate the technological innovation process with robust partnerships with the private sector.

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

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

Learning and Workforce Development

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

Administration Priority Programs

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

- *The Graduate Research Fellowship (GRF)* program supports the development of the Nation’s future scientists and engineers. As noted earlier, FY 2009 marked the beginning of a growth trajectory to triple the number of new awards made each year to 3,000 by FY 2013.
- *The Faculty Early Career Development Program (CAREER)* develops the future scientific and technical workforce through support of young faculty who are dedicated to integrating the excitement of research with inspired teaching and enthusiastic learning.
- *Climate Change Education* is designed to develop the next generation of skilled, educated, and climate-savvy Americans. It catalyzes activity at the national level in four strands of STEM education: preparation of a climate science profes-

sional workforce; public understanding and engagement; resources for learning; and local and national STEM education policy.

- *Advanced Technological Education (ATE)* supports new and enhanced two-year college programs that educate technicians for the high-technology workforce. It is on a growth trajectory begun in FY 2010 to increase the program's funding to \$100 million by FY 2013.

Learning and Broadening Participation

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

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

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

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

Experimental Program to Stimulate Competitive Research (EPSCoR), (4.9 percent increase to \$154.36 million) NSF remains a leader in efforts to broaden participation in science and engineering in all states and regions. EPSCoR's goal is to stimulate sustainable improvements in research participation from institutions in geographical areas that are underrepresented in NSF activities. Strategies include supporting research infrastructure improvement, co-funding of disciplinary and interdisciplinary research, and conducting outreach and workshops. This growth mirrors the overall growth for the R&RA account for FY 2009 through FY 2011.

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

ing knowledge of effective curricular and instructional practices, and how they can be implemented at scale.

NSF K-16 Stem Education Priorities

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

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

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

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

Investment Portfolios

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

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

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

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

Interagency Activities

Networking and Information Technology Research and Development (NITRD), (7 percent increase to \$1.170 billion). NITRD coordinates the unclassified networking

and information technology research and development investments across thirteen Federal agencies. These agencies work together to develop a broad spectrum of advanced networking and IT capabilities to power Federal missions, economic competitiveness, and science, engineering, and technology leadership. NSF is a leader in the program and NITRD activities represent 16 percent of NSF's FY 2011 budget. Funding foci for FY 2011 include large scale networking, cybersecurity and information assurance, high confidence software and systems, human-computer interaction and information management, and software design and productivity.

National Nanotechnology Initiative (NNI), (4 percent decrease to \$401.3 million). NSF actively participates in the NNI, which coordinates nanotechnology research and development with 25 departments and agencies across the Federal Government. Nanotechnology encompasses the systematic understanding, organization, manipulation, and control of matter at the atomic, molecular, and supramolecular levels in the size range of 1 to 100 nanometers. NSF's investment in this activity increases in two key areas in FY 2011: nanomanufacturing (44 percent increase to \$32.2 million) and Environmental, Health and Safety (11 percent increase to \$33.0 million).

NSF contributes to the three NNI Signature Initiatives focusing on:

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

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

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

Stewardship Investments

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

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

- *Staff*, 40 additional full-time equivalents (for a total of 1,350 FTE) and eleven additional IPAs are requested;
- *IT investments*, such as the expansion of *Research.gov*, modernization of the NSF financial system, and improvements in the reliability and security of NSF's operational IT systems; and
- *Acquisition*, (\$2.0 million). This increase is part of the government-wide effort to strengthen the acquisition workforce. A key priority for NSF is improving capabilities in the pre-solicitation phase of major acquisitions.

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

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

investments and identifying the most effective means for continuous improvement across the NSF portfolio.

Concluding Remarks

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

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

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

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

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

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

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

Senator HUTCHISON. Mr. Chairman, I have to go to the floor, as well as Senator Rockefeller, but I just wanted to say that I have certainly enjoyed working with you, Dr. Bement. You have done a super job of navigating some very tough waters over there.

Dr. BEMENT. Well, I look forward to future opportunities to see you, not only here in Washington, but also in Texas.

Senator HUTCHISON. Thank you.

Senator KLOBUCHAR [presiding]. Good answer.

OK. Director Gallagher.

**STATEMENT OF HON. PATRICK D. GALLAGHER, Ph.D.,
DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND
TECHNOLOGY, UNITED STATES DEPARTMENT OF COMMERCE**

Dr. GALLAGHER. Thank you very much.

Members of the Committee, in the spirit of Senator Nelson's guidance, let me briefly give you some highlights about how NIST has directly been touched by the America COMPETES Act.

This seminal piece of legislation played several key roles for the agency. First, it prioritized programs at NIST and established the goal of doubling our funding. It also provided new authorization language, strengthening the Hollings Manufacturing Extension Partnership Program, which we consider one of COMPETES' major successes. It also created a new program at NIST, the Technology Innovation Program.

These impacts of the Act on NIST are directly reflected in the President's 2011 budget, which moves toward doubling the laboratory budget, as called for under COMPETES, which Dr. Holdren has talked about. It has also increased funding levels for the Hollings MEP program and for the Technology Innovation Program.

What this means for NIST is that the laboratory programs have been able to target high-priority areas consistent with the direction provided in COMPETES. This includes unprecedented support for manufacturing technology and innovation, in a number of areas, and emphasizes our work in Smart Grid, national healthcare, information system interoperability, cybersecurity, alternative energy sources, including advanced solar technologies. All of these hold significant promise to transform our society and revitalize the economy. These are challenges that are well suited to NIST, and the President's budget request will support these critical roles.

The request also increases support for the Hollings MEP program. These new funds will allow this important program to target job creation by providing manufacturers with the tools to reinvest, including process improvement and business growth initiatives. These collaborative efforts will lead to more sales, open new markets, and facilitate the adoption of technology to deliver new products and services for America's manufacturers.

The new program that was provided under America COMPETES for NIST was the Technology Innovation Program. This program catalyzes public-private activities to foster high-risk, high-payoff research programs focused on the development of advanced technologies that enable accelerated development of next-generation high-performance processes and materials. And this includes in such areas as nanomanufacturing. The request also includes funding for our construction of research facilities so that the NIST labs can remain at the forefront of their work.

In my written testimony, I provide some information to extend my earlier remarks. But, I wanted to look forward, to make a few comments for the Committee as you consider reauthorization of the America COMPETES Act.

While the efforts at the end of the innovation process—namely, scientific discovery and commercial activity—have well-defined participants, the middle of the process is characterized by a diverse mixture of participants. This means that our efforts must provide effective ways for Federal agencies to catalyze working partner-

ships between government, university, and industry researchers, but also between these groups and the financial, educational, tech-transfer, trade experts, and other critical stakeholders in this process. The authorities provided in the COMPETES Act can facilitate these types of partnership activities.

Another thought is that the Federal Government has an important role in innovation, but it is not the only player. States and local governments are essential government partners, and play a critical role in establishing the right technology ecosystem for innovation to flourish. Programs carried out under COMPETES should support these roles and create incentives for effective partnerships with state and local governments.

And finally, the technology infrastructure plays an absolutely critical role in establishing the right conditions for the development of new technologies. Infrastructure technologies are powered by the standards that define how these systems work together. Our efforts in Smart Grid and health IT have the potential to revolutionize not only the ability to manage electricity distribution and medical information management, but also will provide the opportunity to develop new products and services that we cannot yet imagine.

The budget request for the NIST reflects the Administration's strong support for NIST and the recognition of the important role that we play in innovation and the impact that our services provide.

The Act envisioned a robust NIST which focused on world-class laboratory science, manufacturing, and innovation. It challenged us to push the frontier of innovation.

And I look forward to working with this committee, as you consider the reauthorization.

Thank you.

[The prepared statement of Dr. Gallagher follows:]

PREPARED STATEMENT OF HON. PATRICK D. GALLAGHER, PH.D., DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, UNITED STATES DEPARTMENT OF COMMERCE

Chairman Rockefeller, Ranking Member Hutchison, and members of the Committee thank you for the opportunity to appear before you today to discuss the pending reauthorization of the America COMPETES Act and highlight the President's Fiscal Year 2011 budget request for the National Institute of Standards and Technology (NIST). Mr. Chairman, the COMPETES Act, enacted with overwhelming bipartisan support, and signed into law 3 years ago, provided an unprecedented opportunity to further enhance and accelerate NIST's contributions to innovation and competitiveness. It put forward a clear statement about the importance of Federal research and development in supporting U.S. economic prosperity, reflecting the strong support for advancing an "innovation agenda" through the Congress.

The Act provided a focus for and outlined priorities in the physical sciences, defined roles for agencies within the Act as well as the need to interact and coordinate to leverage each agency's particular strengths. The importance of the Act to NIST cannot be overstated and we commend the Chairman and the entire committee for the vision and leadership that led to its enactment.

America COMPETES—Driving Innovation through Support for Science and Technology

Numerous reports, such as the "Rising Above the Gathering Storm" in 2005, brought into sharp focus for lawmakers, Federal agencies, academia, and other key science and technology stakeholders, the challenges facing America's science and technology policy community. In response, Congress enacted the America COMPETES Act that among other things reauthorized NIST. It had a significant impact on NIST by reaffirming the essential linkage between a strong foundation in phys-

ical sciences R&D and the Nation's capacity to innovate and compete effectively in a global market.

The COMPETES Act provided NIST with a focus and direction, highlighting the important role of measurements and standards in areas of critical national priority, as well as reemphasizing the important role that NIST plays in manufacturing and innovation by strengthening existing programs and authorities. My testimony today will highlight the importance of the COMPETES Act in each of these areas and touch upon how the foundation laid for NIST in the COMPETES Act provides the basis for this year's request, as well as the starting point for our discussions with you, Mr. Chairman, on the reauthorization of the COMPETES Act.

FY 2011 Budget Request—Continuing the Vision of COMPETES While Setting the Course for Tomorrow

In today's global economy, the ability of the United States to remain competitive relies upon our ability to develop and commercialize innovative technologies. The ability of American manufacturers and entrepreneurs to be technologically innovative both drives and is driven by our ability to observe and to measure. If one cannot measure something—one will not be able to control it. And if one cannot control it—one will not be able to reliably manufacture it.

NIST's unique role, or niche, is to advance measurements and standards to enable the next generation of innovation, leading to development and commercialization, thus providing our industries critical tools to remain competitive. Working closely with U.S. industry and academia, as well as providing interagency coordination, NIST plays a central role in advancing and maintaining this technology support system which helps enable innovations and future technologies that lead to the jobs of the future.

The COMPETES Act prioritized resources for the NIST laboratory programs. It also provided new authorization language strengthening the Hollings Manufacturing Extension Partnership (MEP), one of the COMPETES Act's major successes.

The President's FY 2011 budget request for NIST is \$918.9 million, a 7.3 percent increase over the FY 2010 appropriations. The request is a statement that NIST's mission is more important than ever, and highlights the important role that NIST plays under President Obama's agenda for science and innovation. It also continues the commitment to double NIST's laboratory budget as envisioned under the America COMPETES Act.

The request for NIST's laboratory programs is \$584.5 million, an increase of almost \$70 million above FY 10 enacted levels. The budget request specifically targets high priority areas, consistent with the direction provided in COMPETES. The request provides unprecedented support for manufacturing and innovation in a number of areas including:

- advanced manufacturing capabilities necessary to capitalize on advances in nanotechnology and to enable rapid prototyping and manufacture of multiple high technology components;
- measurements to enable the efficient manufacture and regulation of biological drugs; and
- tools to support the establishment of sustainable manufacturing practices.

The request also emphasizes NIST's work in high-priority infrastructure such as electric-power Smart Grid and national health care information systems that hold significant promise to transform our society and revitalize the U.S. economy. In order to succeed, the many interconnected components of these systems must be fully interoperable, in order to ensure that they can exchange information and work together seamlessly and securely.

These are daunting challenges, but well suited to NIST. The request enables NIST to build upon its core competencies in this field, and helps to establish a framework of standards and related test protocols, and conformity assessment requirements that would facilitate seamless, end-to-end interoperability for both of these technologies. As a non-regulatory agency, and a respected and trusted technical partner, NIST is uniquely positioned to bring together stakeholders from industry, government, academia and standards development organizations to establish consensus-based interoperability standards and conformity tests. The President's budget request for NIST will support continued efforts in these critical areas as well as provide the infrastructure necessary to address other emerging interoperability challenges.

One of the key initiatives in the FY 2011 request provides \$10 million to address scalable cybersecurity for emerging technologies and threats. The initiative will enable NIST to collaborate with academic and government organizations to strengthen U.S. standards for managing "cryptographic keys," secret numbers absolutely vital

to protecting the confidentiality and integrity of sensitive information. It also will enable NIST to develop a framework and plan for multifactor authentication that uses interoperable biometric or cryptographic credentials (in addition to passwords) to increase assurance of a user's claimed identity.

The budget also proposes an increase of \$9 million related to sustainable energy sources and nanomaterials development. Sustainability has become a top priority of the Nation. Rapid progress will depend on innovations from many quarters, both private and public. However, a prerequisite for U.S. success will be NIST assistance in establishing agreed upon measurement and data evaluation methods to enable the development and manufacture of new technologies. For example, new nanotechnology-based photovoltaic materials—so called third-generation solar technologies—may greatly enhance the absorption properties of photocells through multi-layer structures optimized to absorb light at specific wavelengths spanning the full spectrum of the sun's output. However, the new materials lack the durability needed for commercial applications and developers need measurement tools to systematically optimize the electricity-generating properties of the devices.

NIST's sustainability initiative will have broad impact. It would help manufacturers improve efficiency, quality, and durability, while lowering the cost of third-generation photovoltaics; allow industry and U.S. regulatory agencies to accurately assess and manage the risks posed by key nanomaterials and products containing them throughout a full product lifecycle; and provide consumers with accurate information on EHS risks associated with specific products containing nanomaterials.

The FY 2011 request for the MEP program builds upon the foundation COMPETES established. The proposed budget of \$129.7 million represents an increase of \$5 million over FY 2010 enacted levels to support the Administration's policy initiatives for reinventing domestic manufacturing. This program will assist in creating jobs and responding to future challenges and opportunities in the manufacturing sector. Through locally based MEP centers it supports the adoption of technological innovations that spur economic growth and foster development of new products, expanded markets, and process improvements. It will also facilitate adoption of technological innovations by smaller U.S. manufacturers, especially clean technologies and processes that improve manufacturers' competitive position.

Over its 20-year history, the NIST MEP program has partnered with thousands of companies to provide them the tools with which to reinvest in themselves through process improvement and business growth initiatives. These collaborative efforts, working with partners at the state and local level, have led to more sales, opened up new markets, and facilitated the adoption of technology to deliver new products and services. The COMPETES Act further strengthened the MEP to continue to serve as a resource for manufacturing and innovation by expanding and leveraging resources to couple cost reduction strategies with profitable growth through new product development and market expansion.

If enacted, in FY 2011 MEP will build upon efforts initiated in FY 2010 to implement and provide a number of new services to U.S. manufacturers in order to promote innovation and competitive practices, including:

- The acceleration of technology adoption and the development of new products and processes
- Green and sustainable manufacturing practices and products
- Market diversification to support development of new markets and supply chain opportunities
- An enabled manufacturing workforce that spans all levels of the organization

Supporting Technological Innovation Through High-Risk, High-Reward Research

As well as highlighting the importance of the NIST laboratory programs and strengthening MEP, the COMPETES Act also provided NIST with a new tool to help stimulate technological innovation and catalyze public-private activities in the form of the Technology Innovation Program (TIP).

Launched in 2008, TIP was created to support innovative, high-risk, high-reward research in areas of critical national need where the government has a clear interest because of the magnitude of the problems and their importance to society. This merit-based competitive program funds cost-shared¹ R&D projects by individual small or medium-sized businesses as well as joint ventures, which may include insti-

¹TIP funds no more than 50 percent of the total project direct costs, but not indirect costs (such as overhead), profits, or management fees.

tutions of higher education, non-profit research institutes, government laboratories, and other organizations.

In December 2009, TIP announced the results of its second competition awarding up to \$71 million in funding through 20 new cost-sharing projects that will support innovative, high-risk research in new technologies that address critical national needs. Examples from the successful proposals include: developing unmanned hovering aircraft for bridge inspections, a high-speed sorting system for recycling aerospace metals, and nanomaterials for advanced batteries. The awards will be matched by other funding sources to achieve nearly \$150 million in new research over the next two to 5 years.

With its focus on broad participation through targeted partnerships with universities and industry, TIP has the potential to have significant impact in developing new, high-potential technologies that have commercial potential and address urgent national needs.

The President's FY 2011 budget request recognizes the potential impact of the Technology Innovation Program (TIP), especially in the area of advanced manufacturing, and includes an increase of \$10 million for the program for a total of \$79.9 million. The request, if enacted, will expand the program to motivate and expedite high-risk, high-reward research focused on the development of advanced, disruptive technologies that enable accelerated development of next-generation, high-performance processes and materials in areas such as nanomanufacturing.

The request also provides \$124.8 million for the Construction of Research Facilities, including \$66.1 million in funds targeting the renovation of NIST's facilities in Gaithersburg and Boulder, and providing a sufficient amount of funds for on-going maintenance and repair of NIST's infrastructure.

Looking Forward to Reauthorization of COMPETES

Looking forward, I believe that the foundation established by COMPETES is the right focus for our on-going discussions. The Act recognized that innovation is more than basic R&D and that we must optimize the entire process from discovery to production to harness the full economic benefits of the Nation's science and technology capabilities. I believe that this broad approach is essential to success and that NIST can play a critical role in this effort.

The process of successfully translating ideas born in our laboratories into successful products and services that are made and sold in the United States is characterized by the breadth of participation. From scientists and engineers working in our university, industry and national laboratories, through a broad spectrum of technology transfer mechanisms, with the lawyers and specialists working on intellectual property, to the bankers, venture capitalists and angel investors that provide funding, to our manufacturers, to our sales and marketing experts working in both domestic and international efforts. These broad efforts, while comprised of very different specialties, must all be effective to realize the economic potential of our technological creativity.

As the Committee considers a reauthorization of the America COMPETES Act, I offer some general thoughts on areas for discussion:

While efforts at the "ends" of the innovation process, namely scientific discovery and commercial activity, have well defined participants, the "middle" of the process is characterized by the diverse mixture of participants. This means that our efforts must provide effective ways for Federal agencies to form or catalyze working partnerships between government, university, and industry researchers; and also between these groups and the financial, educational, technology transfer, trade experts, and other critical stakeholders. Authorities provided in COMPETES can work to facilitate these types of partnership activities. The TIP program is a good example of this type of program.

The Federal Government has an important role, but it is not the only player. States and local governments are essential government partners and play a critical role in establishing the right technology "ecosystem" for innovation to flourish. Programs carried out under COMPETES should support these roles and create incentives for effective partnerships with state and local governments.

Technology infrastructure plays a critical role in creating the conditions for the development of new technologies. Infrastructure technologies, like the Internet, are disruptive developments since they enable entirely new classes of products and services. Infrastructure technologies are powered by the standards that define how these systems work together. Our efforts in Smart Grid and Health IT have the potential to revolutionize, not only our ability to manage electricity distribution and medical information management, but also the development of new products and services that we cannot yet imagine. This is a major opportunity if we can facilitate the

timely development of effective standards—those that define a system so it works, but do not stifle innovation and creativity.

It is not enough to commercialize technology, we must strive to produce it. Manufacturing plays a critical role in the innovation process. Not only because it provides good, high quality jobs, but also because it has a close relationship with engineering and research.

Summary

For more than 100 years, NIST has maintained the national standards of measurement, a role that the U.S. Constitution assigns to the Federal Government to ensure fairness in the marketplace. Today, the NIST Laboratories address increasingly complex measurement challenges. The FY 2011 budget request for NIST reflects the Administration's recognition of the important role that NIST plays in innovation, the impact that the services NIST provides can have on moving the Nation from recession to recovery, and the path this committee and the Congress had in mind when it enacted the COMPETES Act.

The COMPETES Act set the tone and direction for NIST to be optimally positioned to meet the pressing critical challenges facing the American economy. I look forward to working with the Chairman to ensure that the overall structure of NIST is aligned with these priorities to ensure that NIST is optimally organized to meet the challenges ahead.

The Act envisioned a robust NIST, focused on world class laboratory science, manufacturing, and technological innovation. It challenged NIST to continue to push the envelope of technological innovation, and incentivize industry and academia, in partnership with NIST, to do the same. It correctly recognized NIST's unique capabilities and roles. Those themes are still the right ones to emphasize as we commence discussions on the reauthorization of the Act.

I look forward to working with you, Mr. Chairman, and all the members of the Committee, to meet the goal of reauthorizing the COMPETES Act.

Senator KLOBUCHAR. Thank you very much, Mr. Director.
Dr. Braun.

STATEMENT OF DR. ROBERT D. BRAUN, CHIEF TECHNOLOGIST, NASA

Dr. BRAUN. Madam Chairwoman and members of the Committee, thank you for the opportunity to appear today to discuss NASA's research and development activities with a specific focus on the agency's new initiatives in space technology. I look forward to working with you on enactment of the President's direction for NASA in advanced technology, innovation, and continued efforts to engage students in the study of science, technology, engineering, and mathematics.

The President's Fiscal Year 2011 budget request for NASA is part of a larger national research and development effort in science, technology, and innovation that will lead to new products and services, new businesses and industries, and high-quality, sustainable jobs.

For NASA, an enhanced technology and innovation focus responds to input of the Augustine Committee, recommendations from multiple National Research Council assessments, and past Congressional hearings on this subject.

By focusing on innovation and technology, NASA will drive a sustainable, yet aggressive, future mission portfolio, enabling new approaches to its current missions and entirely new science and exploration endeavors.

Central to NASA's innovation initiative is the new Space Technology Program that will meet NASA's needs for a broad range of technological solutions, as well as meeting the needs of other government agencies and the Nation's space industry.

The broadly applicable technologies proven and matured within the Space Technology Program complement the more mission-focused activities in NASA's mission directorates. Together, these programs ensure the development and infusion of innovative technologies to reduce cost, risk, and improve the performance of a wide variety of future space missions.

The NASA Space Technology Program has three major elements:

The early stage innovation program competitively sponsors a range of advanced space-systems concepts and initial technology development efforts across academia, industry, and the NASA centers.

The Game-Changing Technology Program utilizes a DARPA-like approach to mature advanced technologies that have the potential to revolutionize future space missions.

And the Crosscutting Capability Demonstrations Program proves technologies that are of benefit to multiple customers in the flight-relevant environment of space.

These program elements are well aligned with America COMPETES; they're innovative, high-risk, high-return research to improve America's economic competitiveness.

Many positive outcomes are likely from a broadly applicable Advanced Space Systems Concepts and Technology Development Program, including a more vital and productive space future than our country has today, a means to focus NASA's intellectual capital on significant national challenges, a spark to the Nation's technology-based economy, and an international symbol of our country's scientific and technological leadership, and a motivation for many of the country's young minds to enter into educational programs and careers in science, technology, engineering, and mathematics.

On a personal note, I sit before you today, a product of NASA's STEM activities. And I can assure you that these NASA programs were instrumental to my own educational choices and, subsequently, to my career.

I believe a NASA focused on innovation and technology unleashes a range of exciting potential futures for our Nation's civil space program. I see humans going to the Moon, to the asteroids, and, eventually to Mars. I see robotic explorers traveling throughout the solar system and eventually into interstellar space. I see the identification of life on other planets and Earth-like worlds around other stars. I see an Earth observation system that can accurately forecast the emergence of major storms and natural disasters, as well as a NASA that supports the emerging commercial spaceflight industry and is a significant contributor to solving our Nation's technological needs.

Our Nation has made great progress throughout its history by innovating solutions to enormously difficult challenges it has encountered. The grand challenge to build an intercontinental railway or land a man on the Moon and return him safely to the Earth not only motivated a technological workforce, but it also created new technologies and innovations along the way. These achievements inspired generations to pursue challenging goals, created new industries, and ultimately improved our country and the world.

Similar opportunities are in front of us now. The knowledge and technologies required to enable sustainable human exploration of

our solar system, to develop new space industries, and to increase the societal impact of our space program are within our grasp. Through a renewed focus on innovation and technology, I believe NASA can be an important catalyst for economic expansion in this Nation.

Thank you again for this opportunity to testify. I'd be happy to respond to any questions you may have.

[The prepared statement of Dr. Braun follows:]

PREPARED STATEMENT OF DR. ROBERT D. BRAUN, CHIEF TECHNOLOGIST, NASA

Mr. Chairman and members of the Committee, thank you for the opportunity to appear today to discuss NASA research and development activities, with specific focus on the Agency's new initiatives in the area of Space Technology for FY 2011. I look forward to working with you on enactment of the President's pioneering direction in advanced technology and innovation.

The President's FY 2011 budget request for NASA is part of a larger national research and development effort in science, technology, and innovation that will lead to new products and services, new business and industries, and high-quality, sustainable jobs. For NASA, an enhanced technology and innovation focus responds to the input of the final report of the Review of the U.S. Human Space Flight Committee, recommendations from multiple National Research Council (NRC) assessments, and past Congressional hearings on this subject. As recognized by Congress and outlined in the America COMPETES Act (P.L. 110-69), our Nation's economic competitiveness and high standard of living are based on decades of investment in innovation. A focus on innovation and technology is required both to enable new approaches to NASA's current missions and allow the Agency to pursue entirely new missions. This investment also will allow NASA to participate in the development of technological solutions addressing broader national needs in energy, weather and climate, Earth science, health and wellness, and national security. NASA's new direction is well aligned with America COMPETES—innovative, high-risk, high-return research to improve America's economic competitiveness. As a research and development agency, NASA plays a vital role in America's innovation engine and, as such, its future economic prosperity and security. The President's FY 2011 budget request for NASA provides a renewed emphasis on research and development, which clearly recognizes the Agency as a long-standing and important catalyst for innovation and economic expansion in our Nation. Innovative research and technology, tied to exciting missions with national importance, is a strong motivator for students to pursue Science, Technology, Engineering and Mathematics (STEM) disciplines, and a strong attraction for new hires.

Given the importance of technology and innovation as a catalyst for encouraging STEM education, I wanted to say a few words about my background. For over 22 years I have pursued an aerospace engineering career in government and academia, and for 16 of those years, I served on the technical staff of the NASA Langley Research Center in Hampton, Virginia, where I developed advanced space exploration concepts, managed multiple technology development efforts, and contributed to the design, development, test and operation of several robotic Mars flight systems. I arrived at Langley through one of the Agency's educational programs. While at Langley, I earned both my Masters and PhD degrees through other NASA educational initiatives. So, I sit before you today, as a product of NASA STEM activities, and I can assure you these programs were instrumental to my education choices and subsequent career. For the past 6 years, I have served on the faculty of the Daniel Guggenheim School of Aerospace Engineering at the Georgia Institute of Technology, where I led an active research and educational program focused on the design of advanced flight systems and technologies for planetary exploration. In my current capacity as the NASA Chief Technologist, I am honored to address this committee on such an important topic.

NASA Response to Recent External Reviews

Several recent external reviews have addressed the issues of innovation and technology development at NASA, with a strikingly common set of themes. The Report of the Review of U.S. Human Space Flight Plans Committee (Augustine Committee) strongly endorsed an increased focus on innovative technologies and approaches to achieving broadly defined NASA and national goals. This recommendation is similar to one made by the Aldridge commission in 2004. The recently released National Research Council (NRC) report, "*America's Future in Space*," specifically calls for

NASA to create a capability to develop game-changing approaches to National challenges. Finally, last year's NRC report *Fostering Visions for the Future: A Review of the NASA Institute for Advanced Concepts*, for which I had the privilege of serving as a committee co-chair, recommended re-creating an early stage innovation engine like the NASA Institute for Advanced Concepts (NIAC). Each of these NRC reports emphasized the need for organizational independence from the mission-focused parts of the Agency in order to provide stability to the technology investment portfolio and a more risk-tolerant environment to foster innovation. They recommend a broad reach, across disciplines and organizations, to ensure the best ideas are brought forth and supported. All of these reports suggest that failure to invest in technology and innovation puts the Agency's future viability at great risk.

In recognition of the need to rebalance near-term mission and far-term technology and innovation investments, the Agency chartered an internal study team in 2009 to investigate approaches to improve innovation within NASA. The study team found NASA's investments in innovation and technology have been focused on the near term, especially in the space-related disciplines. They concluded the need for cutting edge technology and innovation is more important today than ever before as NASA develops missions of increasing complexity to understand the Earth, our solar system, and the universe. In addition, this team felt the Agency needed to do a better job in engaging our partners from across academia, industry and other Government agencies in its technology development efforts.

Space Technology Program

Through the new Space Technology Program, led by the Office of the Chief Technologist, NASA will increase its support for research in advanced space systems concepts and game-changing technologies, enabling new approaches to our current mission set and allowing the pursuit of entirely new missions. Using an array of management, funding, and partnership mechanisms, this program will engage the brightest minds in private industry, across the NASA Centers, and throughout academia. This new program builds upon the success of the NASA Innovative Partnerships Program and directly responds to input from multiple NRC reports, as well as the Augustine Committee. The Space Technology Program will meet NASA's needs for new technologies to support future NASA missions in science and exploration, as well as the needs of other government agencies and the Nation's space industry in a manner similar to the way NASA's predecessor, the National Advisory Committee on Aeronautics (NACA), aided the early aeronautics industry. The broadly-applicable technologies proven and matured within the Space Technology Program complement the more mission-focused activities in NASA's mission directorates. Together, these programs ensure the development and infusion of innovative technologies to reduce the cost and improve the performance of many important science and exploration missions. NASA will establish a deliberative panel of internal and external stakeholders—including stakeholders from industry and other government agencies—to review and advise on technology development priorities for the Space Technology Program through a transparent and balanced process.

The Office of the Chief Technologist provides a visible Agency entry point for technology transfer and commercialization, interagency coordination and joint activities, intellectual property management and partnership opportunities, providing additional value to external innovators, including a wide range of small businesses and the commercial space industry. The Space Technology Program will use open competitions such as NASA Research Announcements and Announcements of Opportunity, targeted competitions including those for small business and universities, while engaging early career scientists and engineers. NASA will also continue to use challenges and prizes to stimulate innovative new approaches to technology development and will encourage partnerships with both established and emerging commercial space industries. Through the three major elements of this program—Early-Stage Innovation, Game-Changing Technology, and Crosscutting Capability Demonstrations—a broad suite of management, funding and partnership mechanisms are employed to stimulate innovation across NASA, industry and academia.

Early-Stage Innovation

The Early-Stage Innovation program element sponsors a range of advanced space system concepts, and initial technology development efforts across academia, industry and the NASA Centers. This program element includes: (a) the Space Technology Research Grant program (analogous to the Fundamental Aeronautics program within NASA's Aeronautics Research Mission Directorate) that focuses on foundational research in advanced space systems and space technology; (b) re-establishment of a program akin to the NASA Institute for Advanced Concepts to engage innovators within and external to the Agency in accordance with the recommenda-

tions of the NRC's *Fostering Visions of the Future* report; (c) expansion of the Innovative Partnership Programs Seed Fund into a Center Innovations Fund to stimulate aerospace creativity and innovation at the NASA Centers; (d) the NASA Small Business Innovation Research/Small Business Technology Transfer Research (SBIR/STTR) program to engage small businesses; and, (e) the Centennial Challenges Prize Program to address key technology needs with new sources of innovation outside the traditional aerospace community. Competitive selection is a major tenet of all the activities within this program element.

While a broad range of activities are planned in this program element, a few examples include Nanotube Based Structural Materials, Flexible Power Arrays, Energy Storage Systems, Formation Flying Spacecraft Systems (Swarm Operations), Extreme Environment (Temperature/Radiation) Sensors and Mechanisms, Safe Despin/Detumble Approaches for Large Non-operational Spacecraft, Material/Structural Concepts to Mitigate Impact of Small Debris, and Precision Timing and Navigation Using Only Celestial Objects. Early-Stage Innovation efforts not only benefit NASA, but can spur innovation and job growth in the broader economy. For example, NASA's Centennial Challenges led to the formation of new companies such as FLAGSuit LLC started by our first winner, Peter Homer of Maine. FLAGSuit is now developing commercial pressure suits and gloves. In addition, our most recent Centennial Challenges winner, LaserMotive of Seattle, Washington, recently announced plans for commercial expansion based on the laser power-beaming technologies developed to win the Power Beaming Challenge.

An important aspect of the Space Technology Research Grants program is the competitive selection of U.S. citizen graduate student research that shows significant promise for future application to NASA missions. This effort will train the next generation of aerospace engineers and scientists by funding NASA-related graduate student research performed on campus during the academic year, as well as research performed at NASA Centers during the summer months. Each student in this project will be matched to a NASA researcher who will serve as the student's NASA advisor. Through this experience, students will advance their STEM education, gain NASA experience, and learn the research and development processes.

Game-Changing Technology

The Game Changing Technology program element focuses on maturing advanced "push" technologies that may lead to entirely new approaches for the Agency's future space missions and solutions to significant national needs. Responsive to the NRC report, *America's Future in Space: Aligning the Civil Space Program with National Needs*, this program element demonstrates the feasibility of early-stage ideas that have the potential to revolutionize future space missions. Fixed-duration awards are made to Principal Investigator-led teams comprised of government, academia, and industry partners. These awards are evaluated annually for progress against baseline milestones with the objective of maturing technologies through ground-based testing and laboratory experimentation. NASA will draw from DARPA's experience to create and implement collaborative game-changing space technology initiatives. New technologies considered may include advanced lightweight structures and materials, advanced propulsion, power generation, and energy storage. With a focus on such potentially revolutionary technologies, success is not expected with each investment; however, on the whole, and over time, dramatic advances in space technology enabling entirely new NASA missions and potential solutions to a wide variety of our society's major technological challenges are anticipated.

Crosscutting Capability Demonstrations

A Crosscutting Capability Demonstrations program element matures a small number of technologies that are of benefit to multiple customers to flight readiness status. Technical risk, technology maturity, mission risk, customer interest, and proposed cost are discriminators planned for use in the selection process. For infusion purposes, proposing teams are required to have a sponsor or sponsors willing to cost share a minimum of 25 percent of the planned development effort. With objectives analogous to the former New Millennium Program, NASA will pursue flight demonstrations not only as standalone missions, but also as missions of opportunity on planned missions as well as international and commercial space platforms. Performing these flight demonstrations will advance the technology readiness of the selected systems, provide tangible products from the NASA innovation and technology program, and capture significant public interest and awareness. While a broad set of activities are possible in this program element, examples include optical communications, aerocapture, supersonic and hypersonic inflatable aerodynamic decelerators, formation flying, and advanced in-space propulsion. The Commercial Reusable

Suborbital Research (CRuSR) Program (which provides suborbital flight opportunities for technology demonstrations, scientific research, and education); the Facilitated Access to the Space environment for Technology (FAST) program (which focuses on testing technologies on parabolic aircraft flights that can simulate micro-gravity and reduced gravity environments); and, the Edison Small Satellite Demonstration Missions project (which develops and operates small satellite missions in partnership with academia) are also included in this program element.

Partnership Development and Strategic Integration

Two key functions of the Space Technology Program are Partnership Development and Strategic Integration. Partnerships are an integral part of the NASA strategy for reinvigorating technology and innovation. Building upon the success of the Innovative Partnerships Program, NASA will pursue partnerships with U.S. industry, academia, other Government agencies, and international partners. Partnerships provide rich sources of innovation to help address NASA's technical challenges, and also yield other applications of NASA-developed technologies that will benefit the public and contribute to economic growth. Each year, NASA documents 40–50 of the best recent examples of how the public benefits from NASA-derived technology in the annual Spinoff publication, with over 1,600 examples published and available online. One example from last year is the company Allocade, from Menlo Park, California. A NASA scientist founded Allocade then licensed Hubble Space Telescope scheduling technology and adapted it to help hospitals handle dynamic rescheduling issues with the On-Cue system. Efficiency is improving with this NASA technology. One hospital using the On-Cue system reported a 12 percent increase in procedure volume, a 35-percent reduction in staff overtime, and significant reductions in backlog and technician phone time. NASA technologies are also improving safety. The New York company Early Warning developed a new water analyzer—employing a carbon nanotube biosensor licensed from NASA—that can evaluate a water sample and alert operators to potentially dangerous biological contaminants in about 2 hours, a drastic improvement over typical laboratory-based water sampling, which can take several days.

NASA technology is also helping entrepreneurs pursue new space capabilities through technology licensing and partnerships, such as the inflatable structures technology licensed to Bigelow Aerospace and the advanced propulsion technology licensed to Ad Astra Rocket Company for their Variable Specific Impulse Magnetoplasma Rocket (VASIMR). The Strategic Integration function focuses on working with the Mission Directorates and the NASA centers to develop an Agency technology roadmap and measure the significance and performance of the Agency's technology investments. Agency-level technology coordination, integration, and prioritization assessments are performed. Technology roadmapping and portfolio planning activities are driven by the Agency's strategic goals, and coordinated with the technology development activities of our partners in industry, academia, and other government agencies.

Models of Success

NASA has a track record of success in the development of game-changing technologies and the transfer of its products and intellectual capital to industry. As an example, consider the Mars Pathfinder mission of the early 1990s. In addition to accomplishing its science and technology objectives, Mars Pathfinder established surface mobility and ground truth as important exploration principles, created a groundswell of interest and a foundational experience for a new generation of Mars scientists and engineers, re-engaged the public with Mars as a destination worthy of exploration, led to the creation of NASA's Mars program and establishment of a Mars program budget line, and led to a wide spectrum of small missions to Mars, the asteroids, comets and other bodies in our solar system. As an early-career employee, I learned many lessons working on the Mars Pathfinder mission, and within a few years, I was applying these lessons learned to a wide range of more challenging flight systems. For the NASA robotic exploration program, Mars Pathfinder was clearly a game-changer.

In a more recent example, consider NASA's improvements to ablative thermal protection system (TPS) materials through an Advanced Capabilities development project sponsored by the NASA Exploration Systems Mission Directorate. Over 3 years, a NASA-industry team raised the technological maturity of eight different TPS materials from five different commercial vendors, eventually selecting the system for the Orion heat shield. In addition to providing a heat shield material and design for Orion, this team identified a potentially catastrophic problem with the planned Mars Science Laboratory (MSL) heat shield and remedied the problem by providing a viable alternate heat shield material and design within stringent sched-

ule constraints. From this effort, mature heat shield material and designs have been successfully transferred to the commercial space industry, including the material performance and modeling data for the SpaceX Dragon capsule heat shield with implications for a wide variety of customers.

Government-industry cooperation in the inflatable structures arena has also paid significant dividends. In 1996, the TransHab program began the development of large-scale inflatable structures suitable for space habitation. This technology was later transferred to the commercial sector through patents and intergovernmental personnel acts, enabling companies including Bigelow Aerospace to engage in space commerce. Bigelow Aerospace is now poised to take on the final challenge of producing human-rated inflatable space modules, capable of providing the habitation needs for a multi-person crew in low Earth orbit. As a stepping-stone on that path, NASA is presently investigating a proposal to attach a Bigelow Aerospace-produced inflatable module to the International Space Station.

NASA technology investments are of benefit to more than the Agency's missions and the aerospace industry. In 2000, NASA and the University of Arizona developed the Mars Oxygen Generator, a two-pound experiment designed to generate oxygen for life support and fuel production on Mars. The device used solid oxide electrolysis cells to convert carbon dioxide and water into oxygen and fuel. When operated in reverse as a fuel cell, this device has been shown to produce clean, reliable electricity here on Earth. Development and commercialization of this technology as a NASA spin-off by Bloom Energy, which is now largely supported by the private sector, is moving beyond the early demonstration phase, with the goal of generating electricity at prices lower than traditional methods while producing half the amount of greenhouse gases.

Beginning in FY 2011, the new NASA Space Technology Program aims to strengthen and broaden these successful innovation examples across a wide range of Agency and significant national needs.

The Role of STEM Education

NASA recognizes the important role that STEM education plays in developing the diverse scientific and technological workforce required to advance this Nation's economic leadership. Experience has shown that exciting and compelling NASA missions truly inspire the next generation of explorers, innovators, and leaders. The NASA Office of Education administers nationwide education efforts that draw on content from across the Agency in pursuit of its three primary education goals: (1) Strengthening NASA's and the Nation's future workforce; (2) Attracting and retaining students in STEM disciplines; and (3) Engaging Americans in NASA's mission. NASA leverages its unique program content, people, and facilities to spark interest, capture imaginations, and guide students toward careers in STEM fields while increasing their scientific and technological literacy to the benefit of the Nation. NASA accomplishes its STEM education goals through educational investments in Higher Education, Minority Research and Education, Elementary and Secondary Education, Education Technology and Products (e-Education), and Informal Education.

NASA supports the objectives of the America COMPETES Act, as well as the Administration's STEM education teaching and learning improvement efforts through its education portfolio. This summer, NASA will launch *Summer of Innovation*, a new initiative that is aligned with both Congressional and Administration STEM education priorities in mind. *Summer of Innovation* will be an intensive STEM teaching and learning program targeted at the middle school level that includes follow-on activities during the school year. NASA content and products will be incorporated into evidence-based summer learning programs across participating states with the goal of improving student academic performance and motivating students to pursue further education and successful careers.

In addition to this new initiative, NASA's Experimental Program to Stimulate Research (EPSCoR) and University Research Centers (URCs) are long-standing examples of the Agency's commitment to the development of higher education academic research and development. EPSCoR targets states with modest research infrastructure with the goal of enabling them to become more competitive in attracting research funding. The URCs expand the Nation's base for aerospace R&D and increase the number of underserved and underrepresented students studying STEM by increasing the competitive aerospace research capability among the Nation's minority institutions. These awards foster relationships with industries, enabling future research and development opportunities that advance NASA scientific and engineering mission priorities. The educational achievement of America's next generation is an issue that affects our Nation at all levels.

NASA will continue to partner with Federal, industry, state and local organizations and invest our resources toward a shared vision to secure those jobs critical to the 21st century workforce. This means not only inspiring the next generation and improving scientific literacy, but also providing educators with unique resources to aid in achieving national educational excellence in STEM.

Conclusion

Consistent with the objectives of the America COMPETES Act, many positive outcomes are likely from a long-term NASA advanced space systems concepts and technology development program, including a more vital and productive space future than our country has today, a means to focus NASA intellectual capital on significant national challenges and needs, a spark to renew the Nation's technology-based economy, an international symbol of our country's scientific and technological leadership, and a motivation for many of the country's best young minds to enter into educational programs and careers in engineering and science. Major breakthroughs are needed to address our society's energy, health, transportation, and environmental challenges. While NASA investments alone will not solve these major challenges, the Agency has proven to have a unique ability to attract and motivate many of the country's best young minds into educational programs and careers in science, technology, engineering, and mathematics. A suite of game-changing space technology improvements are within our Nation's grasp. With a stronger focus on technology development, the intellectual capital at the NASA Centers will be utilized to deliver solutions to some of our Nation's greatest technological challenges.

The NASA FY 2011 budget request provides the civil space exploration enterprise with multiple exciting potential futures. Previously NASA was marching toward a single human exploration future, where it was leveraging Apollo, Shuttle, and other relatively mature technologies to return to the Moon. In doing so, the budget and schedule pressures from this effort left little room for NASA to invest in the next generation of space technologies. The future now holds a host of possibilities and opportunities, with humans going to the Moon, to asteroids, and eventually to Mars. We envision robotic explorers traveling throughout the solar system and into interstellar space; the identification of life on other planets and Earth-like worlds around other stars; an Earth observation system that can accurately forecast the emergence of major storms and natural disasters; and, NASA supporting an emerging commercial spaceflight industry and contributing substantially to solving our Nation's technological needs. Through the focus on innovation and technology represented in the President's FY 2011 budget request, our Nation's investment in NASA is much more likely to accomplish these potential futures.

Our Nation has made great progress throughout its history by innovating solutions to the enormously difficult challenges it has encountered. The grand challenge to build an intercontinental railway, or to land a man on the Moon and return him safely to the Earth, not only utilized our best talent, but also created new technologies and innovations. These achievements also inspired generations to pursue challenging goals, created new industries, and ultimately improved our country and the world. Similar opportunities are in front of us now.

Focusing NASA on these critical technological capabilities as we move forward is my challenge as NASA's Chief Technologist. I am pleased to be leading NASA's teams in this broadly applicable technological endeavor. In this manner, NASA can be an important catalyst for innovation and economic expansion in this Nation.

Mr. Chairman, I would be happy to respond to any questions you or the other members of the Committee may have.

Senator NELSON . Thank you. You're an outstanding panel.
Senator Klobuchar.

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

Senator KLOBUCHAR. Well, thank you very much.

Thank you, to all of you.

As Chair of the Competitiveness, Innovation, and Export Promotion Subcommittee, we've been very focused on these issues, and I've been actually excited, being out there in my state and some other states, about the emphasis right now on science and technology and making stuff again, and small and medium-sized busi-

nesses, focusing on entrepreneurial endeavors, and really getting things out there.

As you know, Minnesota is home to a lot of entrepreneurship. We brought the world everything from the pacemaker to the Post-it Note, and are continuing in those ways today, with our medical-device industry. We're the Silicon Valley of energy-efficient windows, and we just have a lot of things going on.

So, I've actually—when I come back from recess every time, I feel ready to go and focused on these innovation issues. And clearly, a key part of this is to make sure we're encouraging, Mr. Holdren, more R&D, as well as the science and engineering.

I also am the mother of a 14-year-old, so I've seen firsthand, the excitement of the kids at the Arlington High School's science fair, where they're standing there, holding their awards, 20 of them, just bright-eyed and excited with their experiments on comparing bacterial content in washed and unwashed lettuce—that was my daughter's—and various other things.

And one of the things that I keep trying to figure out is how you take that sense of competitiveness and excitement and interest in science, from that high school stage into our businesses and into our colleges and to continue on. Because I always think about the Beijing Olympics and those 3,000 synchronized drummers. And to me, the drumbeats are getting louder and louder and louder, and we are going to have to really refocus our economy on competing. I have some strong ideas on how that can be done, with encouraging innovation.

So, my first set of questions was really just about that R&D issue. While we lead the world in research and development, other countries are rapidly catching up. Specifically, R&D expenditures have grown at a rate of 5 to 6 percent annually from 1996 to 2007. The R&D growth rate in Asian economies often exceeded 10 percent, and, in China's case, was 20 percent.

If the U.S. doesn't make these critical investments in research and development in the coming years, what effect would our delay have on U.S. industries? I guess, Mr. Bement, if you want to answer that question.

Dr. BEMENT. Yes, thank you, Senator. That's a very good question.

As a measure of how much the world is investing, not only in infrastructure, but education and research, the world share of research investment by the United States is going down as a fraction of the total. It used to be a healthy percentage, almost around 30, 40 percent. Now, it's 25 percent or less, and that's a trend for the future, which means that we're not going to be the front or the origin of many new concepts—they're going to be generated in different parts of the world.

If we're not connected, if we're not networked with top scientists abroad through international exchanges and collaborative activity, we could very well be blindsided in very important areas, and instead of being a leader, we would become a fast follower, at best.

So, as I look to the future, I think we're going to have to recognize that we're not just on top of a small number of major economies, we're part of a large world community that is catching up, and since the U.S. is the exemplar, we're the team to beat. We're

going to have to maintain our competitiveness. We're going to have to maintain our investments, and we're going to have to stay connected with the world, and we're going to have to cooperate in order to compete. And that's our work plan for the future.

Senator KLOBUCHAR. So, as we go through some of these ideas for this—I mean, clearly, more with the—with STEM and encouraging more young people to go into this area, that would be one thing.

Dr. BEMENT. Well, I think almost every major economist in the world today recognizes that in an information economy—an information-driven economy, that the types of investment that really drive the economy are those three things. One is education, the other is investment in research and development, and the third is information and communication infrastructure. Those are the areas that we have to, as a Nation, decide that we're going to invest in order to compete.

Senator KLOBUCHAR. So, to me, it's the—that research, the R&D tax credits, and things like that, to try to get—

Dr. BEMENT. They're all part of—

Senator KLOBUCHAR.—those incentive out there.

Dr. BEMENT.—they're all part of the innovation work plan.

Senator KLOBUCHAR. You talked about worldwide. Would that mean—includes perhaps lifting some of these visa caps to allow, you know, students from other countries that study in our country to be able to stay in our country to do their research?

Dr. BEMENT. Well, we gained dominance, I think, in many areas of research, primarily because we have positioned ourself as an open society. And top scientists from around the world are attracted to the United States because of our openness, the opportunity to excel and the opportunity to pursue new ideas in an open environment.

If we lose that posture, and if we put barriers in the way, we're going to have unintended consequences that we're not going to like.

Senator KLOBUCHAR. And the fourth thing, which I've—sort of trying to get my arms around is, you look at what some of these other countries are doing, we have, clearly, some areas that we are excelling in—I bring up medical device, because it's Minnesota—

Dr. BEMENT. Yes.

Senator KLOBUCHAR.—or, you know, movies and entertainment, or, you know, some of the energy work we've done, although we've been leapfrogged by a lot of countries, because we haven't put these incentives in place. And I think—the energy area is what makes me think, Should we be targeting certain areas, where we want to be the world leaders, so we focus on those areas, instead of just across the board, so it helps us to grow jobs in those areas, because those are our key exports?

Dr. BEMENT. Yes, obviously we need to select those areas where, as a Nation, we must excel in if we're going to maintain our economy and if we're going to maintain our workforce. Certainly, information and community—I'm sorry—information and communications technologies are paramount.

But, there are a lot of intangible areas, that are also job creators in this economy, that we also have to pay attention to—how to manage business systems, how to manage world logistics oper-

ations, how to do a better job in managing our financial institutions.

Senator KLOBUCHAR. Really? OK.

Dr. BEMENT. You know, I've often worried about a system that's so far from equilibrium being managed by equilibrium theory. I think we have to do a better job of anticipating disruptive events in the financial markets.

Senator KLOBUCHAR. OK.

Dr. BEMENT. So, that's a good economic and mathematical—

Senator KLOBUCHAR. OK.

Dr. BEMENT.—problem.

Senator KLOBUCHAR. Just one last question, here.

Mr. Holdren, do you want to comment on any of these policy ideas I've thrown out, here?

Dr. HOLDREN. Yes, I would like to add a couple of comments.

One, on your point about the visas: OSTP agrees, and the President agrees, this is extremely important. We've actually been working with Homeland Security and state and the other relevant agencies—

Senator KLOBUCHAR. You know what happens.

Dr. HOLDREN.—to lower barriers.

Senator KLOBUCHAR. We educate these people, they want to stay in our country. Then they go somewhere else, and then maybe, if we're lucky, we'll contract with them, but we can't get them as employee—

Dr. HOLDREN. We can't get them back, and we are really trying—

Senator KLOBUCHAR. All right.

Dr. HOLDREN.—to work that problem.

Senator KLOBUCHAR. OK.

Dr. HOLDREN. It's extremely important.

Senator KLOBUCHAR. All right.

Dr. HOLDREN. And the second thing—I would second something that Dr. Bement said about the importance of maintaining a very substantial degree of cooperation and collaboration with scientists and technologists in other countries, both for the efficiencies that result from cooperating on many of these big challenges, but also, as he pointed out, to stay connected. And this is—has been another priority in OSTP; we've been reenergizing our joint committees on cooperation in science and technology with Russia, India, Europe, China, Japan, Brazil. All of those have been stood up and reactivated since we came into office.

Senator KLOBUCHAR. The last thing I'd add, too, is just the work that's being done now. Foreign Commercial Service's exports for a small and medium-size business, to make it easier for them to find these markets, get their goods out there. We've just had some amazing success stories from Karlstad, Minnesota, the moose capital of our state, not of Alaska—and various other small businesses that have literally, you know, 10 times more employees because they found some markets where they could sell their goods.

Dr. HOLDREN. Again, I can only agree.

This morning, I was in a meeting of what we call "The Green Cabinet," the members of the Obama Cabinet who are preoccupied with issues of green jobs, of addressing energy and climate chal-

lenges, and so on. We had Karen Mills and the Deputy Secretary of Commerce, Dennis Hightower, and Secretary of Energy, Steve Chu, and I, all interacting on this question of how to advance the ball, with respect to exports. And, of course, Karen Mills, the Administrator of the Small Business Administration, and Deputy Secretary Hightower had some great stories to tell about small and medium-size businesses—

Senator KLOBUCHAR. Right.

Dr. HOLDREN.—that had been very successful in rapidly ramping up projects that were exportable and were being exported.

Senator KLOBUCHAR. Yes. Very good.

I just wish we'd call it the "innovation agenda." I think that would be—capture people more than colors and things. I don't know. It's just what I've seen in my state. And we need to sort of inspire people and bring them together on a common theme, which I believe is bringing back innovation in this country.

Thank you.

Senator NELSON. Senator Begich.

**STATEMENT OF HON. MARK BEGICH,
U.S. SENATOR FROM ALASKA**

Senator BEGICH. Thank you very much, Mr. Chairman.

And thank you all being here. I have a few questions.

Mr. Holdren, let me first start with you, if I can, and maybe kind of move around a little bit.

Within the reauthorization, or the discussion we're having on the COMPETES Act, there's a portion there about NOAA, and it's, kind of, responsibility, and I'm just going to read one little section of it under Title IV, "Conduct, develop, support, promote, and coordinate formal and informal education activities to enhance public awareness and understanding of the oceans, coastal, great lakes, and atmospheric science," so forth.

Give me your thoughts of how NOAA fits into this equation. And I have two parts to this:

The first is, Do you believe that they are, and should be, the principal focal point, when it comes to education, in regards—to public education—in regards to science and—science of climate change? That's the first question.

And then, the second question is, Would you have any objection if we expanded, in the reauthorization, the funding authorization for NOAA, within this bill, to do some of that work?

So, it's a two-part question.

Dr. HOLDREN. First of all, Senator Begich, I would want to agree very energetically with the proposition that NOAA is extremely important in this domain. As you know, my confirmation hearing before this committee was at the same time as the confirmation hearing for Dr. Jane Lubchenco—

Senator BEGICH. Yes.

Dr. HOLDREN.—the Administrator of NOAA. She and I have been friends for 30 years. I had dinner with her Monday night. We talk all the time about these issues and what she's been doing at NOAA, and I think what she's been doing is terrific. They have launched a reorganization at NOAA that brings together, in one office, a wide variety of their activities related to climate, including

climate education. They got a new website that's getting the word out there.

At the same time, I don't think any single agency should be the exclusive locus of activity related to climate science or climate science education. There are important components of that going on in the National Science Foundation, in NASA, in the DOE, and one needs to remember that climate change, climate science, climate technology are all entangled around issues not only of understanding what is happening in the atmosphere and the oceans, but understanding what's happening in ecosystems, understanding what impacts are across the range of issues, from water availability to public health. It is a characteristic of a problem this complicated that capacities related to it are going to be in many different agencies.

Senator BEGICH. OK. The second—

Dr. HOLDREN. And so, I think we all need to work together on that.

Senator BEGICH.—the second part, expanding authorizing capacity within this legislation, for them to have funding?

Dr. HOLDREN. I guess I wouldn't want to comment, at this point, on a specific proposition of an increase. I think the President's budget for Fiscal Year 2011 proposes very substantial increases in climate science, and a good part of that is for NOAA. I'd want to have a conversation with you offline about what—

Senator BEGICH. OK. We'll do that.

Dr. HOLDREN.—actual things you had in mind.

Senator BEGICH. OK. We'll have that conversation.

I'm watching my clock, here, so. And also because I have to be on satellite time at 4 o'clock, and you know how the windows open and close.

So, Dr. Braun, you're next on my list, so you understand that moment, there. But, let me ask you a couple quick things.

You mentioned some of the relationships in education, to a certain extent, in your testimony. But, the one I didn't hear—maybe I missed it—was the utilization of Challenge Learning Centers, which are around the country. And, you know, when I talk to people who run these—we have one in Alaska—when I talk to folks who run these, they're always struggling. And there seems to be a disconnect between some of their work and educating young people—as well as adults, but a lot of young people they focus on—and how NASA can participate in an ongoing relationship with the Challenge Learning Centers. Can you give me any thought on that? And if you don't have an answer, for the record, at some point, would that be—

Dr. BRAUN. Yes, well. Let me give you a little bit of thought on that, and I'll also follow up for you on the record.

Senator BEGICH. OK. That'd be great.

Dr. BRAUN. First of all, education is very important to NASA.

Senator BEGICH. Absolutely.

Dr. BRAUN. And it's been proven, time and time again, that NASA has a unique ability to inspire youth all around our country to go into careers in science, engineering, technology, and mathematics; perhaps have a unique role in that area. Pursuant to the NASA Authorization Act of 2008, NASA has extended that reach

into rural communities, and we're doing so in a number of ways, including using our NASA Explorer School system. The NASA Explorer Schools target underrepresented populations throughout our country, in rural and urban areas, using a digital learning network to, you know, tie in through videoconference—

Senator BEGICH. Yes.

Dr. BRAUN.—NASA researchers with these schools. And we can do the same—we can use that same type of technology with the Challenger Learning Centers. Also, in the State of Alaska, I should point out, that we have a NASA Educator and Resource system, and that system is affiliated with the Alaska Pacific University—

Senator BEGICH. Correct.

Dr. BRAUN.—and it's full of materials that are disseminated to educators all throughout the State of Alaska—science, mathematics educators. And they use those resources, then, with their students, to pull them and to inspire them into these educational programs and careers.

Senator BEGICH. Very good.

Let me end with one question, because my time is up.

But, I appreciate that. I'd be interested if you'd kind of show me the—at some point, just for the record, or for me, personally, just kind of how you work directly, other than just what you laid out, with Challenger Learning Centers around the country.

Dr. BRAUN. I'll follow up—

Senator BEGICH. Now, here's—

Dr. BRAUN.—the record with that.

[The information referred to follows:]

NASA has a rich relationship with the nation-wide network of Challenger Centers. These interactions include competitively awarded grants and cooperative agreements, support for state-based initiatives, participation in special events, and providing speakers and educators for regular Challenger Center education programs. NASA and the national leadership of the Challenger Centers have also formed a Space Act Agreement in which the organizations collaborate in fun and exciting activities to engage students in science, technology, engineering, and mathematics (STEM). Finally, the Science, Space, and Technology Education Trust Fund, established by Congress in 1994 via Public Law 103-327, enables NASA to provide the network with \$250K each quarter.

Numerous Challenger Centers are currently developing new exhibits, teacher professional development and student engagement programs through awards made by the NASA Office of Education (OE). Currently, awards exist at the following institutions:

Challenger Learning Center of Colorado (Colorado Springs, CO)

Challenger Reach 2 U: This four-year award through the OE Competitive Program for Science Museums and Planetariums (CP4SMP), will reach more than 2,500 fourth-grade students each year from underserved communities throughout southwest Colorado and northwestern New Mexico, including primarily rural, lower socio-economic status, Hispanic and Native American districts. The project includes assessment, teacher training, industry speakers, and a live event featuring "Moon, Mars and Beyond" to encourage students to pursue career fields in STEM subject areas. Two traveling mission technology kits will be made available for districts that do not meet the necessary technology requirements.

Challenger Learning Center of the San Joaquin Valley (Atwater, CA)

STARS: Strengthening Teaching, Awareness and Resources in Science: The primary goal of this five-year STARS project, awarded through the CP4SMP, is to build astronomy resources and partnerships in order to maximize the impact of informal education in creating a STEM education pipeline.

Challenger Learning Center of Alaska (Kenai, AK)

Climate Change: NASA's Eyes on the Arctic: In partnership with the University of Alaska Museum of the North, the Imaginarium Discovery Center at the Anchorage Museum, and scientists at the University of Alaska Fairbanks, this project will develop permanent and traveling exhibits and programs that feature climate change data collected by NASA Earth-orbiting satellites. The Magic Planet digital video globe will be used for program delivery. Many rural communities throughout Alaska will be reached directly. This is a three-year CP4SMP award.

Challenger Learning Center at Heartland Community College (Normal, IL) and Challenger Learning Center for Science and Technology (Woodstock, IL)

Mission to Mars: An Urban/Rural Collaborative to Inspire NASA's Next Generation: A new strategic alliance with educators and middle school students in grades 6–8 in Chicago Public Schools, the Museum of Science and Industry, two Challenger Learning Centers, schools serving students in rural and suburban areas of Illinois, and two NASA Centers will jointly develop a live distance learning program called Mission to Mars. Complementary pre- and post-program materials for use in classrooms will be developed by the partnership. Professional development workshops for teachers and preparatory sessions for NASA scientists and engineers will enhance the efficacy of program delivery.

Challenger Learning Center for Space Science Education (Alexandria, VA—national lead)

Exploring Climate Change through Challenger Learning Centers: With funding through the OE Global Climate Change Education project, the Center will develop a set of interactive learning activities that help middle school students learn about and explore climate change from an orbital perspective. State-of-art image and visualization techniques will be combined with NASA data on climate change. Activities will be shared with all 46 Challenger Learning Centers where each year, more than 300,000 students and teachers participate in simulated space missions.

Challenger Learning Center for Space Science Education (Alexandria, VA—national lead)

Challenger Center Missions for High School: Using the power of immersive learning to engage high school students in Earth and space exploration: In partnership with TERC, NASA's Teaching from Space Office, the Lunar Science Institute, Lunar Quest Program, My NASA Data, and Earth Observatory, the Center will develop the next generation of the "Encounter Earth" and "Return to the Moon" mission simulations and associated online activities. A new function-rich software engine will extend the reach of these immersive learning experiences from a traditional middle school audience to high school students and teachers. All students will be able to fly enhanced simulated space missions to study the Earth or the Moon, even from remote locations, and teachers will have new, tailored classroom opportunities to engage them in Earth and lunar science using NASA resources. This project is funded through the OE K–12 Competitive Grants Program.

NASA recently awarded a grant to the Challenger Center for Space Science Education (Alexandria, VA—national lead for the Challenger Center Foundation) to validate the educational goals and content of NASA's new massive multi-player online game, Astronaut School, now in development. The Center will partner on this grant with a wide range of groups including the *Astronaut: Moon, Mars and Beyond* consortium of game developers, Dr. Larry Lowe at Benedict College, Wisdom Tools and NASA's Learning Technologies Program Office, as well a number of diverse Challenger Learning Centers, teachers and students.

NASA Field Centers and Mission Directorates also pursue unique relationships with Challenger Learning Centers. Marshall Space Flight Center has a long history of engagement with the McWane Science Center (Birmingham, AL), home of the Challenger Center of Alabama. Through the NASA-funded "Basic Science Literacy Project," the Center annually provides 200 free Challenger Missions or space and technology programs to approximately 7,200 students in kindergarten through eighth grade. Stennis Space Center works closely with the Challenger Learning Center at Wheeling Jesuit University (Wheeling, WV) to conduct student led mission simulations derived from Stennis expertise in climatology and earth science research. Recent special events offered through this collaboration include support of the international Oceans 2009 Conference. A similar arrangement exists between the Glenn Research Center and the Challenger Learning Center of Northwest Indiana, a collaboration designed to better engage students in NASA's exploration mis-

sion. The Science Mission Directorate has worked collaboratively with the network to develop and present new content related to the Kepler mission's search for other habitable planets, and the NASA Stardust exploration of comets. All Centers and Mission Directorates support the Centers, these being just a few representative examples.

Challenger Learning Centers participate in NASA networks for acquiring data, information on breaking news, special events, and speaker opportunities. The Museum Alliance is a community of practice for providers of informal education. Through this collaborative environment, education professionals are provided with unique access to NASA's missions, scientific findings, artifact loan programs (*e.g.*, space shuttle tires), and scientists and engineers. At this time, 16 Challenger Centers, or science centers/museums with embedded Centers, are active members of the Museum Alliance network. Two Centers also participate in the NASA Space Place, a community specifically geared to small, local informal education institutions.

A Space Act Agreement between NASA and the Challenger Learning Centers fosters numerous special events and activities. In 2008, the Challenger Learning Center network conducted a "Name the Habitat" contest for a proposed inflatable lunar greenhouse. Centers participate in Space Shuttle and International Space Station downlinks, including hosting a high-profile event during the flight of STS-118, a mission that launched Educator Astronaut Barbara Morgan into space. The Centers also conducted NASA Engineering Design Challenge events that tied STEM study to that historic mission. Another collaboration between NASA and the Challenger Learning Centers also garnered international attention. In 2008, a downlink, several ham-radio transmissions, and on-orbit educational activities were led by Richard Garriott and targeted to the Centers. These events represent only a few noteworthy cooperative events. NASA routinely provides workshops and training events for Center staff and hosts several sessions at the annual Challenger Learning Center National Conference.

NASA continues to invest in the Challenger Learning Center network through quarterly distributions from the Science, Space, and Technology Education Trust Fund. As stipulated in Public Law 103-327, in 1994, \$15M was allocated by Congress to establish the trust with the intention of providing the network with four annual distributions of \$250K. NASA has met the \$250K payout obligations from the trust, the most recent occurring in FY 2010, Quarter 2.

Senator BEGICH. That'd be great.

And this last question—this is kind of a "yes" or "no" to each one of you, so this is very quick, hopefully. And that is, as you know, we're in the process of rewriting No Child Left Behind, which is a very large educational piece.

Are you, as an agency that you represent, engaged in that process at any level?

Dr. BEMENT. Yes, definitely.

Senator BEGICH. OK.

Let's just walk through the list.

Dr. GALLAGHER. No.

Senator BEGICH. OK.

Dr. BRAUN. I'm going to have to get back to you on that.

Senator BEGICH. OK.

Dr. BRAUN. Sorry.

[The information referred to follows:]

NASA is an active participant in the National Science and Technology Council (NSTC) education subcommittee. Working with other Federal agencies with a role in STEM education, such as the National Science Foundation and Department of Defense, NASA leadership has participated in discussions related to the revision and reauthorization of the Elementary and Secondary Education Act (ESEA) also known as "No Child Left Behind." As with all legislation proposed by the Administration, NASA and the members of the NSTC subcommittee had the opportunity to review proposed ESEA language and participate in discussions with the Department of Education. The March 2010 meeting of the NSTC subcommittee focused heavily on the role and potential contributions of Federal STEM agencies in improving K-12 teaching and learning.

NASA continues to offer elementary and secondary education opportunities and experiences to teachers and students. Materials, instructional resources, and educational activities meet national education standards for science, technology, and mathematics. Projects utilize evidence-based approaches to achieving performance targets and expected impacts. Efforts are regularly evaluated.

NASA is ensuring that the education models and infrastructures for all of its educational investments are consistent with the goals, strategies, and intended outcomes of recent Executive Orders and Department of Education policy directives, including *Race to the Top*, *Educate to Innovate*, and *Investing in Innovation*.

Dr. HOLDREN. I think only on the STEM education—

Senator BEGICH. OK.

Dr. HOLDREN.—ramifications.

Senator BEGICH. My only comment would be the thing that I've learned about the Federal Government is, it is so big, we do many of these authorizing bills, and none of us connect with each other. So, I would encourage each one of—you knew where I was going. And so, that's a big piece of legislation—talks about lots of resources authorizing—and it's about educating our young people for the future. I am, personally, no big fan of "No Child Left Behind," because it has hurt rural states and rural communities, but in its rewrite, I think it's important that all of us make that cross-connection. I know, Mr. Holdren, you've been doing a good job of cross-connecting on certain issues. This is one that, as we look at this reauthorization, that's a perfect combination of the two. That's my two bits.

Dr. BEMENT. Just a quick response.

Senator BEGICH. Great.

Dr. BEMENT. NSF and NASA have long had a joint MOU in sharing investments in education and learning, and also sharing best practices. So, we do have a cooperative arrangement with NASA. We have cooperative arrangements with other Federal agencies, as well.

Senator BEGICH. Well, I just think, in the rewrite of this law, that, as we rewrite that law and this one, my bet is, there's great synergy between these two. And if we can figure out how to do that so we enhance our capacity to educate our future young people, this is a gain all the way around. So, I'd just encourage you.

Thank you all very much.

Thank you, Mr. Chairman.

Senator NELSON. Senator Warner.

**STATEMENT OF HON. MARK WARNER,
U.S. SENATOR FROM VIRGINIA**

Senator WARNER. Thank you, Mr. Chairman. Thank you for holding this hearing.

And, gentlemen, thank you all for your testimony.

And let me say at the outset, you know, not only do I support the reauthorization of the America COMPETES Act, but, both in this job and my old job as Governor, whether it's STEM education, R&D, tax credits, space that the Chairman—and NASA activities that the Chairman cares so deeply about, as I do—all for it all.

But, frankly I think our innovation and competitiveness strategy has been nonexistent for more than a decade-plus. And I think from garnering political support from connecting with the American people, from, you know, same old, same old, which we all talk

about being supportive of and just does not mean dismissive of all of—particularly the STEM education, which is so important. But, I believe this country needs a true national competitiveness strategy. I would make the case that over the last decade-plus that we haven't had one. Actually, I think the last time there was any formal effort was back in the Carter administration. You know, most major industrial countries—UK, South Korea, Ireland, Denmark, the Dutch, all have national competitiveness strategies. I would make the case—and this is more of a statement, I guess, than a question, that, you know, the last 10 or 12 years, what have you—and it goes within Democrats and Republicans alike—you know, the only way America has been able to perhaps compete, in terms of innovation, is creating, you know, sophisticated financial products that ended up bringing the world to the brink of a financial meltdown.

You know, why would anybody go and be the next great scientist, when you can—I spend a lot of time around the financial market—if it—markets—go a different direction and, you know, outside of financial markets and the real estate industry, there has been very little innovation. I think we've ranked, since 2000, 40th in the Nation—40th in the world, in terms of innovation growth.

So—and I know Senator Klobuchar was raising things, in terms of, you know, some of the activities, in terms of how we do a better job of—with exports and taking American business abroad, and I think that's important. And I know this is beyond the bailiwick of some of you all, but I'd love to start a conversation with you and the panel and my colleagues.

But, you know, I think we need—if we're going to really have a competitiveness strategy, it may go to something as basic as the kind of enormous increasing preference we have, in our financial system, of debt over equity. I used to be in the venture capital business. Why in a—why go be a venture capitalist, and take a—or a young entrepreneur, and take a risk that way, when you can go with a—what is supposedly a more guaranteed return on debt instruments, as opposed to the private equity needs that we have, to really spur innovation in the private sector?

Clearly, our tax code that made America competitive in the 70s and 80s, you know, we're getting our lunch eaten on a tax code basis, in terms of R&D tax credits—I believe at 14 percent, we're way below the average in OECD, way down the list—the fact that we can't make it permanent—we have a—both the lack of predictability, as well as a percentage that makes us competitive on a global economy.

You know, I think if we're going to really sell innovation as much as we kind of all argue for STEM, what have you—unless we have a strategy that says, How are we going to include rural America and urban America, so that we don't continue to simply have pockets of prosperity, mostly fostered around our top research universities, is really something that is challenging to me.

And, as states—perhaps I'm getting biased, as a former Governor—as states fundamentally deal with a budget crisis and shortfalls that may not repair itself any time in the foreseeable future, the whole concept of our traditional 4-year higher education, I think, needs to be reexamined. I mean, we are, you know—particu-

larly for the middle class—I commend top-tier universities who say to a family of four, “If you’re making \$60,000 a year and below, you’re fine.” For families of—mine have been well—done well enough that were fine, but everybody in that vast middle class is rapidly being priced out of higher education. And I don’t think there’s nearly radical enough thinking about a whole restructuring of higher education—at least from a discussion standpoint of perhaps even starting folks in their first year or two, even if you’re Harvard- or Stanford-bound, at a community college.

But I guess my comment Mr. Chairman, is that in the context of this America COMPETES Act, I hope that we can add a provision that would also look at creating a broad-based national competitiveness strategy that goes beyond the parameters of the America Competes act—that is would go beyond, kind of, our traditional focus, simply on R&D and STEM and education, and really take on this issue in a much broader, more comprehensive way, and this is a request beyond the purviews of your respective administrative—administration jobs, but I sure as heck would love to have your thinking on this topic.

And I know I’ve now, basically, used up all my time and—as typical as Senators sometimes do. When I was a Governor, I just asked questions.

But if you—anybody’s got a quick comment, recognizing I don’t want to impart on the Chairman’s time.

Dr. HOLDREN. I would love to make a very quick reaction, which is—first of all, I agree with you, Senator Warner, that we need more creative thinking in this domain, but I do think that the Administration, in rolling out, as the President did last year, a Strategy for American Innovation, put on the table a lot of the kinds of ingredients we need.

You may remember that that strategy had three different components. The foundation was investing in the building-blocks of innovation, which includes STEM education, broadband, the various kinds of information and communications and transportation and energy infrastructures we need, space, and more.

But, the middle level was a set of elements under the heading of “Promoting Competitive Markets in Ways that Spur Productive Entrepreneurship.” And I think there were a variety of good ideas in there that the Administration is trying to advance, and that we’d love to see reflected, as well, in the reauthorization of the COMPETES Act.

And then the top level of this, sort of, pyramid—the way the President announced this strategy—was catalyzing breakthroughs to advance various national priorities. And again, the number of specific elements in there that we would love to work with you on getting into—

Senator WARNER. Correct me, if I’m wrong, but wasn’t that when the President outlined that at a small town in Upstate New York?

Dr. HOLDREN. Yes, it was.

Senator WARNER. And that was the day that, I think, there were certain other things going on in New York, and—

Dr. HOLDREN. It didn’t get as much attention as it—

Senator WARNER. And, you know—

Dr. HOLDREN.—might have.

Senator WARNER. I think it got third paragraph in a—otherwise political story. And, respectfully, I would just say, I have not seen anything else in a major emphasis-way from the Administration since that day of the rollout in New York.

Dr. HOLDREN. I will send you a few things. But I'd love to talk with you about this offline, because we're thinking about a lot, and I think we're moving ahead on a number of these fronts, but we'd sure like your help.

Senator WARNER. Thank you, Mr. Chairman.

Senator NELSON. Gentlemen, thank you for your service.

Dr. Holdren, the budget makes a \$3.7 billion commitment to the STEM education, and that's across the Federal Government. It includes a billion for improving math and science education for K-12, and that is to increase student expectations, supporting resources and professional development for STEM teachers, and then, to evaluate the STEM education outcome measures.

Tell us, briefly, How can we make these investments make sure that they are preparing our children for the high-tech careers in the fields such as information technology, engineering, healthcare?

Dr. HOLDREN. Well, of course, the—sorry—the billion dollars you referred to is for science and math education in K-through-12, the \$3.7 billion, the total for all of our efforts together. And I think one of the things we have to look at—and Senator Klobuchar also referred to this, in talking about her daughter and her daughter's enthusiasm for science, and how you maintain that through college and into careers that are productive and contribute to the economy and contribute to discovery. And we are trying to think about it in that way in the Administration; that is, we're trying to look at all of the levels, and what we do in college, to make sure we sustain the excitement and the interest that I hope we will increasingly generate with these investments in the K-through-12 level.

But, the other part of your question relates to, How do you measure whether you're succeeding? And I've spent some time with Education Secretary Arne Duncan, I know he's very interested in that. The folks in the Domestic Policy Council in the White House—Melody Barnes and her crew—are very interested in that, and I think we're going to have some innovative offerings for you as to how we're going to do a better job of monitoring what's working and what's not. Because, as interested as we are in developing new projects and programs that will advance the ball with respect to STEM education, we're also interested in discontinuing the ones that aren't working—in part, in order to make the resources available for the good ones. And so, we have to get better at measurement, at monitoring, at metrics—and it's our intention to do it.

Senator NELSON. Dr. Braun, NASA has announced the Summer of Innovation for math, science, engineering. What does NASA expect to accomplish with this proposal?

Dr. BRAUN. So, Summer of Innovation is part of NASA's strategy for Educate to Innovate. We are—we have a pilot program that'll be starting this year. It'll be rolled out in five states that are actually—there's a callout and there are proposals being prepared for the selection of those states.

We hope to roll out the program to over 100,000 middle school students. And the program will take place in their states, with

NASA content infused into that program. And we'll conclude with a major national event, where all of that is brought together with a science, technology, and education—mathematics focus.

Senator NELSON. And how much funding are you going to be allocating to this?

Dr. BRAUN. There's \$10 million in this first part of the program, and then the program grows in the out years.

Senator NELSON. In the 2011 budget, Dr. Holdren, it continues a commitment to double the budgets of NSF, DOE Office of Science, and NIST laboratories, and all of those are authorized by the COMPETES Act.

Now, in your testimony, you note that, quote, "trim parts that have been proven to be less valuable," end of quote. And since the COMPETES Act is only 3 years old and full funding hasn't come through, how can we evaluate programs in such a manner?

Dr. HOLDREN. I think that's a good question. One of the indicators is places where one has had opportunities that we thought were attractive put out there, that people aren't taking us up on, which suggests that maybe those particular programs have misjudged the demand or the opportunity. And even in a fairly short period of time, if people aren't lining up to take advantage of the resources and the opportunities, you can pretty well conclude that there's probably something better you can do with the resource.

But, again, I think you're right in the implication that we need to invest more effort in determining what's working and what's not.

Senator NELSON. What do you think that you ought to do with NOAA on an expanded role as we reauthorize this Act?

Dr. HOLDREN. Well, I've already said, I think NOAA's immensely important in the domain of understanding what's going on with our oceans and our atmosphere and their interaction, what's going on with our fisheries, in the large domain of climate science and the domain of weather and climate monitoring. We've put, in the budget proposal for Fiscal Year 2011, a substantial increase for NOAA. Some of it is part of the resolution of the problems of the NPOESS—the National Polar Orbiting Operational Environmental Satellite System—which we're fixing, in part, by giving NOAA a larger responsibility in that domain. And, you know, I'm sure hoping that the Congress goes along with the President's budget proposal for increasing NOAA's budget, for all of these reasons.

Senator NELSON. Dr. Bement, the COMPETES Act stressed the need for basic research funding for high risk, high reward. Then, a couple of years ago, the National Science Board report found that investigators are reluctant to submit radical or paradigm-challenging research ideas to NSF, given the low conventional success rate. So, describe what steps NSF has taken to increase funding for high-risk, high-reward research.

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

We're taking such steps that members of the community that submit proposals that they have shaved because they don't reflect high risk will probably be turned down. We have allocated \$2 million, in each of our divisions this year, to develop new approaches for not only doing merit review, and conducting solicitations, but also using new methodologies for identifying high-risk research. We

would like to believe that all of our proposals are potentially transformative, but that's a little bit different than high risk.

There are a lot of proposals that are very high return that aren't necessarily high risk, so the risk-to-return ratio is perhaps even more favorable.

But, nevertheless, identifying research activities that are potentially transformative, that can really make a paradigm shift, that perhaps can even define a new field of research, especially interdisciplinary research, is what the Foundation is all about.

So, we're providing training, not only for our program officers, but also for our panelists, our reviewers, to activate them to invest, or at least to examine more carefully, proposals for potential candidates for high-risk research. Furthermore, in some cases, we're even activating shadow panels to do a second-round review to see what might have been overlooked.

We're developing new methodologies for attracting and soliciting high-risk research with the community itself. We've used things called "sandpits," which I can provide, for the record, what that's all about.

[The information referred to follows:]

Sandpits

THE NSF Sandpit (now renamed as Ideas Labs) is modeled on the "IDEAs Factory" program developed by the Engineering and Physical Sciences Research Council (EPSRC) of the United Kingdom (UK). The concept of the IDEAs Factory program is to organize intensive interactive residential workshops (called sandpits) involving 20–30 participants, with the aim of developing new and bold approaches to address grand challenge questions for topics that could benefit from a new dimension in thinking.

An essential element of the Ideas Lab is a highly multidisciplinary mix of participants, some being active researchers and some being potential users of research outcomes, to drive lateral thinking and radical approaches to addressing particular research challenges. NSF issues an open solicitation, and interested individuals submit a 2-page preliminary proposal, in which they answer questions about their experience and expertise as well as questions designed to assess personal attributes such as communication skills, collaborative behavior, and level of creativity. A panel of reviewers evaluates the applications and identifies a pool of potential participants from a range of disciplines and backgrounds that have a high potential to contribute to research at the interface between disciplines and to develop new and highly original research ideas. NSF program directors make the final selections from the pool.

During the Ideas Lab, which is run by professional facilitators, the participants develop research projects on the selected topic, incorporating real-time peer review from the other participants and a panel of reviewers. Iterative project development activities are used to select and advance the most meritorious, transformative, and innovative project ideas. Outcomes at the end of the workshop are research project concepts that vary in scale and scope in addressing the grand challenge topic of the Ideas Lab. At the end of the Ideas Lab, the panel of reviewers provides a consensus report summarizing their evaluation of each project concept. Based on this review, the NSF program directors invite the submission of full proposals for some, none, or all of the project concepts. The participants have 8 weeks to submit the full proposals, which are then reviewed by the same panel using NSF's two merit review criteria. A specified amount of funding is set aside up front to support some or all of the meritorious research projects emerging from the Ideas Lab; however, no one is guaranteed funding by virtue of participating.

The current Ideas Lab activity was developed following NSF participation in a joint NSF–EPSRC sandpit focusing on synthetic biology, held in spring 2009. Five innovative, interdisciplinary, and international projects were funded as a result of that activity:

1. Synthetic integrons for continuous directed evolution of complex genetic ensembles (lead award is 0943392)

2. Synthetic aesthetics: connecting synthetic biology and creative design (0944139)
3. Engineering genetically augmented polymers (lead award is 0943383)
4. Cyberplasm: An autonomous micro-robot constructed using synthetic biology (lead award is 0943345)
5. Programming the rhizosphere through highly integrated genetic, spatio-temporal control systems (lead award is 0943385)

Dr. BEMENT. It's something we do jointly with the research councils in the United Kingdom to support high-risk research. We've had a very successful round in the area of biosciences for synthetic biology.

We have some solicitations that stress transformative high-risk research. Our program in Cyber-enabled Discovery and Innovation is a case in point. And there are other such programs.

So, this year we're doing the development, we're doing the exploration, we're trying new things. At the same time, we're assessing those activities, and we hope to, by next year, have a pretty good sense of what works, what's effective, and what will increase the ratio of proposals that we fund that are truly transformative, or potentially transformative.

Senator NELSON. Dr. Braun, are you going to be engaging in high-risk, high-reward innovative research funding?

Dr. BRAUN. Absolutely. In fact, the Space Technology Program was set up specifically for that purpose. It's a DARPA-like program, but we're going after grand challenges. We're going after large goals. I don't—it's possible that several of the items within that program that we fund—that they won't all succeed. But in total—if you want to go after game-changers—in total, we're going to make significant progress in a number of technological areas through that program.

Senator NELSON. Dr. Gallagher, high-risk, high-reward technologies in the Technology Innovation Program—it's about 80 million a year. It's funded more like a pilot program than a serious investment and critical national needs. What do you think about that?

Dr. GALLAGHER. I agree with you on that. I think the Technology Innovation Program, which was specifically designed to target high-risk, high-payoff projects on technologies to address critical national needs, has all the right ingredients for an effective program. But, it has to be considered, in this context, really at a pilot level, only because, at this level, it's not going to have a large national impact. And so, in that spirit, one of the things we're focused on is trying to determine—to your first question, How are we going to look at it and assess whether this is something that should grow or that we should look at? And, as Dr. Holdren said, maybe it's not the right program for the right time.

So, we're really focused on the metric question right now. But, it seems to have all the right ingredients for this kind of program.

Senator NELSON. Well, in the current Fiscal Year, you were authorized 140 million for the Technology Innovation Program. Are you going to have meaningful money in the Fiscal Year 2011 increase to award a competition?

Dr. GALLAGHER. Yes. With the increase proposed in the President's budget, there is certainly money for a very meaningful competition in new critical national need areas.

Senator NELSON. Dr. Bement, broadband for research purposes requires a national network, and we think it ought to connect the entire research community. What's NSF's vision for the next-generation network?

Dr. BEMENT. Well, your point is right on target. We are currently paying attention to greater connectivity, especially in the EPSCoR states. And we invested some of the Recovery Act funding to bring about greater connectivity, not only intracampus, but intercampus, among universities.

We do have a robust backbone network across the country in—interconnecting major regions. But, this middle road, which is between the local area network on campus and connection to the broadband backbone networks, is still missing, in some respects. So, this is going to take time, but—with the resources that we have at hand—but it clearly is part of our facility and infrastructure investment portfolio.

Senator NELSON. I have a number of questions I'm going to submit for the record so that we can get on to our colleagues.

I'm going to ask two more.

We want to get more bang for the buck when it comes to converting research into high-tech goods and services, and therefore, the stimulation to the economy. Dr. Holdren, what specific steps should we do to help you make that happen?

Dr. HOLDREN. Well, Senator Nelson, I think one of the important ingredients of a strategy for doing that is promoting public-private partnerships of a wider variety of kinds in a wider variety of applications. When you want to get something into the market—am I not coming through?

Senator NELSON. Yes. Please.

Dr. HOLDREN. When you want to get something into the marketplace, you really need to have folks intimately involved in the effort who understand the market, and nobody understands the market like the private sector. And that's one of the reasons that, in the Department of Energy, for example, where we're very eager to bridge the gap between research and development and actual application, we're working more and more with public-private partnerships.

We've spent a lot of effort over the years connecting the National Laboratories to the private sector to get innovations from the National Laboratory system out into the marketplace. And a major part of the President's innovation strategy is promoting partnerships of a variety of kinds, but including, especially, the government-private sector partnerships, so that you get the benefits of the government's engagement at the more fundamental and early applied level, and the benefits of the private sector's insights, as you're starting to move toward converting these things into products.

Senator NELSON. Has OSTP's integrity review process uncovered any instances of suppression or distortion of federally funded research?

Dr. HOLDREN. No, we have not encountered any instances of that to this point. We're not, I should emphasize, engaged in a systematic review. We're not—you know, we're not inspector generals. We've been—we're looking at principles and guidelines, but we are interacting with the agencies, and we're looking at cases that have been identified as potentially problematic. And I have not seen anything so far, that would meet the description of suppression or distortion.

Senator NELSON. All right.

I've got a number of questions I going to submit for the record. Senator Klobuchar has to leave.

Senator Thune, I, too, have a big delegation that's waiting on me, so if you would ask your questions and then adjourn the hearing.

[Laughter.]

Senator KLOBUCHAR. I can stay for 5 minutes, Mr. Chairman.

Senator NELSON. OK. Thank you.

Senator KLOBUCHAR. [presiding]. Thank you.

Senator NELSON. Senator Thune.

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

Senator THUNE. I was wondering if you were going to turn the gavel over to me. That would be kind of dangerous, I would think. But—

[Laughter.]

Senator THUNE. Well, I want to—I appreciate the hearing today, and I want to thank the panelists for joining us.

As everybody knows, we are still coping with the effects of a deep recession; and understandably, when you've got about 15 million people who are out of work, most of the discussion in Congress is focused on immediate economic growth and job creation. Today's hearing, however, brings a slightly different perspective, because it's about improving THE science, technology, education, and research programs that'll keep our country competitive in the long term. And I think it's fair to say that wise investments today will ensure the United States is a leader in technology and development years into the future.

And so, I want to thank our witnesses for their testimony.

I look forward to working with my colleagues on the Committee as we reauthorize the America COMPETES Act and improve other important programs.

And in the interest of time, I will just ask a couple of quick questions, and then yield to my colleague from Minnesota.

Dr. Bement, you had mentioned, in your testimony, that since 2001, the number of proposals submitted to NSF has increased by over 50 percent, and I'm interested if you could comment on how the NSF ensures that the selection process is done in a fair and transparent manner. You also mentioned increasing participation in science and engineering in all states and regions, as a goal, and I would be interested in knowing what your specific plans are to geographically diversify NSF programs, particularly as those plans relate to the future of EPSCoR.

So, first question has to do with the selection process, and making sure that it's done on a fair and transparent basis.

Dr. BEMENT. We work very hard to maintain our merit review process as the gold standard in the world, for rigorous, objective review—proposal review. And we take whatever measures are necessary to assure that, independent of the amount of proposal volume, so that even during Fiscal Year 2009, with the Recovery Act, where we put out 80 percent of \$3 billion on top of our omnibus bill, we were able to achieve that, which indicates that the Foundation is resilient, for a time. It's something that can't be sustained, but in the motivation that NSF staff feel in supporting the science and engineering community, they'll put the extra effort in.

But, I have to say that 2009 broke up a few families, perhaps, and caused some physical hardship—health hardship, on some of our staff. So, it's absolutely essential, if we're going to sustain that quality of effort, that we pay attention to additional staffing requirements within the Foundation, because the work stress has continued to go up as the proposal volume has gone up.

With regard to the second question, we have a lot of respect for the EPSCoR community, and we want to see the EPSCoR community succeed. So, we have taken a strategic approach, over the last 3 or 4 years, working with the community to develop, with the state, the strategic plans to get the best impact for the amount of resources that are available to EPSCoR.

We have also tried to achieve an appropriate balance between cofunding and research infrastructure improvement. It's true that most universities would prefer to have the research infrastructure improvement funding. On the other hand, it's the cofunding that causes most of the leverage within the Foundation. And in many cases, that leverage can be quite significant, perhaps as much as three times.

So, in the Fiscal Year 2011 budget, our intent is to reemphasize cofunding, inasmuch as so much RII funding was made available during the Recovery Act. And some of that funding will spend out over the next 2 or 3 years, in any case, because it was forward-funded to begin with.

I think that's our basic strategy, unless you have a follow-up question.

Senator THUNE. On the issue of geographic diversification, how do you go about seeing that some of these are distributed around the country.

Dr. BEMENT. Well, there is one other aspect of that, and that is that we have been encouraging some of the EPSCoR—two things—we've been encouraging some of the EPSCoR jurisdictions to take a more regional approach so that there can be a greater leveraging of overall resources, not only physical resources, but intellectual resources, because some states don't have all the capacity or capability to do all the research—the kinds of research they would like to do. So, trying to get more geographic leverage, more intellectual leverage, more financial leverage, and try to find the sweet spot in that, among those functions, is one of our strategies.

The—I forgot what the second one was that I wanted to point out. It was very important, but I lost it.

Senator THUNE. All right. Well, if you think of it, that would be fine. We'll make sure we get it into the record.

[The information referred to follows:]

EPSCoR and Geographic Diversity

Another approach follows from the leveraging by states of resources provided by NSF EPSCoR and by other agencies having EPSCoR or EPSCoR-like programs in complementary areas of science and engineering.

At present, seven Federal agencies (DOD, DOE, EPA, NASA, NIH, NSF, and USDA) have EPSCoR or EPSCoR-like programs. In FY 2009, sixteen of the twenty-nine NSF EPSCoR jurisdictions were eligible to participate in the EPSCoR and EPSCoR-like programs of all seven Federal agencies. The extent of leveraging of these programs at the jurisdictional level varies, and manifests itself primarily where there are complementary areas of science and engineering.

For example, in New Hampshire, the NSF EPSCoR and NIH Centers of Biomedical Research Excellence (COBRE) teams work together to assess and address cyberinfrastructure needs across the state.

In South Carolina, NSF EPSCoR awards and NIH Institutional Development Award (IDeA) leverage efforts to infuse research into education, provide research opportunities for diverse groups of institutions, students, and faculty, and increase collaboration among key stakeholders of the state's science and technology enterprise. Currently, this South Carolina EPSCoR/IDeA cooperation enables collaborative and complementary research among the state's three PhD granting institutions (Clemson University, the Medical University of South Carolina, and the University of South Carolina) and several predominately undergraduate institutions including Furman University, Claflin University, the College of Charleston, Winthrop University, and South Carolina State University (the state's largest public historically black college).

In Puerto Rico, NSF EPSCoR and NASA EPSCoR have contributed to the establishment of an integrated experimental/theoretical program to address issues relevant to the design, modeling, fabrication, and characterization of nanoscale materials suitable for enhanced rechargeable lithium batteries and fuel cells. In collaboration with researchers at the NASA Glenn Research Center, EPSCoR researchers are pursuing the development of proof-of-concept and scale-up of these devices. This synergistic collaboration addresses critical early stages of nanomaterial selection and synthesis and is expected to proceed to prototype testing and production readiness.

And I will, with that, Madam Chair, yield back the little time I have, and allow you to close things out.

Thank you.

Senator KLOBUCHAR. Thank you very much, Senator Thune.

And we would have totally trusted you with the gavel.

[Laughter.]

Senator KLOBUCHAR. I just have a few more questions to ask.

We actually did a forum together on this in Sioux Falls—

Senator THUNE. We did.

Senator KLOBUCHAR.—on exports and innovation.

So, I just had one last set of questions for you, Director Gallagher, and it is just about this idea of innovation being more than R&D, something that you talked about in your testimony. I fully support—when I talk about an “innovation agenda,” it's similar to what Senator Warner was talking about, with the competitiveness strategy for our Nation. And to me, that means everything from the visa caps I brought up, to the education and America COMPETES Act, to exports, to looking at, you know, what are these hot industries that we want to be promoting.

But, my specific question to you is how we build on all phases of the process so innovations actually spur economic development. One of our biggest challenges that I've heard from our businesses is transitioning a product from R&D to business development. It's often called the “Valley of Death,” because these things get lost, either because they're not approved or they're just having trouble getting the financing. So, my question is if you could comment on

that and talk about what role you believe the Federal Government can play in bridging this valley and assisting in bringing new products to the market. Or what should we be not doing?

Dr. GALLAGHER. Great. Thank you. I thought that your comments at the beginning of the hearing encapsulated, for me, very much what I think of when I think of the innovation process. It is not simply the R&D; it's the entire process of taking ideas and turning them into new products and services, and, in the end, economic activity. And the truth of the matter is, it's a fragile process with lots of pitfalls. A great many number of participants—not simply researchers, scientists, and engineers, but business people, market people, trade experts, financial organizations—and I think the national innovation strategy that Dr. Holdren talked about actually starts to really capture the fact that this is a very broad program. And it's had a strong impact, because that diversity is going to lead to a large number of Federal agencies each having specialized roles. And one of the things we want to make sure of is that there are synergies created, and not unnecessary overlaps. And I think the America COMPETES authorization and the innovation strategy that the President's put forward has gone a long way to start to create some very effective synergies.

One of the points I wanted to highlight is that, in this middle process of innovation, where you're taking the ideas out of the laboratory, it's characterized by no one process; there is no one way that this takes place. What it's characterized by is its diversity, by the large number of participations. And the one ingredient that I find to be quite central to all of them is the key role that the states, local governments, and regional governments play in this process. And so, as we look at the reauthorization of America COMPETES, one of the important things to look at is the extent to which the authorities that are given to the agencies enable us to work closely with Federal, state and local governments.

The MEP program was a good example, where those partnership programs were not created out of whole cloth in the states by NIST. NIST is one-third of the funding, and what it did was allow an existing infrastructure of centers that were already in the states to begin to operate in new ways and create synergies by networking them together and disseminating best practices. And I think that might be a key Federal role that allows us to both leverage the big state involvement, but also to really nurture what are the best ideas out there, and to share those with other areas.

Senator KLOBUCHAR. OK. Thank you.

Well, thank you, everyone.

Oh. You wanted to comment, Mr. Bement.

Dr. BEMENT. I had a much longer comment, which I'll provide for the record.

[The information referred to follows:]

The President's Innovation Agenda clearly describes the importance of three fundamental elements in developing a strong innovation-based economy. Those three elements are: (a) support for new discoveries through basic research; (b) support for translational research activities primarily through interaction with industry; and (c) focus on national grand challenge issues, such as the grand challenges identified by the National Academy of Engineering.

The primary mission for the National Science Foundation is support for basic research in science and engineering. However, a portion of the Foundation's portfolio

also supports activities which help to make progress toward bridging the so-called "Valley of Death." Primarily through the Engineering and the Computer and Information Science and Engineering directorates, NSF supports multidisciplinary, multi-institutional "center" activities that seek those synergies described by Dr. Gallagher in his testimony. For example, the Engineering Research Centers (ERCs) and Industry/University Cooperative Research Centers (IUCRCs) require partnership among multiple universities, industries, and even state and local economic development and government agencies where appropriate. These partnerships have led to both significant success in commercial product development and the spinoff of new companies. Since the beginning of the ERC program, over 2,000 patents and licenses have been awarded to ERC researchers, and 150 spinoff firms have been established. In addition, the environment fostered by this multidimensional partnership not only facilitates the translation of discoveries from basic research to innovative products and processes; it also provides an opportunity for industry and commercial interests to inspire new areas of pursuit in the basic research arena.

Dr. BEMENT. But, I did want to make an observation, and that is, not only with my experience on the TIP program, under a different name, but also longer-term experience.

Oftentimes in bringing innovations into the marketplace, the failures are generally not technology failures, they're business failures. And it's that skill and that knowledge base necessary to link business with technology that's absolutely critical for survival and sustaining an enterprise through that Valley of Death.

The other point is that oftentimes invention is pretty much an individual effort, or at least—small number of people. Innovation is a community effort, and that's oftentimes not recognized. So, people who aspire to innovate or aspire to be entrepreneurs have to understand that teams are involved, and you have to have the right skills, and this is what Pat was calling attention to.

Senator KLOBUCHAR. OK. Well, thank you very much.

And I will say that I was pleased that the President talked about innovation at the beginning of the State of the Union, and exports, and things like that, because I believe that this can be a defining way to move our country forward with this competitive strategy innovation. I think it brings people together in a way, and it's the right thing to do for our country. So, I'm hoping we're going to hear a lot more about it. And it crosses over so many areas, but it's a theme that we can use.

And I just—again, every time I get home, that's what we're talking about, you know. And we all know Medtronic started in a garage and 3M started as a little company in Two Harbors, Minnesota, and so, we have so many examples of it in our state, that it's real to people, and they see the success that we can get with this. So, that's what I'm hoping that we are going to hear more and more from the Administration as a way of defining what we're doing and how we're moving forward. I think it will be very helpful.

There's so much we can say here on these hearings for the C-SPAN audience and our friends, and there is so much that we can say at home, but we really need this—the President to take this on as a defining strategy and agenda. And I know he believes in it, and I know there are a lot of things going on, but I believe that's what's going to bring us together and move this country forward.

So, thank you for your work. I appreciate it.

[Whereupon, at 4:29 p.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO
HON. JOHN P. HOLDREN, PH.D.

Question 1. Why does the EPSCoT program continue to go unfunded?

Answer. The Experimental Program to Stimulate Competitive Technology (EPSCoT) was a program to stimulate technology commercialization in eligible states by promoting partnerships between state governments, universities, community colleges, and the private sector. The Administration is highly supportive of policies to catalyze the formation of regional innovation clusters in areas that currently lack the scientific and technological infrastructure for technology-based economic growth. Instead of EPSCoT, the 2011 Budget proposes: support for regional innovation clusters in Commerce's Economic Development Administration; new funding for innovation ecosystem partnerships in the National Science Foundation; expanded funding for the Hollings Manufacturing Extension Partnership; and expanded linkages between existing agency programs to foster regional economic growth, such as in the recently announced initiative undertaken by 7 Federal agencies to support an Energy Research Innovation Cluster (E-RIC). These initiatives show great promise in spurring job creation from technology-based economic development in areas that currently lack strong partnerships and regional innovation collaborations.

Question 2. As policymakers look for innovative ways to spur job creation, isn't it worth looking at EPSCoT as a potential model?

Answer. Although EPSCoT is a potential model, the other policies described in the response to Question 1, above, appear to show greater promise for regional economic development and job creation.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK WARNER TO
HON. JOHN P. HOLDREN, PH.D.

Question 1. The United States is one of the few countries without a national competitiveness strategy. The UK, South Korea, the Netherlands, Ireland, and Denmark have all created their own strategies while the most recent comparable U.S. assessment was in 1978.

- If Congress authorizes a new national competitiveness strategy, what are the top two or three issues you think we should include? Please be specific.
- To what extent are you aware of competitiveness strategies in other countries? Do you think we could use other approaches as a starting point or should we be focusing on other issues? Which ones?
- Which competitiveness strategies and which competitors should we be most influenced by as we develop our own strategy? How should the U.S. measure itself against these other strategies?

Answer. The Obama Administration in September 2009 released *A Strategy for American Innovation: Driving Toward Sustainable Growth and Quality Jobs*. It serves as a competitiveness strategy for the Administration; we believe it is very close to being a national competitiveness strategy. The strategy identifies the top three issues for achieving sustainable growth and quality jobs: catalyzing breakthroughs for national priorities; promoting competitive markets that spur productive entrepreneurship; and investing in the building blocks of American innovation. The strategy discusses specific policy measures the Administration is pursuing or plans to pursue to make progress toward each of the top three issues. For example, to invest in the building blocks of American innovation the strategy outlines specific policies, including: the President's Plan for Science and Innovation to double the budgets of three key science agencies as identified in the America COMPETES Act; the 2011 Budget's proposal to make the Research and Experimentation Tax Credit permanent; and ongoing support for the Next Generation Air Transportation System (NextGen) as part of an effort to build a leading physical infrastructure. In pre-

paring the strategy, the National Economic Council and OSTP considered the competitiveness strategies of other countries, as well as ideas for a U.S. strategy proposed by U.S. organizations such as the Council on Competitiveness and the National Academies. These documents share many common themes with the Administration strategy, including investments in R&D, STEM education, and infrastructure; policies to encourage open markets, access to capital, and innovation-based entrepreneurship; and a focus of government attention on key national priorities. Some of the specific policy proposals in the Administration strategy are inspired by specific proposals from other nations' strategies; for example, the goal for the U.S. to invest 3 percent of GDP on R&D is similar to the European Union's 3 percent goal articulated as part of the EU's Lisbon agenda. As we measure the United States' progress toward improving economic competitiveness, we will be measuring our progress most closely against the progress of our closest economic competitors such as the European nations, Japan, and South Korea, and also against the progress of rapidly growing lesser-developed competitors such as China.

Question 2. The America COMPETES act has been largely successful, but it seems to assume commercialization of new technology will just happen, assuming we do the right research and come up with good ideas. We need more than that for long-term success and innovation.

- One possibility is to create a new Federal initiative, in partnership with universities, to create a system of university-based support for entrepreneurs and tech transfer. In addition to existing programs such as STTR—which provides funding to specific companies for technology transfer—the Federal Government could fund incubation centers within university communities. What do you think about this concept? Could this type of program help spur commercialization?
- Are there other ideas that should be considered such as public-private partnerships or other concepts? If so, what should they look like?

Answer. The Obama Administration is supportive of new Federal initiatives to create a system of university-based support for entrepreneurs and tech transfer. As one example, the 2011 Budget proposes \$12 million in the National Science Foundation's (NSF) Engineering directorate for an "NSF Innovation Ecosystem." This program would provide research grants to universities in partnership with other institutions to increase the social and economic impacts of university research, including the impacts of commercialization, industry alliances, and start-up formulation. The program aims to develop regional innovation communities around universities. We believe this type of program could help spur commercialization of promising university research. Also, the Department of Commerce's Economic Development Administration is implementing a regional innovation cluster initiative that seeks to promote public-private partnerships that support the commercialization of new technologies.

Question 3. Should there be more focus on clean energy technology, as part of a COMPETES reauthorization? Do you have ideas in terms of other initiatives Congress could create or existing programs we could improve?

Answer. As I stated in my testimony, Congress has the opportunity this year to strengthen the parts of the COMPETES Act that have the most capacity to leverage the American economy and secure America's future. Just as the original COMPETES Act authorized the creation of ARPA-E and laid the foundation for its eventual launch in April of last year, the reauthorization of the COMPETES Act is an opportunity for Congress to lay the foundations for other innovative approaches to addressing the challenges we face. One of the grand challenges we face as a nation is the challenge of developing and deploying a new generation of clean energy technologies. To meet this challenge, Congress has the opportunity to authorize DOE's Energy Innovation Hubs. The 2011 Budget includes support for four Energy Innovation Hubs to accelerate cross-disciplinary R&D for transforming advances in energy science into commercially deployable materials, devices, and systems: three appropriated by Congress last year to advance fuels from sunlight, modeling and simulation for nuclear reactors, and energy-efficient building systems design; and one new Hub to conduct R&D on batteries and energy storage.

ARPA-E supports high-risk, high-reward research to yield revolutionary changes in how we produce, distribute, and use energy. ARPA-E announced its first set of grants last October and in 2010 will make additional awards with Recovery Act funds. Now that it is a fully operational agency, Congress has the opportunity to reauthorize ARPA-E in the reauthorization of the America COMPETES Act.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO
DR. ARDEN BEMENT, JR.

Question 1. What efforts does NSF have underway for universities to teach computer science and software engineering graduates to develop software securely? If NSF doesn't support secure software engineering, who can be responsible for this?

Answer. The Directorate for Computer and Information Science and Engineering (CISE) supports a significant effort in foundational cybersecurity research, most notably through the Trustworthy Computing (TwC) program. The goal of TwC research is to ensure that our increasingly ubiquitous and distributed computing and communication systems deliver the quality of service they are designed to achieve, without disruption, while enabling and preserving privacy, security, and trust. Education programs are included in several large TwC awards, such as:

- A center-scale award at the University of Illinois at Urbana-Champaign on trustworthy cyber infrastructure for the power grid includes an education program that provides an integrated undergraduate and graduate experience for students in cyber trust issues.
- A science and technology center at the University of California—Berkeley on ubiquitous secure technology includes an education and outreach program that transfers new and existing knowledge to undergraduate colleges, educational institutions serving under-represented populations, and the K–12 community, thus laying the groundwork for training the scientists and engineers who will develop the next generation of trustworthy systems.
- A collaborative award at North Carolina State University on trustworthy virtual cloud computing involves both graduate and undergraduate students and will produce open source software and tools which will be made available to the public.

These and other education and outreach programs in large CISE awards help ensure that computer science and engineering students have access to education and training in safety and security issues for all computing components, *i.e.*, hardware, software, systems and networks, etc.

CISE and the Directorate for Education and Human Resources (EHR) are jointly sponsoring a summit on research and education in secure software engineering, planned for the last week in July 2010, in Washington, D.C. The summit will bring together a multi-disciplinary group of experts in trustworthy computing research and education to develop a comprehensive agenda focused on research and education challenges related to secure software engineering. The group of participants will include representatives from academia, professional organizations across the public and private sectors, as well as policymakers and government representatives. This multi-disciplinary group will bring the needed depth (technical challenges) and breadth (operational constraints) to advance and improve the state-of-the art in education in trustworthy computing and software engineering.

In addition to these research programs and educational outreach, CISE also supports a number of graduate research fellowships in fields of study that promote reliability and security, such as information security and assurance, and funds workshops focused on secure software and trustworthy computing.

EHR supports secure software engineering education through several programs, including:

- Advanced Technological Education (ATE) focuses on the education of technicians for the high-technology fields that drive our Nation's economy, with an emphasis on two-year colleges. Several projects, including three regional centers in cybersecurity, focus on education related to secure coding.
- Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (TUES) aims to improve the quality of STEM education for all undergraduate students. The program supports several projects that create, adapt, and disseminate new learning materials and teaching strategies in secure software engineering.
- Federal Cyber Service: Scholarship for Service (SFS) seeks to increase the number of qualified students entering the fields of Information Assurance and to increase the capacity of the United States higher education enterprise in cyber security, including secure software development.

Thus, NSF supports secure software engineering through basic research and education activities. NSF also works closely with other agencies on these topics through the Networking and Information Technology Research and Development (NITRD) program and through collaborations with the Department of Education.

Question 2. What was the problem with the way NSF was managing the grant program for minority serving institutions?

Answer. Three separate NSF programs with similar goals—the Louis Stokes Alliances for Minority Participation (LSAMP), the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), and the Tribal Colleges and Universities Program (TCUP)—will serve as the basis for the new comprehensive broadening participation program. These long-standing programs have facilitated learning and development for tens of thousands of undergraduate students pursuing STEM careers. More importantly, LSAMP, HBCU-UP, and TCUP institutions have contributed to the success of African American, Hispanic, and Native American undergraduate students in STEM at disproportionate rates compared to other institutions. These specific NSF programs have also helped to strengthen the success of the institutions where large populations of those underrepresented minority students attend.

The new comprehensive broadening participation program will be introduced in FY 2011, but existing programs will not be terminated abruptly. NSF intends to develop a five-year transition period of bridging between programs. During the planning and transition, we expect to incorporate community feedback in shaping the new program.

However, the numbers for underrepresented minorities in STEM remain small relative to the general STEM workforce. In higher education, there is a disproportionate rate of attrition for underrepresented minority students in STEM majors. A strategic and cost-effective approach is needed to maximize impact in broadening participation in undergraduate STEM. We believe that a single, new comprehensive program, that draws the best of these three NSF programs into a comprehensive effort with additional new features and emphases, will lead to solutions that are significantly more effective than what has been achieved. We hope to build on the knowledge accumulated and structures identified from LSAMP, HBCU-UP and TCUP and stimulate new approaches that will develop more talent within current high-producing institutions and catalyze expansion of institutions that can become high-producing.

Question 3. Are you concerned that this new approach will force the MSIs to compete against each other? How is this a desirable policy objective?

Answer. NSF plays the role of catalyst for new ideas and innovations in awarding grants. An expected outcome of the comprehensive effort is that institutions would collaborate and cooperate across institution types to learn from each other and create a community of scholars in sync with cultivating talent and increasing outputs and outcomes in STEM for all underrepresented minority students. This is especially important for bringing together institutions that may have common commitments to growth in particular disciplinary areas and to broadening participation in those areas. We see the program as creating new opportunities for collaboration among MSIs, as well as for forming partnerships with other research institutions.

Another expected outcome is to position the program for future growth and greater impact. The FY 2011 Budget Request represents an increase of \$13 million more than the combined budgets of the current undergraduate programs. Additional resources in the form of co-funding and other leveraging will be available from other NSF directorates and offices. There is very strong Foundation-wide interest in the potential of this new program for broadening participation in specific scientific disciplines, and initial planning conversations across the Foundation are generating a number of creative suggestions for collaboration and leveraging of both intellectual and fiscal resources.

Question 4. How can we tell how much NSF plans to dedicate to historically black colleges and universities, Hispanic serving institutions, and tribal colleges?

Answer. Consistent with other NSF programs, the new comprehensive program does not guarantee particular levels of funding to categories of organizations submitting proposals, but funds proposals on a competitive basis following the agency's merit review process. The solicitation for the new comprehensive program will include strategically designed project tracks with emphasis on collaboration and co-operation that provide a range of options and avenues for HBCUs, TCUs, and HSIs to seek funding. Institutions will be able to create new alliances and partnerships that can leverage more resources, build on effective practice, and enhance efforts to move STEM education and research to the next level of innovations. Institutions that face challenges in infrastructure and capacity for innovation will have opportunities to employ targeted approaches that are tailored to the needs and context of the institution and its students but will also link collaboratively and cooperatively through partnership to intensify efforts from a national perspective.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK WARNER TO
DR. ARDEN BEMENT, JR.

Question 1. The United States is one of the few countries without a national competitiveness strategy. The UK, South Korea, the Netherlands, Ireland, and Denmark have all created their own strategies while the most recent comparable U.S. assessment was in 1978. If Congress authorizes a new national competitiveness strategy, what are the top two or three issues you think we should include? Please be specific.

Answer. The National Economic Council and the Office of Science and Technology Policy have developed “A Strategy for American Innovation: Driving Toward Sustainable Growth and Quality Jobs.”¹ This strategy focuses on three critical areas: investing in the building blocks of American innovation; promoting competitive markets that spur productive entrepreneurship; and catalyzing breakthroughs for national priorities. Within those areas, the strategy emphasizes fundamental research, education, physical infrastructure, entrepreneurship and innovation.

Question 2. To what extent are you aware of competitiveness strategies in other countries? Do you think we could use other approaches as a starting point or should we be focusing on other issues? Which ones?

Answer. As the Director of NSF, I meet with my counterparts around the world and our discussions often include issues such as competitive strategies. In the global wave of market liberalization since the 1990s, many governments have come to view S&T as integral to their economic and social development. They have taken steps to open their markets to trade and foreign investment, develop or recast their S&T infrastructures, stimulate industrial R&D by domestic and foreign-based companies or their joint ventures, expand their higher education systems, build indigenous R&D capabilities, and develop the capability to compete at the highest level of technical excellence in the world economy.

This has brought a great expansion of the world’s S&T activities and their shift toward developing economies in Asia. In the midst of these changes, the United States continues to maintain a position of leadership in most broad aspects of S&T activities but, as noted, it has experienced a gradual erosion of its position in many specific areas, from education to intellectual property, innovation and high technology goods exports, where we have run a persistent deficit in this decade.

Most of the rapid growth in S&T activity is driven by China and several other Asian economies (India, Indonesia, Malaysia, the Philippines, Singapore, South Korea, Thailand, Taiwan) that seek to boost access to and quality of higher education and to develop world class S&T infrastructures. These other Asian economies form a loosely structured supplier zone for China’s high technology manufacturing export industries. Japan, long a preeminent world S&T nation, is losing ground to these other Asian economies in overall high-tech manufacturing and trade.

The EU largely has held its own in the face of these changes. Its innovation-focused policies have been supported by a shared currency and the elimination of internal trade and migration barriers. (Much of the EU trade is with other EU members.) EU research performance is strong and marked by pronounced EU-supported intra-EU collaboration. The EU is also focusing on boosting the quality and international standing of its universities.

What can one conclude from this? Science and technology are no longer the province of developed nations but have, in a sense, become “democratized.” These developments open the way for widespread international collaboration; they also carry with them the challenge of competition. And in a world where many more centers of excellence in S&T are rising, broad international engagement will enable the United States to capitalize on advances made elsewhere.

Question 3. Which competitiveness strategies and which competitors should we be most influenced by as we develop our own strategy? How should the U.S. measure itself against these other strategies?

Answer. While the U.S. should look at the competitive strategies of our allies in Europe, our neighbors in North America, and countries such as China, South Korea, India and Japan, we need to evaluate how successful those strategies have been.

However, we also need to be cognizant of the differences between other countries and our own. The true strength of this country is the strong entrepreneurial culture that allows small businesses to take risks and fail, and connecting that willingness to take risks with the S&T knowledge coming out of universities. Our universities spawn innovation and connect with both small and large companies. This is a unique situation that other countries are imitating around the globe. This entrepre-

¹ www.whitehouse.gov/sites/default/files/microsites/ostp/innovation-whitepaper.pdf.

neurial culture has been our strength in the past, and it must be a continuing emphasis as we move forward.

Question 4. The America COMPETES act has been largely successful, but it seems to assume commercialization of new technology will just happen, assuming we do the right research and come up with good ideas. We need more than that for long-term success and innovation.

One possibility is to create a new Federal initiative, in partnership with universities, to create a system of university-based support for entrepreneurs and tech transfer. Rather than just funding programs like STTR, which provide funding to specific companies, the Federal Government could fund incubation centers within the university communities. What do you think about this concept? Could this type of program help spur commercialization? Are there other ideas that should be considered such as public-private partnerships or other concepts? If so, what should they look like?

Answer. When discussing global competitiveness, every possible mechanism to jump start innovation and commercialization should be on the table. According to a 2008 report issued by the National Research Council, both the STTR and SBIR programs have been shown to be effective, not just at NSF but across the Federal Government.² With venture capital in the U.S. declining, the Federal Government may need to step in to help traverse the “valley of death.” We should look at other complementary methods and programs, of which university-based incubation centers are just one.

NSF has numerous university-based partnership programs with industry with proven value. Many of our centers programs partner closely with industry, including our Science and Technology Centers, Centers for Chemical Innovation, Engineering Research Centers, and Materials Research Science and Engineering Centers.

In the FY 2011 Budget Request, NSF proposed to further explore the acceleration of innovation through a significant investment in a new aspect of the Partnership for Innovation program called the “NSF Innovation Ecosystem.” This effort will provide research grants to universities in partnership with other institutions to increase the economic and social impacts of research, as well as develop a regional community to support an innovation ecosystem around the university.

Question 5. Should there be more focus on clean energy technology, as part of a COMPETES reauthorization? Do you have ideas in terms of other initiatives Congress could create or existing programs we could improve?

Answer. There should be careful consideration given to whether the COMPETES reauthorization should highlight specific areas of research and education (such as clean energy) or if it should focus on advancing innovation and competitiveness broadly.

A key input for this discussion should be NSF’s ability to address national priorities while also advancing science and engineering generally. Two examples of this are presented in NSF’s FY 2011 Budget Request.

- Science, Engineering and Education for Sustainability (SEES) will integrate NSF’s efforts in climate and energy science and engineering to generate the discoveries and capabilities needed to inform societal actions that lead to environmental and economic sustainability. Included in this investment is a focus on research and development in the area of clean energy.
- RE-gaining our ENERGY Science and Engineering Edge (RE-ENERGYSE), a partnership between NSF and the Department of Energy, will help the Nation retain its leadership position in science and engineering by attracting and educating future scientists in the clean energy field.

Question 6. Over the past 3 years, the America COMPETES Act has sought to increase funding at the NSF, NIST and the DOE Office of Science in order to increase our Nation’s innovation and competitiveness. In your opinion, what were some of the key areas that were positively affected by COMPETES and what areas need further work? Do you have any specific recommendations that you would like to see the Committee address during the reauthorizing of the COMPETES Act?

Answer. Continued support for NSF, NIST, and the Department of Energy’s Office of Science is critical to increase our Nation’s innovation and competitiveness. Putting NSF on a doubling path allows the Foundation to make healthy investments in both its core programs and in new areas of research, such as Cyber-Enabled Discovery and Innovation and Science and Engineering Beyond Moore’s Law. With additional funds, NSF has been able to invest in the Networking and Information Technology Research and Development program and certain aspects of the National

²http://sites.nationalacademies.org/PGA/sbir/PGA_054939.

Nanotechnology Initiative, such as nanomanufacturing and nanoenvironmental health and safety, both Administration priorities. NSF's Centers program has also grown over the past few years, from about \$250 million annually to the current FY 2011 Budget Request of \$314 million. The America COMPETES Act helped the Foundation focus on the importance of transformational research and on awards that meet critical national science needs.

In reauthorizing the National Science Foundation, flexibility is the key requirement. We need to pay careful attention to our STEM workforce programs. The Graduate Research Fellowship program is widely recognized as a unique fellowship grant program because it supports the broad array of science and engineering disciplines across all fields of science as well as international research activity. The President plans to triple the number of new fellows by FY 2013. Other programs, such as the Integrative Graduate Education and Research Traineeship (IGERT) program, also have important roles to play in shaping the future STEM workforce. However, every STEM program needs to be considered based on its own merit.

NSF's planning is consistent with Administration and National Science Board guidance. In FY 2011 and beyond, NSF will invest in areas of national interest, such as climate and energy research, cyberinfrastructure, and Science and Engineering Beyond Moore's Law. These investments, along with our strong core programs, will help the U.S. maintain global competitiveness.

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

Question. Over the past 3 years, the America COMPETES Act has sought to increase funding at the NSF, NIST and the DOE Office of Science in order to increase our Nation's innovation and competitiveness. In your opinion, what were some of the key areas that were positively affected by COMPETES and what areas need further work? Do you have any specific recommendations that you would like to see the Committee address during the reauthorizing of the COMPETES Act?

Answer. Continued support for NSF, NIST, and the Department of Energy's Office of Science is critical to increase our Nation's innovation and competitiveness. Putting NSF on a doubling path allows the Foundation to make healthy investments in both its core programs and in new areas of research, such as Cyber-Enabled Discovery and Innovation and Science and Engineering Beyond Moore's Law. With additional funds, NSF has been able to invest in the Networking and Information Technology Research and Development program and certain aspects of the National Nanotechnology initiative, such as nanomanufacturing and nanoenvironmental health and safety, both Administration priorities. NSF's Centers program has also grown over the past few years, from about \$250 million annually to the current FY 2011 Budget Request of \$314 million. The America COMPETES Act helped the Foundation focus on the importance of transformational research and on awards that meet critical national science needs.

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RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO
PATRICK D. GALLAGHER, PH.D.

Question 1. Please tell me more about the additional \$10 million that NIST plans to invest in cybersecurity research.

Answer. NIST will leverage its expertise and internationally recognized success in cybersecurity R&D and its decades-long working relationship with industry and its Federal agency partners to accelerate its focus on several critical research areas including advanced cryptographic techniques, identity management and authentica-

tion technologies, security automation technologies, as well as security requirements for new information technologies.

Question 2. You know that this is a critically important issue for the entire nation. If you were given additional resources, what additional research can NIST conduct to improve cybersecurity?

Answer. A \$10 million increase as requested in the President's Budget helps address the need to grow NIST's cybersecurity efforts significantly while ensuring that the level of growth is manageable. In support of its cyber security mission to develop standards, guidelines and conformance testing, NIST will continue to develop research programs in security technologies such as security controls including protocols, vulnerability management, information infrastructure protections, biometrics, software assurance, security forensics, and security metrics and testing techniques.

Question 3. Why does the EPSCoT program continue to go unfunded?

Answer. We believe that NIST has a number of existing and pilot programs that have proven to be effective for spurring technological and economic development.

Question 4. As policymakers look for innovative ways to spur job creation, isn't it worth looking at EPSCoT as a potential model?

Answer. We believe that NIST has a number of existing and pilot programs that have proven to be effective for spurring technological and economic development.

The NIST Technology Innovation Program (TIP) has demonstrated the ability to leverage Federal investments in transformational technologies. TIP supports, promotes, and accelerates innovation in the United States through high-risk, high-reward research in areas of critical national need. TIP has the agility and flexibility to make targeted investments in transformational R&D that will ensure our Nation's future through sustained technological leadership.

The Hollings Manufacturing Extension Partnership (MEP) has increased the program's focus on the development of new profit opportunities for our Nation's manufacturers. The Next Generation MEP strategy is focused on developing the tools and services to help strengthen American manufacturing by accelerating its ongoing transformation into a more efficient and powerful engine of innovation to drive economic growth and job creation.

Finally, in 2007 NIST began its pilot implementation of its Partnerships for Regional Innovation (PRI) program. Working in the area of post-CMOS electronics, this program has shortened the timescale of innovation in this critical area, has highly leveraged a limited amount of Federal research dollars, and attracted commitments in excess of \$200 million in state and private funds to support business development opportunities that result from the research performed in this program.

Question 5. What role do you envision MEP playing in promoting advanced manufacturing?

Answer. As outlined in the Next Generation Strategy, MEP is focused on developing the tools and services to help manufacturers recognize technology opportunities and solutions for the development of innovative products and process improvements. In addition, the MEP Advisory Board recently issued a white paper, "Innovation and Product Development in the 21st Century" (http://www.nist.gov/mep/upload/MEP_advisory_report_4_241.pdf) that outlines a set of recommendations focused on expanding current service offerings and developing new partnerships to help manufacturers adopt technological advances.

Question 6. How is MEP helping small and medium manufactures compete in the growing global marketplace?

Answer. MEP has a number of services and tools focused on helping manufacturers identify opportunities and expand into new markets.

Specifically, NIST MEP, in partnership with other resources, is developing a process to help companies introduce new or improved product concepts and outline the market potential of those new ideas.

Companies are also provided assistance and guidance to move into international markets through the ExporTech program. ExporTech is a collaborative effort between MEP, the U.S. Export Assistance Centers, District Export Councils, Small Business Development Centers, and state-based international trade programs. This program is a "how to" service to help companies expand into global markets by developing a proactive international growth plan customized for their business and moving the company into actual, profitable export sales. The program offers detailed guidance—all in one place—on the variety of elements critical to understand for executing an exporting program, from banking and financing to freight forwarding, licensing, and strategy.

Question 7. Access to capital is a major factor that limits the ability of small and medium manufacturers to grow. This is especially true in this tough economy. If MEP were given the authority to develop a loan program, how would it be used?

Answer. To avoid creating a loan program that may be duplicative of existing Federal programs, a first step would be to inventory and assess the performance of existing loan programs and to determine the extent to which existing credit programs, such as DOE's loan guarantees for innovative energy technologies and SBA's 7(a) loan program, can be used to achieve the same policy goals. The Administration recognizes the difficulties that small manufacturers face. That is why the FY 2011 Budget proposed to increase the maximum loan size in SBA's 7(a) and 504 programs from \$2 million to \$5 million (\$4 million to \$5.5 million for 504 loans to manufacturers). The Administration has also supported a temporary increase through FY 2011 to the maximum size of SBA express loans from \$350,000 to \$1 million. These loans have a quicker turnaround than other loans and are often made as revolving lines of credit to small businesses, including small manufacturers. Finally, the Administration has called for the extension of fee holidays and increased guarantee percentages, as provided in the Recovery Act, on eligible SBA-backed loans through the end of FY 2010.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TOM UDALL TO
PATRICK D. GALLAGHER, PH.D.

Question 1. I am very encouraged by the green manufacturing and construction initiative discussed in NIST's FY 2011 budget request. Buildings consume 73 percent of electricity and 40 percent of overall energy. Yet many construction firms do not have the skills or expertise to take advantage of new technologies to improve the energy efficiency. NIST researchers at the Building and Fire Research Lab already help develop standards and technologies to improve buildings. Since manufacturing now plays an increasingly important role in the construction industry, I think there is an important opportunity for the Hollings Manufacturing Extension Partnership (MEP) program to promote green jobs and energy independence. Builders today already rely on manufactured components and sub-assemblies. Manufacturing will become even more important to construction as homes are increasingly "assembled" onsite from components made in a factory. MEP Centers have already helped thousands of small and medium-sized manufacturers across the country. Now that lean, high quality manufacturing is applicable to construction, it is not a stretch for MEP Centers to teach the same skills to the construction industry, where small firms are the norm. That is why I am working on legislation to fund MEP Center pilot projects for green jobs related to energy efficiency. This would build on provisions already authorized by America COMPETES legislation. Dr. Gallagher, I want to encourage NIST efforts to promote green manufacturing and construction. I hope that I can work with you and your staff to find ways that the MEP program can play a central role in these efforts.

Will you consider ways that the Hollings Manufacturing Extension Partnership (MEP) program can assist in NIST's efforts to promote green manufacturing and construction to promote job growth and energy independence?

Answer. Yes. MEP, along with the Building and Fire Research Laboratory at NIST, are in preliminary discussions with DOE's Building Technologies Program to identify potential collaborations focused on efforts to identify materials and equipment manufacturers that employ green and environmentally sustainable practices, to educate building and construction designers/contractors on how to use these green processes and products, and to develop best practices guidance to encourage the implementation of cost-effective technology solutions in new and existing buildings.

Question 2. Dr. Gallagher, as you know, I am a supporter of the Hollings Manufacturing Extension Partnership (MEP) program. The New Mexico MEP Center has helped small manufacturers from across my home state. I know the Administration has said it wants to double the MEP program to \$180 million by 2015. How do you see MEP program fitting into the Administration's overall plan for an America COMPETES reauthorization?

Answer. The Administration recognizes the role of the Manufacturing Extension Partnership in helping to improve the competitiveness of U.S. manufacturers, as noted in the December 2009 *Framework for Revitalizing American Manufacturing* and reflected in the President's Budget, which proposes to increase funding for the MEP to \$180 million in FY 2015.

Question 3. Dr. Gallagher, in your written statement, you mention that NIST's sustainability initiative includes work related to improving the cost and efficiency

of solar panels. As a native of New Mexico, you certainly know that the Land of Enchantment has no shortage of sunshine to help boost renewable energy production. This is one reason why I am interested in how solar and other renewable energy sources can reduce pollution and increase our energy independence.

- When does NIST expect its work on photovoltaics to affect the market place?
- What kind of efficiency improvements are we hoping for in next generation solar panels?
- What cost improvements are possible?

Answer. NIST is currently engaged in work that is affecting the solar marketplace.

NIST research and testing protocols enable users to optimize current solar technologies to maximize their efficiencies through optimal placement. In addition, NIST provides accelerated testing capabilities that provide accurate data service life and changes to performance with aging. While these activities focus mainly on current solar technologies in the market place, NIST is also working to develop the measurement science and tools necessary to enable the development of advanced third generation photovoltaic (PV) technologies, which will likely impact the market in the next 10 years.

Although first and second generation silicon-based PV devices will see gains as manufacturing processes improve, they are fundamentally limited in efficiency by the properties of silicon and in cost by the use of near-crystalline material.

New third-generation PV technologies seek to dramatically improve the overall efficiency by exploiting new nanostructures and quantum devices. Despite the substantial investment in PV technology, commercialization of third-generation devices is limited by a lack of accurate and reproducible measurements of some key fundamental properties associated with this new technology. With the proposed increase in funding, NIST will address this issue by extending its current state of optical, electrical, chemical and physical measurement to deliver advanced measurement and modeling tools that will enable researchers to understand and optimize the intrinsic electronic and optoelectronic processes that govern the efficiencies of third-generation PVs.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK WARNER TO
PATRICK D. GALLAGHER, PH.D.

Question 1. The United States is one of the few countries without a national competitiveness strategy. The UK, South Korea, the Netherlands, Ireland, and Denmark have all created their own strategies while the most recent comparable U.S. assessment was in 1978.

- If Congress authorizes a new national competitiveness strategy, what are the top two or three issues you think we should include? Please be specific.
- To what extent are you aware of competitiveness strategies in other countries? Do you think we could use other approaches as a starting point or should we be focusing on other issues? Which ones?
- Which competitiveness strategies and which competitors should we be most influenced by as we develop our own strategy? How should the U.S. measure itself against these other strategies?

Answer. There have been a number of bipartisan studies over the past several years providing consistent recommendations on steps that should be taken to strengthen America's competitive posture, including the National Academies "Rising Above the Gathering Storm" report, which was often referenced during the development and consideration of the America COMPETES Act in 2007 (P.L. 110-69).

COMPETES provided a very aggressive and strong starting point to address some of the issues raised in the report.

Continued support for the programs identified in the COMPETES Act and the priorities outlined in the President's Plan for Science and Innovation provide a strong strategic foundation for enhancing American competitiveness.

Question 2. The America COMPETES act has been largely successful, but it seems to assume commercialization of new technology will just happen, assuming we do the right research and come up with good ideas. We need more than that for long-term success and innovation.

- One possibility is to create a new Federal initiative, in partnership with universities, to create a system of university-based support for entrepreneurs and tech transfer. Rather than just funding programs like STTR, which provide funding

to specific companies, the Federal Government could fund incubation centers within the university communities. What do you think about this concept? Could this type of program help spur commercialization?

- Are there other ideas that should be considered such as public-private partnerships or other concepts? If so, what should they look like?

Answer. We must adapt our mechanisms and policies for investing in science and technology to meet the challenges of the 21st century in ways that maximize the return on our investments and increase our capacity and capability for innovation.

There are a number of consensus building blocks that can be used to build novel Federal R&D programs and create new Federal R&D investment strategies. Chief among these is that R&D is the foundation for innovation. Finally, there is a consensus that Federal science and technology policy should aim to increase the efficiency of this discovery-invention-innovation process and promote competition within industry.

Programs that combine and coordinate Federal R&D, research grants, grants to build cutting edge laboratories and research facilities, laboratories and the formation of novel public-private partnerships will directly address the challenges of innovation in the 21st century.

Question 3. Should there be more focus on clean energy technology, as part of a COMPETES reauthorization? Do you have ideas in terms of other initiatives Congress could create or existing programs we could improve?

Answer. The development of clean and sustainable sources of energy is a major challenge for the Nation. The Administration has placed a high priority on the development of new and cleaner sources of energy while reducing atmospheric emissions from energy production. Efforts in this area will benefit the environment and will help drive a revitalized manufacturing sector.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. OLYMPIA J. SNOWE TO
PATRICK D. GALLAGHER, PH.D.

Question 1. The Manufacturing Extension Partnership (MEP) is a tremendously successful program that assists small and medium-sized manufacturers with technical assistance projects, training, and long-term strategic support. And while I am certainly pleased that the MEP program is slated to receive \$129.7 million for FY 2011, I am concerned that centers across the country will find it difficult to draw down this funding because of a high cost-share requirement of two-thirds. That means that for every dollar a state MEP center receives, it must match that dollar with an additional two dollars. Indeed, of the 80 programs that the Department of Commerce funds, the MEP is the only program with a statutory cost-share requirement above 50 percent!

While it has always been a difficult burden in the past for MEP centers to satisfy this high cost share requirement, it will be even more difficult now in this trying economy. State governments facing budget shortfalls are cutting back the amount they provide to these centers, and private entities are reducing their contributions as well. That is why I introduced legislation (S. 695) last year that would reduce that requirement to 50 percent, a much-needed step that will provide relief to these centers that have a significant role in aiding thousands of small and medium-sized manufacturers nationwide.

My cost share legislation has been referred to the Senate Committee on Commerce, Science & Transportation. Can I enlist your support, as Director of NIST, for the change in cost share that would help inject parity in this critical manufacturing program, relative to other Commerce programs?

Answer. The current cost share aspect of the MEP program encourages significant state and local buy-in and is a core component of the program's success. I understand there are proposals, such as yours, proposing changes and flexibility to the cost share. I recognize the fiscal constraints many states are currently facing, and I am happy to work with you to explore ways to address situations in which states are in particularly dire circumstances.

Question 2. On February 1, I joined with nearly 30 of my colleagues in writing to Commerce Secretary Gary Locke about our concerns that a portion of Fiscal Year 2010 funding for the MEP program may not be used to help existing MEP centers. In that letter, we wrote, "We understand that the MEP program is contemplating diverting some of the funds from existing MEP Centers, and instead providing them to unproven alternatives. The best way to help manufacturers and create jobs is to utilize the existing, proven MEP network in all 50 states. It is clear that Congress intended this funding to go to existing MEP Centers, as has been the practice for

the entirety of this program's history." We are still awaiting a response. At the same time, I appreciate that your staff has had constructive conversations with mine on this issue.

Director Gallagher, MEP centers nationwide are struggling. State governments facing shortfalls are cutting back the amount they provide to these centers, as are private entities. Every dollar that these centers receive allows them to focus on the urgent task of helping small and medium-sized manufacturers create jobs.

Will you assure me that aside from administrative costs, any Federal funding appropriated by Congress for the MEP program will go either directly to existing MEP centers or to centers for their use in conjunction with partnering organizations and entities, and not directly to outside organizations or groups that are not working with existing centers?

Answer. The Secretary of Commerce responded to your letter on March 1, 2010 (attached). The letters states, ". . . the MEP program does not intend to divert funding from existing Centers."

MEP has competitively awarded funds for a number of years in order to ensure the best value for the American taxpayer. Centers have benefited from such competitions in the past. This year's planned competition, consistent with previous competitions, will help to ensure that MEP's customers, small and medium-sized manufacturers, such as those in Maine, will receive the most benefit: cutting-edge, forward-thinking services and programs to help manufacturers succeed and grow in this increasingly global economy.

In FY 2010 MEP will make available \$9.5M, an amount that is 7.6 percent of MEP's total funding, for competitive grants. As we communicated to staff representing members of the Northeast-Midwest Senate Coalition, including your office, a priority will be on applicants partnering with an existing Center or Centers.

The grant awards are to be used to accelerate and incentivize Centers and other nonprofits to create or strengthen partnerships to develop specific tools and services, including environmental best practices and emerging technologies. MEP is committed to leveraging its resources and its funds to deliver the highest quality tools and services to U.S. manufacturers to ensure their competitiveness.

Question 3. In regard to the Technology Innovation Program (TIP), I am concerned that smaller states, such as my home state of Maine, are not receiving any funding under this initiative. When the program was known as the Advanced Technology Program, or ATP, in the 45 competitions throughout that program's history—from 1990 to September 2007—Maine firms submitted 17 applications and received zero awards. Indeed, nine states received no funding under ATP—six of which have populations of less than one million people. All of those states except Alaska had more than one application for funding. Additionally, in TIP's two-year history, Maine firms have continued to receive no funding. Thus far, companies in only 22 states have received awards under TIP.

While I appreciate the unique nature of TIP, I am concerned that large states like New York, California, and Massachusetts are receiving the vast majority of the funding while smaller states that still have much innovation to offer are left out of the process. What can you do at NIST to ensure that all states have a fair opportunity to compete for TIP funding? Furthermore, is there anything we in Congress can do, when reauthorizing the America COMPETES Act, to accomplish that goal?

Answer. TIP awards cost-shared funding for high-risk, high-reward research in areas of critical national need. The program offers competitive funding opportunities that are publicly announced in the Federal Register, on the www.grants.gov website (Announcement of Federal Funding Opportunity), and on the TIP website at www.nist.gov/tip. Whenever TIP announces a funding opportunity, we hold public meetings to explain application procedures and funding criteria, and these meetings are broadly communicated through webcasts and related webinars. TIP selects proposals for funding based on a multi-disciplinary peer review process.

TIP has held two competitions and announced 29 awards to lead organizations in 16 states since the program's inception in 2007. However, because many of the projects that TIP funds feature collaborations between multiple companies, universities or other organizations, these 29 awards have included 69 participants across 22 states. One of those companies is Caron Engineering located in Wells, Maine. This company is a sub-recipient on a project funded as part of our 2009 manufacturing competition. This \$3.17 million project (\$1.564 million from TIP) will develop physics-based predictive modeling tools for developing machinable advanced alloys (see project description at <http://tipex.nist.gov/tippb/prjbriefs/prjbrief.cfm?ProjectNumber=090062>).

TIP has received 184 proposals from 44 states from its two competitions in civil infrastructure and manufacturing in 2008 and 2009. None were from Maine. How-

ever, TIP has received a “white paper” from Maine as part of the program’s on-going solicitation for input into potential topics for future funding.

Similarly, Maine organizations were participants in two joint ventures that received financial support under ATP. Pepin Associates of Greenville, Maine, was a participant on a joint venture funded in 1995 to develop technologies for advanced composite electric vehicles (see <http://jazz.nist.gov/atpcf/prjbriefs/prjbrief.cfm?ProjectNumber=95-11-0036>), and Brunswick Technologies of Brunswick Maine was on a 1994 joint venture engaged in research for high performance composites for large commercial structures (see <http://jazz.nist.gov/atpcf/prjbriefs/prjbrief.cfm?ProjectNumber=94-02-0033>).

Question 4. In your testimony, you noted that NIST’s Fiscal Year 2011 budget request “. . . provides \$124.8 million for the Construction of Research Facilities, including \$66.1 million in funds targeting the renovation of NIST’s facilities in Gaithersburg and Boulder, and providing a sufficient amount of funds for on-going maintenance and repair of NIST’s infrastructure.”

As Ranking Member of the Senate Committee on Small Business and Entrepreneurship, I am always concerned that, when government agencies contract construction projects to private firms, they keep in mind the government-wide statutory 23-percent small business contracting goal. The Department of Commerce and NIST have a prime opportunity to utilize this funding to help small businesses gain access to the Federal contracting arena.

Will you pledge that your agency will keep small businesses in mind when entering into contracts for construction of research facilities and renovation of NIST facilities, in furtherance of meeting the Department’s statutory contracting goals?

Answer. Yes. NIST partnered with the Montgomery County Chamber of Commerce to sponsor an Industry Day to inform small businesses of Recovery Funded opportunities. The Industry Day was attended by over 500 small businesses from the local area. Additionally, the staff conducted a separate Industry Day for the Net Zero Energy Facility construction project to inform small businesses in the housing industry on the specifics of the requirement and encourage competition. The staff has awarded all but one of the construction design projects to small businesses. The actual construction requirements are all small business set-asides with the exception of the Building One Expansion in Boulder, Colorado.

Question 5. I have heard concerns from several stakeholders about NIST’s implementation of the America COMPETES Act, specifically surrounding restrictions on matching costs for MEP centers. To clarify any issues surrounding matching costs, I, along with Senators Kohl, Reed and Collins, authored an amendment to the bill stating that, “All non-Federal costs, contributed by such entities [such as private industry, universities, and State governments] and determined by a Center as programmatically reasonable and allocable under MEP program procedures are includable as a portion of the Center’s contribution.” To my understanding, however, present MEP regulations do not accurately reflect the intent of this provision. What, specifically, has your agency done thus far to fully implement this legislation with regard to Section 3003(a) of P.L. 110–86?

Answer. As indicated in Secretary Locke’s recent letter to you and your colleagues (attached), NIST works to ensure that the partnerships established by the program’s centers further the mission of the program while meeting all applicable rules and regulations, consistent with Section 3003(a) of P.L. 110–69.

As a component of the MEP program procedures for annual renewal of center cooperative agreements, the NIST MEP program and grant management personnel routinely review MEP center operating plans to ensure that the cost share proposed by centers is allowable, reasonable and allocable to the MEP program. MEP has updated the Hollings MEP General Terms and Conditions and Operating Plan Guideline to ensure center compliance with Statute and Legislative requirements and has conducted a series of system-wide webcasts and training sessions to ensure all Centers have access to the updated information.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO
DR. ROBERT D. BRAUN

Question 1. What is your timeline for developing a research strategy that includes specific R&D priorities?

Answer. The Office of the Chief Technologist (OCT) is developing an integrated and prioritized Agency technology R&D strategy and roadmap, that includes the technology programs within the Mission Directorates and the new Space Technology Program.

An integrated set of technology area roadmaps will be developed, setting and prioritizing technology “pathways” to meet NASA’s Strategic Mission and Goals in a technology-pull manner. Once established, this Agency-level technology roadmap will be visited each year to assess performance and make mid-course corrections. In addition, these roadmaps will be fully revised every 4 years (consistent with NASA Strategic Plan updates) through a formal peer review process. The Office of the Chief Technologist will use NASA’s Strategic Goals, Outcomes and Objectives to break down NASA’s R&D needs into a set of technology areas as a way of categorizing, tracking and measuring NASA’s technology investments. A team of technology experts comprised of both NASA and external representatives—from industry, academia, and other government organizations—will develop the respective roadmaps for each technology area. Delivery of the initial draft version of these roadmaps will occur by October 1, 2010. A formal release of the first complete (externally peer reviewed) version of this planning material will occur by October 1, 2011. A detailed roadmap process timeline will be available in June 2010.

Concurrently, the NASA Office of the Chief Technologist is moving forward with planning activities associated with the three main elements of the Space Technology Program: Early-Stage Innovation; Game-Changing Technology; and, Crosscutting Capability Demonstrations. At present, an Agency-wide team, including civil-servants from each NASA Center, is in place developing detailed plans for these three major program elements and an Agency partnership development and strategic integration function. By June 2010, the Office of the Chief Technologist will produce draft technology program/project plans, technology focus areas, and procurement strategies and schedules for this technology-push program. These efforts will be coordinated with the needs of other government agencies and the aerospace industry. NASA will keep the Congress informed of our progress. Pending Congressional approval, it is our goal to have all the necessary plans in place so that we will be poised to effectively manage and implement the Space Technology Program beginning on October 1, 2010.

Question 2. How do you plan to coordinate NASA’s R&D efforts across the different mission directorates and NASA centers, especially aeronautics?

Answer. NASA is in the process of establishing two key elements of our program governance model to manage and integrate our technology investments across Programs, Mission Directorates, and Centers. The Office of the Chief Technologist is charged with providing strategic coordination, integration and communication of the Agency’s technology investments. This responsibility requires knowledge of all Agency technology programs, as well as execution of a strategic planning process among these programs and their sponsoring organizations. The NASA Technology Executive Council (NTEC), organized and chaired by the NASA Office of the Chief Technologist is the key portfolio management and decision-making body through which these R&D efforts will be coordinated. NTEC membership will include the Mission Directorate Associate Administrators and the NASA Chief Engineer. Agency-level technology integration, coordination, strategic planning, and prioritization of both aeronautics and space efforts will be performed by the NTEC through regularly held assessment and decision meetings.

Additionally, the Office of the Chief Technologist is forming a Center Technology Council (CTC), chaired by the NASA Office of the Chief Technologist with membership that includes the Center Chief Technologist (CCT) from each NASA Center and JPL. This Council will assess the Agency technology road-mapping and technology prioritization activities from a bottoms-up perspective, and provide these assessments to NTEC.

Question 3. In your testimony, you state that an internal study team found that NASA needs to improve its coordination with industry, academia, and other government agencies. How do you plan to improve this cooperation?

Answer. NASA will seek input from industry, academia, and other government agencies as we move forward with the Agency’s roadmapping activities as well as the program planning and development of the Space Technology Program. Subject matter experts from NASA, industry, academia and other government agencies will comprise the teams assigned to develop the cross-Agency technology area roadmaps.

NASA will also vet the technology roadmaps with both internal and external review teams. NASA Office of the Chief Technologist personnel and the NASA Technology Executive Council will serve as the internal review team. The Office of the Chief Technologist will coordinate with external entities including the National Academies and other government agencies to form an external review team. NASA has a long history of working with the National Academies in various space science, Earth science, and aeronautics decadal surveys and reviews and greatly values the Academies input.

Additionally, a key element of the Office of the Chief Technologist organization is Partnerships, Innovation and Commercialization. This functional element has the specific responsibility of increasing NASA collaboration with industry, academia, and other government agencies. NASA is re-establishing a program akin to the NASA Institute for Advanced Concepts to engage innovators within and external to the Agency in accordance with the recommendations of the NRC's *Fostering Visions of the Future* report. Unlike previous NASA Technology Programs, the three elements under the OCT Space Technology Program will issue open calls for technology development and demonstration activities that encourage partnerships between industry, academia and other government agencies. These open calls represent a significant fraction (greater than 70 percent) of the Space Technology Program funding.

Collaboration is also a matter of organizational culture. Based on input received from the newly formed NASA Advisory Council Committee on Technology and Innovation, the NASA Office of the Chief Technologist is planning a wide range of activities to improve the collaboration culture of the NASA Centers. This includes increasing our on-going external outreach activities including workshops, conferences, forums, advisory committee meetings, and symposia as key methods of coordinating and communicating with our external key technology customers and stakeholders as well as making use of Intergovernmental Personnel Agreements and other mechanisms for short-term personnel developmental assignments with other government agencies, academia, and industry.

Question 4. As NASA increases its reliance on the private sector for R&D, how will you guarantee that this money is being spent wisely?

Answer. NASA intends to ensure wise use of Space Technology R&D funds through the utilization of far-reaching technology goals, milestones, and the use of open competition. The three elements under the OCT Space Technology program will issue open calls for technology development and demonstration activities that encourage partnerships between industry, academia and other government agencies. These open calls represent a significant fraction greater than 70 percent) of the Space Technology program funding.

The new Space Technology program will incorporate many of the positive tenants of an ARPA/DARPA type organization in its planning, procurement and program execution strategies. The Space Technology program will increase its support for research in advanced space systems concepts and game-changing technologies, enabling new approaches to our current mission set and allowing the pursuit of entirely new missions. Using an array of management, funding, and partnership mechanisms—some similar to those utilized by DARPA—this program will engage the brightest minds in private industry, across the NASA Centers, and throughout academia.

Specifically, the Space Technology program's Game Changing Development element will use an ARPA/DARPA-like "end-game" approach. Research teams will be provided a list of challenge goals with top-level requirements for the desired capability. Under the direction of a Project Manager (PM) who is a technical expert in the subject area, multiple teams (performers) will compete to define solution approaches using advance technology to enable new capabilities that reduce cost and improve performance of space systems. Multiple solution approaches foster innovative, high payoff, high impact advances. The PM will be held accountable for ensuring that discoveries will move rapidly from laboratory to application. However, if certain research areas do not produce desired results or meet planned milestones; the Project Manager will have the authority to terminate the research effort.

Question 5. Since SBIR will now be under your programmatic responsibility, what specific changes will you implement to make sure that we can minimize fraud?

Answer. NASA SBIR is well integrated with the NASA Mission Directorates Strategic Goals, Outcomes and Objectives. The NASA SBIR Program develops its targeted topics and subtopics based on Mission Directorate objectives, under their oversight, and in collaboration with Mission Directorate personnel. NASA ensures quality and investment value through careful evaluation of all responsive proposals to SBIR/STTR Phase I and Phase II solicitations for technical and commercial merit, feasibility, and relevance to NASA research.

The NASA SBIR program also seeks to promote technologies that allow small businesses to contribute to the commercial aerospace market place. In a recent assessment conducted by the National Research Council (NRC),¹ the NASA SBIR program was found to provide substantial, frequently decisive, support for small businesses. Sixty-eight percent of NASA SBIR Phase II award recipients stated that

¹ See *An Assessment of the SBIR Program at the National Aeronautics and Space Administration*, National Academies Press, Washington, D.C., 2009, p. 7.

they definitely or probably would not have undertaken the funded research project without SBIR funding. The NRC study also showed that the SBIR program measurably stimulates collaboration, technological innovation and generates new knowledge. Approximately one quarter of NASA SBIR projects responding to their data collection survey reported filing at least one patent. NASA believes that SBIR provides a significant contribution through the private sector, supporting the kinds of knowledge and intellectual property necessary to generate innovation and economic growth.

Integration of the SBIR/STTR program within NASA's Office of the Chief Technologist brings this program within the central organization responsible for technology development in the Agency. This integration will increase opportunities for coordination and collaboration of SBIR/STTR awards with NASA's other R&D program investments and provide a central entry point for external innovators seeking opportunities for technology infusion in NASA's future missions.

NASA shares the Committees concern in ensuring that all of its programs, including the SBIR program, are free from waste, fraud, and abuse. We are committed to taking all necessary steps to improve the SBIR program in this regard. In December 2009, the NASA HQ Senior Assessment Team and its Internal Controls Office completed an internal assessment of the NASA SBIR program and a review of the programs internal controls, with a focus on waste, fraud and abuse. Since this assessment and review, the SBIR program and other offices having responsibility for program administration have implemented a number of supporting corrective actions. Some of these specific changes have already been implemented and others are in process.

Specific implemented changes are as follows:

- Augmentation of Procurement Office and Contracting Officers Technical Representative (COTR) training to include specific SBIR waste, fraud and abuse modules covering proposal evaluation and review responsibilities through contract surveillance.
- Additional Agency specific training requirements under the NASA Acquisition Integrity Program Office focused on waste, fraud and abuse detection and prevention.
- Increase waste, fraud and abuse general awareness across the SBIR/STTR programs.
- Bottoms-up review of annual SBIR solicitation instructions to ensure clarity in both technical and costing data requirements for proposal submittals.
- Greater past performance validation and checks, including:
 - Utilization of additional reference and bank checks.
 - Implementation of improved technical evaluation forms and checklists to facilitate source selection and cost/price analysis.
- Increase annual firm re-certification to quarterly submittals.
- Increased use of contract audit support such as DCAA/DCMA rate analysis capabilities.

Specific planned changes are as follows:

- Increased workforce resources to provide better coordination and oversight at NASA Centers, with the addition of program administrative capability at every Center.
 - Increase oversight of COTR roles and activities at each Center.
 - Ensure compliance of SBIR/STTR COTR certification requirements.
 - Management of implementing center "Virtual Site" visits.
 - Guidance on Surveillance Plans and understanding of monitoring roles over contractor performance.
- Clear communication of the importance of the SBIR/STTR program to the Agency's R&D efforts by the NASA Office of the Chief Technologist.
- Personnel and organizational changes as part of the transition of the SBIR/STTR program to the Office of Chief Technologist to provide better oversight and senior management of this key Agency program.
- Enhance SBIR/STTR Electronic Tool Enhancements to help identify similar proposal submissions.
 - Use software, which can electronically compare key words and correlate phrases between technical proposals.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. TOM UDALL TO
DR. ROBERT D. BRAUN

Question. Dr. Braun, you mention the success of NASA's Experimental Program to Stimulate Research (EPSCOR) program. EPSCOR has been critical to academic research and development at New Mexico State University. This is an important initiative for states with modest research infrastructure, and I believe NMSU has made the most of its EPSCOR funding. However, it now seems that NMSU is a victim of its own success. After successfully competing for EPSCOR funding in previous years, NMSU is no longer eligible to apply for another year. Should EPSCOR eligibility rules be changed to allow successful universities to continue to compete for NASA research funding?

Answer. Through EPSCoR, NASA strives to develop academic research enterprises that are long-term, self-sustaining, and nationally competitive. By supporting states with modest research infrastructure, these EPSCoR-designated states are able to become more competitive in attracting research funding. Funding is awarded to lead academic institutions in 28 eligible states (designated by the National Science Foundation each year) to advance scientific and engineering research capabilities in areas of strategic importance to the NASA mission.

New Mexico is an EPSCoR-eligible state and currently has four active NASA EPSCoR Research Awards and one EPSCoR Research Infrastructure Development (RID) award. As in previous NASA EPSCoR Research competitions, the number of active awards within an individual state was a key consideration in the determination of states permitted to propose to the cooperative agreement notice for FY 2010 Research Awards. The current policy regarding award eligibility is designed to afford each EPSCoR jurisdiction a fair opportunity to compete for awards, consistent with the EPSCoR goal of supporting states with the greatest science, technology, engineering and math research infrastructure needs.

In recent years, New Mexico has been among a select few EPSCoR states that have been highly successful in competing for NASA EPSCoR Research Awards. As New Mexico has won a total of three Research Awards in the last two competitions (one in 2008 and two in 2009), the state was not permitted to propose to the FY 2010 Research Award solicitation. In addition to New Mexico, four other states have won at least three Research Awards in the last two competitions and were not permitted to propose to the FY 2010 solicitation. Although not permitted to propose to the Research Award solicitation, New Mexico has been invited to submit a proposal for a two-year continuation of their RID award in FY 2010.

The geographic distribution of EPSCoR awards has always been an important aspect of the program. The success of New Mexico in the NASA EPSCoR Research Program is an indicator of the growing capabilities of the New Mexico institutions and their potential ability to successfully compete for awards outside the NASA EPSCoR Program. In upcoming research opportunities, we expect to continue to receive high-quality research proposals from New Mexico.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK WARNER TO
DR. ROBERT D. BRAUN

Question 1. The United States is one of the few countries without a national competitiveness strategy. The UK, South Korea, the Netherlands, Ireland, and Denmark have all created their own strategies while the most recent comparable U.S. assessment was in 1978. If Congress authorizes a new national competitiveness strategy, what are the top two or three issues you think we should include? Please be specific.

To what extent are you aware of competitiveness strategies in other countries? Do you think we could use other approaches as a starting point or should we be focusing on other issues? Which ones? Which competitiveness strategies and which competitors should we be most influenced by as we develop our own strategy? How should the U.S. measure itself against these other strategies?

Answer. Our Nation's economic competitiveness and high standard of living are based on decades of investment in innovation. A focus on innovation and technology is required both to enable new approaches to NASA's current missions and allow the Agency to pursue entirely new missions. This investment also will allow NASA to participate in the development of technological solutions addressing broader national needs in energy, weather and climate, Earth science, health and wellness, and national security. The President's FY 2011 budget request for NASA is well aligned with America COMPETES Act (P.L. 110-69)—innovative, high-risk, high-return research to improve America's economic competitiveness. NASA's FY 11 budget request provides a renewed emphasis on research and development, clearly recognizing the importance of R&D as a longstanding and important catalyst for innova-

tion and economic expansion in our Nation. Innovative research and technology, tied to exciting missions with national importance, is also a strong motivator for students to pursue Science, Technology, Engineering and Mathematics (STEM) disciplines, and a strong attraction for new hires.

Clearly, an economic competitiveness strategy is important for maintaining our standard of living and our economic prosperity. In my view, the three most important elements of a comprehensive strategy are: (1) a highly educated citizenry, especially in the area of science, technology, engineering, and mathematics (STEM); (2) a sustained national commitment to innovation, research and technology; and, (3) a government which fosters and stimulates innovation in the commercial market place, and collaborates closely with industry and academia. In September 2009, the Obama Administration released *A Strategy for American Innovation: Driving Toward Sustainable Growth and Quality Jobs*. It serves as a competitiveness strategy for the Administration. NASA is part of this strategy's larger national research and development effort in science, technology, and innovation that will lead to new products and services, new business and industries, and high-quality, sustainable jobs. These research and technology investments by both the public and private sector will reap significant future benefits—whether it is in the areas of information systems, biomedical, nanotechnology, space, energy or the environment. Our Nation has made great progress throughout its history by innovating solutions to the enormously difficult challenges it has encountered. The grand challenges of building an intercontinental railway, and landing a man on the Moon and returning him safely to the Earth, not only motivated a technological workforce, but also created new technologies and innovations along the way. These achievements inspired generations to pursue challenging goals, created new industries, and ultimately improved our country and the world.

Numerous studies over the past twenty years, including the President's *Strategy for American Innovation*, have highlighted the difficult challenges and issues facing our educational system. The educational achievement of America's next generation is an issue that reaches our Nation at all levels. An educated, highly skilled workforce in the area of STEM is critical to our future economic competitiveness. While NASA investments alone will not solve our Nation's major educational challenges, the Agency has proven to have a unique ability to attract and motivate many of the country's best young minds into educational programs and careers in science, technology, engineering and mathematics. NASA will continue to partner with Federal, industry, state and local organizations and invest our resources toward a shared vision to secure those jobs critical to the 21st century workforce. This means not only inspiring the next generation and improving scientific literacy, but also providing educators with unique resources to aid in achieving national educational excellence in STEM.

Since comparisons of national economic competitiveness strategies are not within our areas of expertise, NASA defers to a more appropriate organization such as the Department of Commerce or the Office of Science and Technology Policy to answer the final two parts of Senator Warner's question.

Question 2. The America COMPETES act has been largely successful, but it seems to assume commercialization of new technology will just happen, assuming we do the right research and come up with good ideas. We need more than that for long-term success and innovation.

One possibility is to create a new Federal initiative, in partnership with universities, to create a system of university-based support for entrepreneurs and tech transfer. Rather than just funding programs like STTR, which provide funding to specific companies, the Federal Government could fund incubation centers within the university communities. What do you think about this concept? Could this type of program help spur commercialization? Are there other ideas that should be considered such as public-private partnerships or other concepts? If so, what should they look like?

Answer. There is considerable evidence that the Nation's major research universities are not only hubs of innovation, but also focal points for commercialization. As such, it is my opinion that the concept of incubation centers within university communities is an excellent idea, provided that the universities have strong research programs in science and engineering. In addition to providing basic necessities such as office space and office equipment and legal counsel at low cost, incubation centers provide valuable services such as linkages to potential sources of capital business development counsel. Incubation centers would encourage and help enable entrepreneurial-minded research faculty, as well as expand the training ground and research opportunities for graduate students, all of which should serve to spur commercial application of technology.

Regarding public-private partnerships, NASA's Innovative Partnerships Program encourages and facilitates partnerships between NASA and the U.S. private sector and other external entities for technology development and maturation of technology of both NASA mission relevance and commercial interest. The program has produced several technologies that have been infused into NASA's missions or been commercially applied. As a result of this experience, NASA is a believer in the concept of public-private partnerships to produce technologies for application in both the public and private sectors. In this proven model, both sides contribute significant resources to the collaboration. Technologies produced under such partnerships, as well as those created and licensed by NASA, are already mitigating global problems confronting mankind such as providing assistance in developing countries, environmental cleanup, disaster warning and relief, threat detection, and other applications contributing to public safety. NASA is interested in furthering these successful programs through additional collaborations and the addition of other approaches including partnerships with not-for-profit venture capital organizations.

Question 3. Should there be more focus on clean energy technology, as part of a COMPETES reauthorization? Do you have ideas in terms of other initiatives Congress could create or existing programs we could improve?

Answer. NASA technology investments are of benefit to more than the Agency's missions and the aerospace industry. The Space Technology Program fosters innovative solutions to improve America's ability to conduct space science and exploration. NASA technology investments in electric energy, used to power spacecraft systems and to propel vehicles through space can also spur advances in power generation, storage, and management. NASA will sponsor innovative new technologies and fundamental physics and materials developments to improve electric power generation and storage for application to future space missions. Solar and thermal processes used to create energy for NASA spacecraft and novel energetic materials may also be used for energy storage and transmission on the Earth. In addition, NASA's space technology investments include wireless beaming of electrical energy using electromagnetic waves or lasers over long distances.

As an example, in 2000, NASA and the University of Arizona developed the Mars Oxygen Generator, a two-pound experiment designed to generate oxygen for life support and fuel production on Mars. The device used solid oxide electrolysis cells to convert carbon dioxide and water into oxygen and fuel. When operated in reverse as a fuel cell, this device has been shown to produce clean, reliable electricity here on Earth. Development and commercialization of this technology as a NASA spin-off by Bloom Energy, which is now largely supported by the private sector, is moving beyond the early demonstration phase, with the goal of generating electricity at prices lower than traditional methods while producing half the amount of greenhouse gases. These clean energy systems will advance the Nation's ability to meet future power demand.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. KAY BAILEY HUTCHISON TO
DR. ROBERT D. BRAUN

Question. The FY 2011 Budget Request includes a 14 percent increase over the FY 2010 request for education. It appears, based on the proposed program allocations for those funds as described in your prepared statement, that NASA is beginning to step up to the plate more fully as a participant in the STEM education activities and in competitiveness and innovation enhancement activities, as directed in the America COMPETES Act. However, the entire education budget could be a rounding error when compared to the much larger research and development activities proposed in the FY 2011 Budget Request. What steps will you take to ensure that there is a tie-in to the broader research and technology development activities you expect to undertake and the STEM education initiatives that NASA has such great potential to provide value to?

Answer. NASA's new direction is well aligned with America COMPETES—innovative, high-risk, high-return research to improve America's economic competitiveness. As a research and development (R&D) agency, NASA plays a vital role in America's innovation engine and, as such, its future economic prosperity and security. The President's FY 2011 budget request for NASA provides a renewed emphasis on research and development, which clearly recognizes the Agency as a longstanding and important catalyst for innovation and economic expansion in our Nation. Innovative research and technology, tied to exciting missions of national importance, is a strong motivator for students to pursue Science, Technology, Engineering and Mathematics (STEM) disciplines, and a strong attraction for new hires.

NASA recognizes the important role that STEM education plays in developing the diverse scientific and technological workforce required to advance this Nation's economic leadership. The NASA Office of Education administers nationwide education efforts that draw on content from across the Agency in pursuit of its three primary education goals: (1) Strengthen NASA's and the Nation's future workforce; (2) Attract and retain students in STEM disciplines; and (3) Engage Americans in NASA's mission. NASA leverages its unique program content, people, and facilities to spark interest, capture imaginations, and guide students toward careers in STEM fields while increasing their scientific and technological literacy to the benefit of the Nation. While NASA investments alone will not solve these major challenges, the Agency has proven to have a unique ability to attract and motivate many of the country's best young minds to pursue educational programs and careers in science, technology, engineering and mathematics.

Office of Education (OE) programs like the Experimental Program to Simulate Competitive Research (EPSCoR) and University Research Centers (URC) exist to build university R&D infrastructure and competitiveness at universities in states and regions that are underrepresented in Federal R&D competition. The OE works collaboratively with the R&D organizations in NASA to plan and execute these programs. When offering a competitive Announcement of Opportunity (AO), Cooperative Agreement Notice (CAN), or other solicitation, the OE works with the Mission Directorates to identify R&D priorities. It is toward these priorities and anticipated outcomes that the Mission Directorates and OE work cooperatively to select award recipients. In the course of performing these multi-year awards, university-based R&D professionals actively engage with scientists and engineers from NASA and industry so that both the individual and the institution develop capability and proficiency in advanced technology development and competitive opportunities. URC institutions benefit from the guidance of a Technical Review Committee (composed of NASA scientists/engineers) that meets regularly to discuss the progress of the work, provide problem-solving guidance, and identify possible growth opportunities. Each URC also has an Advisory Committee whose membership includes industry and collaborating university representatives. NASA Technical Monitors (TM) review the progress and outcomes of OE-funded R&D work and provide results and findings to the appropriate organizations within NASA's programs.

Both the URC and the NASA Science and Technology Institute for Minority Institutions (NSTI-MI) projects require the faculty involved in the institutional research to work with NASA scientists and engineers. For example, the Research Clusters under the NSTI-MI project collaborate directly with NASA scientists and engineers on current NASA projects. NSTI's Information and Emerging Technologies Cluster (composed of five minority institutions) worked with the engineers at the Ames Research Center to develop a new method of monitoring live streaming traffic instead of storing the incoming data in the memory before processing.

Within the Office of the Chief Technologist, an important aspect of the Space Technology Research Grants program is a new graduate fellowship program. This program focuses on competitive selection of U.S. citizen graduate student research that shows significant promise for future application to NASA missions. This effort will train the next generation of aerospace engineers and scientists by funding NASA-related graduate student research performed on campus during the academic year, as well as research performed at NASA Centers during the summer months. Each student in this project will be matched to a NASA researcher who will serve as the student's NASA advisor. Through this experience, students will advance their STEM education, gain NASA experience, and learn the research and development process. NASA plans to highlight this student research through a number of symposia, conferences, and mission-related events over the course of the student's academic career. In addition, by bringing students to the NASA Centers for considerable periods of time and matching their research interests with those of a NASA advisor, the Agency intends to rebuild the pipeline of new STEM talent needed for NASA's future missions. In FY11, \$30M within the Space Technology Program is planned for this new program.

NASA is committed to integrating and expanding STEM activities in the Agency's research and technology efforts. Working in collaboration with the NASA Office of Education, NASA's Office of the Chief Technologist will serve as a central tie-in between NASA's broader research and technology development activities and our STEM education initiatives.