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COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS FOR 2012

HEARINGS

BEFORE A

SUBCOMMITTEE OF THE

COMMITTEE ON APPROPRIATIONS

HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

SUBCOMMITTEE ON COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES

FRANK R. WOLF, Virginia, *Chairman*

JOHN ABNEY CULBERSON, Texas
ROBERT B. ADERHOLT, Alabama
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JOSÉ E. SERRANO, New York

NOTE: Under Committee Rules, Mr. Rogers, as Chairman of the Full Committee, and Mr. Dicks, as Ranking Minority Member of the Full Committee, are authorized to sit as Members of all Subcommittees.

MIKE RINGLER, STEPHANIE MYERS, LESLIE ALBRIGHT, DIANA SIMPSON, and COLIN SAMPLES,
Subcommittee Staff

PART 8

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Printed for the use of the Committee on Appropriations

PART 8—COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS FOR 2012

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COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS FOR 2012

THURSDAY, MARCH 3, 2011.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

WITNESS

CHARLES F. BOLDEN, JR., ADMINISTRATOR

CHAIRMAN WOLF'S OPENING REMARKS

Mr. WOLF. Good morning. The hearing will come to order and the record will be open.

We want to welcome everyone to today's hearing on the fiscal year 2012 budget request of the National Aeronautics and Space Administration.

Our witness today is Major General Charles Bolden, the Administrator of NASA.

We thank you for being here.

Last night looking through all the material for the hearing, I reread your bio, and I just want to say I appreciate your distinguished service to the country. I notice your son is a Marine Corps aviator, and I want to thank you and thank him for the service. Thank you very much.

Last year at this time, we were in the early stages of what turned out to be a very lengthy and contentious debate about the future direction of NASA's human spaceflight program. I think everyone was hoping that the enactment of the NASA authorization bill would put an end to the programmatic uncertainty and conclude the debate, but that really has not been the case.

Instead the debate has shifted to whether NASA can effectively implement the direction provided by the authorization, and that places the budget squarely in the middle of the discussion. No amount of authorizing language can hold NASA to a particular goal or commitment if that language is not backed up by a budget that adequately funds those obligations.

But fully funding everything that was authorized is not a feasible possibility in the current fiscal environment. We saw that on the CR the other day on the Weiner amendment, which cut from this committee I think it was 300 and some million dollars, whatever the exact number.

And so when you look at those circumstances, you really cannot have everything.

Instead, NASA will be forced to look across its programs and make some very hard choices. You have done that to some extent with your fiscal year 2012 request, which holds the NASA agency-wide total to its fiscal year 2010 level, more than $700 million below the authorized amount. In order to work within that total, you have chosen to fund some programs significantly below previously projected levels.

Congress has asked a lot of NASA and we need to seriously consider whether we can afford to simultaneously maintain our human exploration program, support the extension of the Space Station, continue with planned science missions, advance commercial spaceflight, and engage in NASA's many other activities.

My disagreement with NASA comes in the decision making about what budgetary tradeoffs are necessary to make. Your request has chosen to sacrifice progress on the development of the Space Launch System and the Multi–Purpose Crew Vehicle. The levels in your budget for these activities virtually guarantee that NASA will not have core launch and crew capabilities in place by 2016.

Our failure to meet that goal will further erode our international standing in human spaceflight, which I think is beginning to take place, eventually ceding our prominency to places like Russia, China, India, or others. That is just not an outcome that I think is really good for the country.

I know these are complicated issues and we can spend a lot of time on them.

And this, Mr. Bolden, is really not directed toward you. I think until this Administration, and the President step forward and deal with the fundamental important issues in the entitlements, whatever concerns will be expressed by you or anyone in the audience or anyone in the country about these budget cuts cannot really be solved.

We are fundamentally trying to balance the budget on 15 to 17 percent of the pie, maybe even less. The President put forward the Bowles-Simpson or Simpson-Bowles, whoever you want to put first, Commission. It had the support of Tom Coburn, who I have a great respect for and even more respect for after he voted for it, and Dick Durbin, who used to serve on this committee and who I have worked with over the years.

Nobody will ever remember except Dick Durbin, because I remind him periodically, but I was the deciding vote on eliminating smoking on airplanes. And I remember my side and the tobacco industry went after me. Virginia was a big tobacco state. And so to Senator Durbin's credit, he also supported the Bowles-Simpson Commission.

There was an editorial in the *Washington Post* yesterday by Ruth Marcus, who I read constantly, saying "Where's Waldo", meaning the President. We are waiting for the President to come forward. Leadership is doing what President Reagan did on the Social Security issue, or what President Clinton did coming forward to deal with the fundamental entitlement issues.

There is a Simon and Garfunkel song called "The Boxer" that says, "man hears what he wants to hear and disregards the rest." We cannot disregard this. Groups come in to see me and say, "Mr. Wolf, you are cutting this." But I voted for the package that came

out because we have to begin somewhere. We have got to deal with the entitlements.

I appreciate your service to the county. I was very impressed when I actually read your bio. You never mentioned those things to me, and I just wanted to be totally prepared.

The way to deal with this problem is to come together in a bipartisan way and link arms the way that Senators Durbin and Coburn and Chambliss and Mark Warner are doing. If we do not deal with the overall entitlement issue, and I speak now as a grandfather of 15 and father of five kids, fundamentally this Nation will begin to reach a tipping point.

People are going to be concerned that we are cutting this, we are cutting that. But until we deal with the fundamental reality of the entitlements, we will never be able to resolve this issue.

So you might tell the President, I do not even think he even knows who I am, but Mr. Wolf said, "if you do not deal with these entitlement issues, no one can complain about the budget cuts on any area unless they then come forward and say what they are prepared to do."

I have said I am prepared to step forward and support the Bowles-Simpson Commission, although there are things in there that I do not like and I would attempt to change. But coming up for a vote up or down, I would be there with those who want to save this country by dealing with this fundamental issue.

I will go to Mr. Fattah.

RANKING MEMBER FATTAH'S OPENING REMARKS

Mr. FATTAH. And let me thank the Chairman and thank him for his leadership and for this hearing, and welcome the Administrator.

Later on this evening, the President is going to reach out by phone and speak to the crew of the Discovery and congratulate you and the staff at NASA for such a great achievement given Discovery's last mission.

You know, the chairman has made some very courageous votes over his life here in the Congress and that is just one that he mentioned about ending smoking on airplanes. And I think that the President's decision to proceed with a Debt Commission was a courageous one. The report is one that I feel very favorably about, that if we could get it to a vote and, yes, you could tinker around the edges, but that we as a country do need to come to grips with this.

The other thing is that the public has to come to grips with something, which is that we have to make investments and we have to make sacrifices. When NASA was created, the country was not doing as well as we are doing today, but we have made sacrifices for space exploration and NASA has been a beacon of hope for the country and has created a lot of aspirations among our young people in terms of math and science. And I think that we have to make sacrifices.

In fact, when you look at whether the President's commission or whether you look at the majority CR, neither one of them cut NASA as much as the public would cut NASA if given a chance. And I think that those of us in a leadership position have to say that the public is wrong. That is to say that we as a country have

to invest, and we invest in technology. And NASA can be and should be always the leading technology entity in the world.

I want to tell you that in terms of the budget request, I am very happy to see that in Exploration, there is a significant increase. Your leadership of the agency in a whole host of areas has made a tremendous difference.

And your bio is quite impressive. Your work at NASA is quite impressive, and the breakdown of the budget request in which we have the lion's share of the dollars in human spaceflight because I think that is the thing that excites the country.

Obviously there is much more work that you do, and people in the Gulf Coast benefitted during the BP spill because of the work of NASA in being able to track where this oil was going. There are lives that probably were saved in Haiti because of the work in terms of what you do in terms of science. So there are a lot of great things that we can be proud of.

I think those of us in the Congress have to speak forcefully on the need for our country to continue to invest in science. We, as the world's only superpower, have to invest in this area, plus we have others who want to join us in this ranking in terms of superpower who are making significant investments. And we cannot afford to be caught short. A lot of benefits here on earth have been created through the work of NASA in all range of activities, medical, science, and also in industrial activities.

And so I am happy to have you. I look forward to your testimony. And I think that on a bipartisan basis, that you have both in the Chairman and myself and other Members of the committee a lot of support for the work that NASA is doing now and will do in the future.

And the Administration has put forth a very aggressive program in terms of aiming our sights outside of Earth's orbit in terms of human flight. And I think it is a challenging mission, but I think that is what we should be doing. We should be challenging ourselves to develop the technology to move in even greater ways than we have to date.

So thank you, and welcome.

General BOLDEN. Thank you very much.

Mr. WOLF. Thank you, Mr. Fattah.

Administator Bolden, your full statement will appear in the record, but you can proceed as you see appropriate.

ADMINISTRATOR BOLDEN'S OPENING STATEMENT

General BOLDEN. Thank you very much, Mr. Chairman——

Chairman Wolf and Ranking Member Fattah and other Members of the committee. Let me, first of all, to the Chairman and Ranking Member, let me congratulate both of you on your new leadership roles, and I want to thank you both for all that you do as well as all the Members of the committee for the long-standing support that all of you have given to NASA.

As is obvious from both of your opening statements, we have a common passion for space exploration and the benefits it brings our Nation. As you take on new responsibilities, I look forward to our continuing work together in the same collegial fashion as we have done in the past.

I would like to take just a moment to note the absence in the House in general of one of your colleagues, Congresswoman Gabrielle Giffords, who continues to undergo rehabilitation in Houston following the assassination attempt on her life. Not a day goes by that I personally do not think about and pray for Gabby. All of us in the NASA family continue to pray for her speedy and full recovery.

Today it is my privilege to discuss the President's fiscal year 2012 budget request of $18.7 billion for NASA. Despite the President's commitment to fiscal constraint, I am pleased that we are proposing to hold funding at a level appropriated for 2010 which, of course, continues to be our spending level under the Continuing Resolution.

This budget request continues the agency's focus on a reinvigorated path of innovation and technological discovery leading to an array of challenging destinations and missions that engage the public.

Mr. Chairman, you and other Members of the Committee—Subcommittee should have a package of six charts that looks like this. I hope you do because I will be referring to them periodically. So, if there is anybody who does not and would like to get one, I think we may—it just does not have that cover on it. And the cover is not important at all anyway, so I will hold them up as we get there.

The Authorization Act of 2010 gave NASA a clear direction. We are moving forward to implement the details of that act with this fiscal year 2012 budget. The President's budget for NASA funds all major elements of the Act while supporting a diverse portfolio of key programs.

Because these are tough fiscal times, we also had to make some difficult choices. Reductions were necessary in some areas, so we can invest in the future while living within our means.

This budget maintains a strong commitment to human spaceflight and the development of new technologies. It invests in the excellent science, aeronautics research, and education programs that will help us win the future. It carries over programs of innovation to support long-term job growth and a dynamic economy that will help us out-innovate, out-educate, and out-build all others in the world.

Along with our budget proposal last week, we published our 2011 Strategic Plan, and hopefully, that has been made available to everyone. If not, we can get you that.

NASA's core mission remains unchanged. It is the same as it was at our inception in 1958, and this mission supports our vision that is in the Strategic Plan, which essentially says to reach for new heights and reveal the unknown, so that what we do and learn will benefit all humankind.

Just this past week, we launched STS–133 on the Shuttle Discovery, one of the final three Shuttle flights to the ISS. Along with supplies that will support the Station's scientific research and technology demonstrations, Discovery is delivering a robotic crew member, Robonaut 2 or R2.

The Glory Earth Science Mission will launch from California this week, tomorrow morning as a matter of fact, on a mission to help

us better understand Earth and its atmosphere and the variables affecting our climate.

Our Space Program continues to venture in ways that will have long-term benefits and there are many more milestones in the very near term.

Yesterday, in fact, it was the day before yesterday, we announced three new program offices to carry out future work. NASA brings good jobs and bolsters the economy in communities across the Nation.

I do not think you have the overall budget chart, so I am going to skip that. You know what it is because it was presented to everyone when I rolled it out, but it breaks down the $18.7 billion, but it provides the scope of our activity in the year 2012.

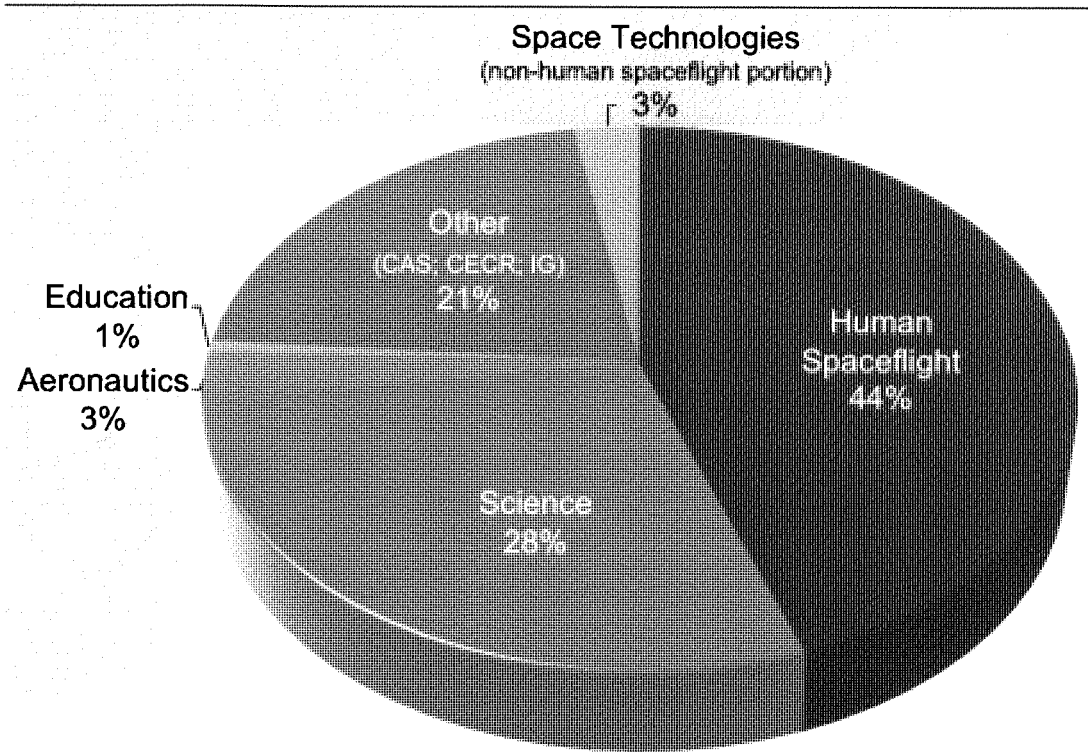
Our priorities in human spaceflight in the fiscal year 2012 budget request are to maintain safe access for American astronauts to low Earth orbit as we fully utilize the International Space Station; to facilitate safe, reliable, and cost-effective U.S.-provided commercial access to low Earth orbit for American astronauts and their supplies as soon as possible; to begin to lay the groundwork for expanding human presence into deep space, the Moon, asteroids, and eventually Mars through the development of a powerful evolvable heavy-lift rocket and multipurpose crew capsule; and to pursue technology development to carry humans farther into the solar system.

These initiatives will enable NASA to retain its position as a leader in space exploration for generations to come. At the same time in our other endeavors, our priorities are to extend our reach with robots and scientific observatories, to learn more about our home planet and the solar system, and to peer beyond it to the origins of the universe; pursue groundbreaking research in the next generation of aviation technologies; and carry out dynamic education programs that help develop the next generation of science, technology, engineering, and mathematics professionals. That's a lot, but NASA thrives on doing big things. We have vastly increased human knowledge and our discoveries and technologies have improved life here on Earth.

There has been some concern that NASA is abandoning human spaceflight. This simply is not true. I think you all do have a copy of our charts that look like this but show you a pie.

[The information follows:]

NASA Budget

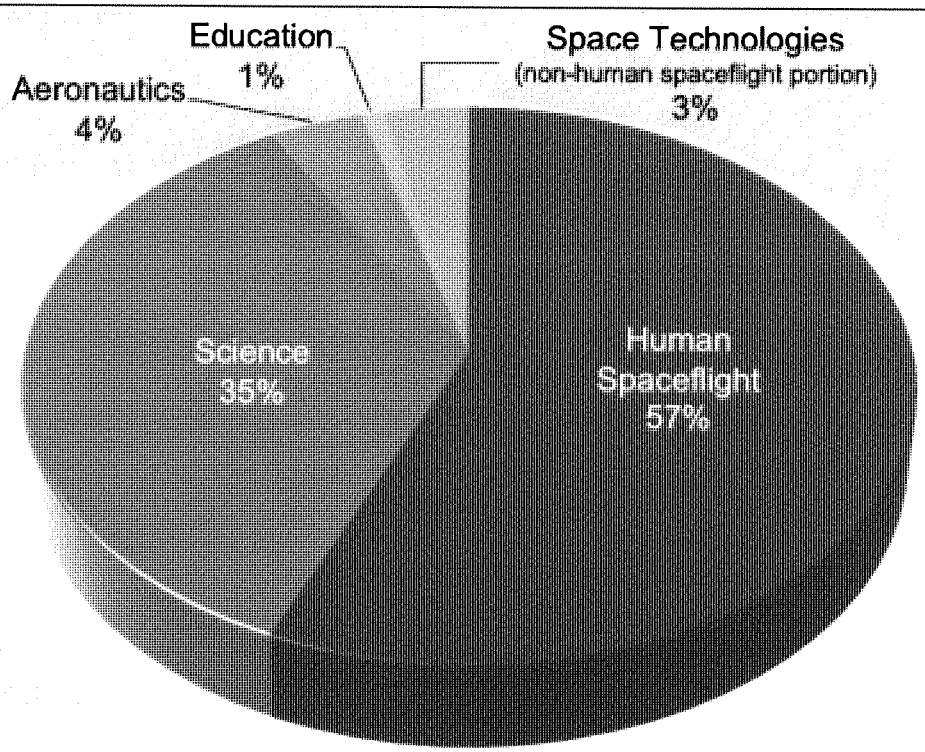

Space Technologies
(non-human spaceflight portion)
3%
Other
(CAS; CECR; IG)
21%
Education
1%
Aeronautics
3%
Human
Spaceflight
44%
Science
28%

General BOLDEN. The reason I give you these few charts is that it will show you that contrary to what is conventional wisdom, human spaceflight in this budget constitutes a significant portion. It is 44 percent of NASA's proposed budget.

If you take the chunk out that deals with what it costs me to operate NASA's centers and do other things, human spaceflight represents an even larger piece, and it is actually 57 percent of NASA's budget. So I would say that I would not call that shrinking away from human spaceflight when over 50 percent of the budget is going to human spaceflight.

[The information follows:]

NASA Programmatic Budget

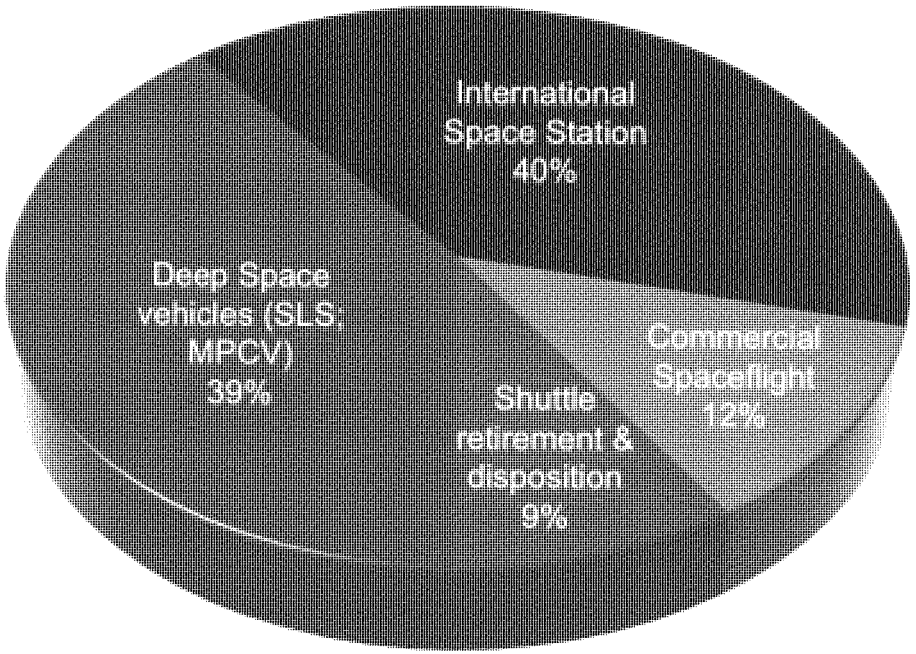


General BOLDEN. The final chart that I hope you all have is one that just takes human spaceflight, and it breaks it down into where that money is being spent. We devote some resources to closing out the Space Shuttle as you will see in this very small chunk. As the centerpiece of human spaceflight and the critical anchor for our future deep space exploration, the International Space Station actually gets the largest portion of funds at about 40 percent. The next generation of vehicles, the evolvable heavy-lift rocket and the Multi-Purpose Crew Vehicle received 39 percent of human spaceflight budget.

Our continuing efforts to facilitate commercial access to space received a significant boost in this budget; however, that still represents the second smallest piece of the human spaceflight pie, at about 12 percent.

[The information follows:]

NASA Human Spaceflight Budget



General BOLDEN. I want to commend my NASA workforce both civil servants and contractors across the Nation for their dedication to our missions during this time of transition and change. These workers are our greatest assets, and they make us proud. They fully understand the risk of exploration and welcome the challenge. They will be the ones making tomorrow happen.

These are exciting and dynamic times for us at NASA. The challenges ahead are significant, but so are our opportunities. We have to achieve big things that will create a measurable impact on our economy, our world, and our way of life.

I thank you for allowing me to make my opening statement and I look forward to your questions, Mr. Chairman.

[The information follows:]

Statement of
The Honorable Charles F. Bolden, Jr.
Administrator
National Aeronautics and Space Administration

before the

Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
U.S. House of Representatives

Mr. Chairman and Members of the Subcommittee, today it is my privilege to discuss the President's FY 2012 budget request of $18.7 billion for NASA. This request continues the Agency's focus on a reinvigorated path of innovation and technological discovery leading to an array of challenging destinations and missions that increases our knowledge, develops technologies to improve life and expand our presence in space for knowledge and commerce, and engages the public. With the President's signing of the NASA Authorization Act of 2010 (P.L. 111-267) on October 11, 2010, NASA has a clear direction and is moving forward. NASA appreciates the significant efforts that advanced this important bipartisan legislation, particularly efforts by the leadership and Members of this Committee. This is a time of opportunity for NASA to shape a promising future for the Nation's space program.

Because these are tough fiscal times, tough choices had to be made. But the proposed FY 2012 budget funds all major elements of the Authorization Act, supporting a diverse portfolio of programs, while making difficult choices to fund key priorities and reduce other areas in order to invest in the future. A chart summarizing the President's FY 2012 budget request for NASA is enclosed as Enclosure 1.

We have an incredible balance of human space flight, science, aeronautics and technology development. Within the human space flight arena, our foremost priority is our current human spaceflight endeavor – the International Space Station – and the safety and viability of the astronauts aboard it. The request also maintains a strong commitment to human spaceflight beyond low Earth orbit. It establishes critical priorities and invests in the technologies and excellent science, aeronautics research, and education programs that will help us win the future. The request supports an aggressive launch rate over the next two years with about 40 US and international missions to the ISS, for science, and to support other agencies.

At its core, NASA's mission remains fundamentally the same as it always has been and supports our new vision: **"To reach for new heights and reveal the unknown so that what we do and learn will benefit all humankind."** This statement is from the new multi-year 2011 NASA Strategic Plan accompanying the FY 2012 budget request, which all of NASA's Mission Directorates, Mission Support Offices and Centers helped to develop, and reflects NASA's proposed direction and priorities.

Our human spaceflight priorities in the FY 2012 budget request are to:

- safely fly the last Space Shuttle flights this year and maintain safe access for humans to low-Earth orbit as we fully utilize the International Space Station;

- facilitate safe, reliable, and cost-effective U.S.-provided commercial access to low-Earth orbit first for cargo and then for crew as quickly as possible;
- begin to lay the groundwork for expanding human presence into deep space—the Moon, asteroids, eventually Mars—through development of a powerful heavy-lift rocket and multi-purpose crew capsule; and
- pursue technology development that is needed to carry humans farther into the solar system. Taken together, these human spaceflight initiatives will enable America to retain its position as a leader in space exploration for generations to come.

At the same time, we will extend our reach with robots and scientific observatories to expand our knowledge of the universe beyond our own planet. We will continue the vital work to expand our abilities to observe our planet Earth and make that data available for decision makers. We will also continue our groundbreaking research into the next generation of aviation technologies. Finally, we will make the most of all of NASA's technological breakthroughs to improve life here at home.

With the FY 2012 budget, NASA will carry out research, technology and innovation programs that support long-term job growth and economic competitiveness and build upon our Nation's position as a technology leader. We will educate the next generation of technology leaders through vital programs in science, technology, engineering, and mathematics education. And we will build the future through those investments in American industry to create a new job-producing engine for the U.S. economy.

This year we honor the legacy of President John F. Kennedy, who, 50 years ago, set the United States on a path that resulted in a national effort to produce an unprecedented achievement. Now, we step forward along a similar path, engaged in a wide range of activities in human spaceflight, technology development, science, and aeronautics – a path characterized by engagement of an expanded commercial space sector and technology development to mature the capabilities required by increasingly challenging missions designed to make discoveries and reach new destinations.

NASA's Science Mission Directorate (SMD) continues to rewrite textbooks and make headlines around the world. Across disciplines and geographic regions worldwide, NASA aims to achieve a deep scientific understanding of Earth, other planets and solar system bodies, our star system in its entirety, and the universe beyond. The Agency is laying the foundation for the robotic and human expeditions of the future while meeting today's needs for scientific information to address national concerns about global change, space weather, and education.

- The Mars Science Laboratory will launch later this year and arrive at Mars in August 2012. It will be the largest rover ever to reach the Red Planet and will search for evidence of both past and present life.

- The Nuclear Spectroscopic Telescope Array (NuSTAR) mission will launch in early 2012 and become the first focusing hard X-ray telescope to orbit Earth.

- Research and Analysis programs will use data from an array of sources, including spacecraft, sounding rockets, balloons, and payloads on the ISS. We will continue to evaluate the vast amounts of data we receive from dozens of ongoing missions supported by this budget.

- A continued focus on Earth Science sees us continuing development of the Orbiting Carbon Observatory-2 (OCO-2) for launch in 2013 and other initiatives to collect data about our home planet across the spectrum.

- The budget reflects the scientific priorities for astrophysics as expressed in the recent Decadal Survey of the National Academy of Sciences. The budget supports small-, medium-, and large-scale activities recommended by the Decadal Survey.
  - The Radiation Belt Storm Probe mission will launch next year, and development of other smaller missions and instruments to study the Sun will get underway here on the ground.

With the appointment of a new Chief Scientist, NASA will pursue an integrated, strategic approach to its scientific work across Mission Directorates and programs.

As we continue our work to consolidate the Exploration Systems and Space Operations Mission Directorates (ESMD and SOMD), both groups will support our current human spaceflight programs and continue work on technologies to expand our future capabilities.

- We will fly out the Space Shuttle in 2011, including STS-135 if funds are available, and then proceed with the disposition of most Space Shuttle assets after the retirement of the fleet. The Shuttle program accomplished many outstanding things for this Nation, and in 2012 we look forward to moving our retired Orbiters to museums and science centers across the country to inspire the next generation of explorers.

- Completing assembly of the U.S. segment of the ISS will be the crowning achievement of the Space Shuttle's nearly 30-year history. The ISS will serve as a fully functional and permanently crewed research laboratory and technology testbed, providing a critical stepping stone for exploration and future international cooperation, as well as an invaluable National Laboratory for non-NASA and nongovernmental users. During FY 2011, NASA will award a cooperative agreement to an independent non-profit organization (NPO) with responsibility to further develop national uses of the ISS. The NPO will oversee all ISS research involving organizations other than NASA, and transfer current NASA biological and physical research to the NPO in future years.

- In 2012, we will make progress in developing a new Space Launch System (SLS), a heavy-lift rocket that will be the first step on our eventual journeys to destinations beyond LEO.

- We will continue work on a Multi Purpose Crew Vehicle (MPCV) that will build on the human safety features, designs, and systems of the Orion Crew Exploration Vehicle. As with the SLS, acquisition strategy decisions will be finalized by this summer.

- NASA will continue to expand commercial access to space and work with our partners to achieve milestones in the Commercial Orbital Transportation Services (COTS) Program, the Commercial Resupply Services (CRS) effort, and an expanded Commercial Crew Development (CCDev) program. As we direct resources toward developing these capabilities, we not only create multiple means for accessing LEO, but we also facilitate commercial uses of space, help lower costs, and spark an engine for long-term job growth. While the request is above the authorized level for 2012, NASA believes the amount is critical, combined with significant corporate investments, to ensure that we will have one or more companies that can transport American astronauts to the ISS. With retirement of the Space Shuttle in 2011, this is a top Agency priority.

- Most importantly, NASA recognizes that these programmatic changes will continue to personally affect thousands of NASA civil servants and contractors who have worked countless hours, often under difficult circumstances, to make our human spaceflight, science, and aeronautics programs and projects successful. I commend the investment

that these dedicated Americans have made and will continue to make in our Nation's space and aeronautics programs. These are tremendously exciting and dynamic times for the U.S. space program. NASA will strive to utilize our workforce in a manner that will ensure that the Nation maintains NASA's greatest asset – the skilled civil servants and contractors – while working to increase the efficiency and cost-effectiveness in all of its operations.

- The 21st Century Space Launch Complex program will focus on upgrades to the Florida launch range, expanding capabilities to support SLS, MPCV, commercial cargo/launch services providers, and transforming KSC into a modern facility that benefits all range users. The program will re-plan its activities based on available FY 2011 funding to align with 2010 NASA Authorization's focus areas, including cross organizational coordination between 21stCSLC, Launch Services, and Commercial Crew activities.

NASA's Aeronautics Research Mission Directorate (ARMD) continues to improve the safety, efficiency and environmental friendliness of air travel.

- Our work continues to address the challenge of meeting the growing technology and capacity needs of the Next Generation air travel system, or "NextGen," in coordination with the FAA and other stakeholders in airspace efficiency.

- NASA's work on green aviation technologies that improve fuel efficiency and reduce noise continues apace.

- We also continue to work with industry to develop the concepts and technologies for the aircraft of tomorrow. The Agency's fundamental and integrated systems research and testing will continue to generate improvements and economic impacts felt by the general flying public as well as the aeronautics community.

The establishment last year of the Office of the Chief Technologist (OCT) enabled NASA to begin moving toward the technological breakthroughs needed to meet our Nation's space exploration goals, while building our Nation's global economic competitiveness through the creation of new products and services, new business and industries, and high-quality, sustainable jobs. By investing in high payoff, disruptive technology that industry cannot tackle today, NASA matures the technology required for our future missions in science and exploration while improving the capabilities and lowering the cost of other government agencies and commercial activities.

- In OCT's cross-cutting role, NASA recently developed draft space technology roadmaps, which define pathways to advance the Nation's capabilities in space and establish a foundation for the Agency's future investments in technology and innovation. NASA is working collaboratively with the National Research Council (NRC) to refine these roadmaps. The final product will establish a mechanism for prioritizing NASA's technology investments, and will support the initial Space Technology Policy Congress requested in the NASA Authorization Act.
- As leader of the Space Technology Program, OCT will sponsor a portfolio of both competitive and strategically-guided technology investments, bringing the agency a wide range of mission-focused and transformative technologies that will enable revolutionary approaches to achieving NASA's current and future missions.

- In FY 2012, a significant portion of the Exploration Technology Development Program is moved from ESMD to Space Technology. These efforts focus on developing the long-range, exploration-specific technologies to enable NASA's deep space human exploration future. The integration of Exploration Technology activities with Space Technology creates one robust space technology budget line, and eliminates the potential for overlap had NASA's space technology investments been split among two accounts. ESMD will continue to set the prioritized requirements for these efforts and will serve as the primary customer of Space Technology's Exploration-specific activities.

- OCT continues to manage SBIR and STTR, and integrates technology transfer efforts ensure NASA technologies are infused into commercial applications, develops technology partnerships, and facilitates emerging commercial space activities

Recognizing that our work must continuously inspire not only the public at large but also students at all levels, NASA's Education programs this year focus on widening the pipeline of students pursuing coursework in science, technology, engineering and mathematics (STEM). As President Obama has said, "Our future depends on reaffirming America's role as the world's engine of scientific discovery and technological innovation. And that leadership tomorrow depends on how we educate our students today, especially in math, science, technology, and engineering."

- The FY 2012 request for NASA's Office of Education capitalizes on the excitement of NASA's mission through innovative approaches that inspire educator and student interest and proficiency in STEM disciplines. NASA's education program in FY 2012 and beyond will focus and strengthen the Agency's tradition of investing in the Nation's education programs and supporting the country's educators who play a key role in inspiring, encouraging, and nurturing the young minds of today, who will manage and lead the Nation's laboratories and research centers of tomorrow.

- Among NASA's Education activities will be a continued Summer of Innovation, building on the successful model piloted with four states this past year.

All of these activities place NASA in the forefront of a bright future for America, where we challenge ourselves and create a global space enterprise with positive ramifications across the world. The FY 2012 budget request provides the resources for NASA to innovate and make discoveries on many fronts, and we look forward to implementing it. See Enclosure 2 for a more detail summary of each activity.

Conclusion

As we enter the second half-century of human spaceflight, the Nation can look back upon NASA's accomplishments with pride, but we can also look forward with anticipation to many more achievements to come. The NASA Authorization Act of 2010 (P.L. 111-267) has provided us with clear direction that enables the Agency to conduct important research on the ISS, develop new launch vehicle and crew transportation capabilities to go beyond the bounds of LEO, utilize a dazzling array of spacecraft to study the depths of the cosmos while taking the measure of our home planet, improve aviation systems and safety, develop new technologies that will have applications to both space exploration and life on Earth, and inspire the teachers and students of our country. In developing and executing the challenging missions that only NASA can do, we contribute new knowledge and technologies that enhance the nation's ability to compete on the global stage and help to secure a more prosperous future.

These are tough fiscal times, calling for tough choices. The President's FY 2012 budget request makes those choices and helps advance all of these bold aims, and we look forward to working with the Committee on its implementation.

Mr. Chairman, thank you for your support and that of this Subcommittee. I would be pleased to respond to any questions you or the other Members of the Subcommittee may have.

MATCHING NASA'S MISSIONS WITH ITS BUDGET

Mr. WOLF. Thank you, Mr. Administrator.

In the current fiscal environment, we will have to consider the possibility that NASA has too many missions for the amount of money that is available. If we continue to divide a relatively static NASA budget between an ever increasing number of programs, we will just perhaps ensure that there is not enough money to execute any of these programs.

Do you agree with that assessment?

General BOLDEN. Mr. Chairman, these are tough times. And we have had to make tough choices and the FY 2012 budget that the President and I have submitted reflects those tough choices. So I think we have submitted a budget that will allow us to carry out the programs that the Congress and the President have asked us to do.

Mr. WOLF. If we were to take another look at NASA's various programs and responsibilities with the intention of reducing or deferring some of the lower priority activities, where would you recommend that we start?

General BOLDEN. Mr. Chairman, because I think we have taken a very thorough look at where we stand under the Continuing Resolution of the FY 2010 spending level and that the President's Budget for FY 2012 essentially represents a continuation of that Continuing Resolution with some adjustments, I would not propose any cuts.

Mr. WOLF. How about moving money around?

General BOLDEN. Mr. Chairman, we did move some money. We propose moving some money around because of priorities, readjusting priorities. When the President submitted his FY 2011 budget, the world was different. Our fiscal situation was different. I don't think any of us in this room thought it was different, but everybody came to, I hope everyone came to the realization that we are in dire straits as a Nation economically, and so what we did with developing the FY 2012 budget was we looked at what our priorities are.

My number one priority is safely flying out the Shuttle right now. Very close to that is providing for safe access to the International Space Station over the next 10 years because the President and the leaders of all of our international partners have agreed that the International Space Station as the anchor for human exploration should be on orbit for another 10 years, and in order to maintain the Space Station as we operate it today, I have to be able to get cargo and crew there.

Because the Shuttle will stop flying in June, the only way that I will have until I can bring aboard a commercial access to Low-Earth Orbit for crew will be the Russians. They are an incredibly reliable partner, but I do not think anybody in this room wants to go for the next 10 years having to rely on Russia to take American astronauts to orbit.

So we made an adjustment in the balance within the FY 2010 budget. We complied with the elements of the 2010 Authorization Act, but I took a look at it with the people that I really respect in my agency, and we decided that in order to ensure that we would

have a commercial capability for both cargo and crew as early as possible, I needed to put a little bit more funds in there than was in the Authorization Act. That is how we got to the $850 million for 2012 and subsequent years. That is far lower than what we originally needed and still believe we need to be certain that we will bring this program on board, but we think we can make that work.

DUPLICATION AMONG FEDERAL AGENCIES

Mr. WOLF. I believe your Earth science programs support valuable work, but I am concerned that we are consuming a significant portion of the budget to fund those activities when other agencies have sufficient authorities and abilities to do some of the same things.

Do you believe there are activities currently funded in Earth science that could be adequately performed instead by NOAA or USGS or the National Science Foundation or entities that they fund? For projects that support those other agencies' missions but still require NASA's assistance, could they or should they contribute more funds toward NASA's expenses in order to free up NASA's resources for its own unique activities?

General BOLDEN. Mr. Chairman, because these are such difficult times, we took a look at where we were in all aspects of our budget. Everything that we do in Earth science is unique to NASA. We have looked and there is no duplication across agencies. Everything that we do with weather, for example, we manage programs that use weather satellites under NOAA's budget that then we take to orbit, make sure that they are operating, and we turn them over to NOAA.

So when I look at our budget, I do not think there is duplication.

My concern about allowing other people to take the Earth science projects that NASA does is that money will not go with that, and so the requirements that go with those projects will not be able to be met.

It is just like giving me operational control of NOAA projects. If I do not get money, that means those projects do not get done. So moving projects back and forth among Federal agencies where there is presently no duplication does not represent a solution. What it represents is just another way to get rid of some of the critical programs that we have in Earth science right now.

Mr. WOLF. Well, I do not agree with you there. I think it would allow you to have more money to go and do what you are doing.

I heard the other day that Senator Coburn and I think Senator Durbin had asked for an in-depth GAO analysis. The first initial report came out and identified duplications, I think, of $200 billion.

Are you part of that report? For instance, GAO said there are so many manpower training programs. I forget how many, and I am not going to guess because I may be inaccurate. Is GAO looking at NASA? Are you part of the Coburn request to see if there is duplication?

General BOLDEN. Mr. Chairman, we are a part of all the GAO studies. Actually, I understand what you are saying, and there was a previous GAO study and I will take it for the record to bring you the exact—I do not think they gave any statistics, but there was

a definitive GAO study done on whether there were duplications between NOAA and NASA, and that study said they found no duplications between NOAA and NASA in the Earth science work that we do and the climate research that we do and the weather research that we do. The study that I think you refer to for Senator Coburn, and I was not aware that that was at his request——

Mr. WOLF. Yes.

General BOLDEN [continuing]. But I have seen that one as recently as this past week.

Mr. WOLF. Right.

General BOLDEN. That one dealt with education, everything across the spectrum of government, and I would agree that there is duplication.

Mr. WOLF. Is NOAA part of that report?

General BOLDEN. NOAA and everything were a part of that, but GAO had previously said that there was no duplication between NASA and NOAA in our Earth science efforts.

Mr. WOLF. Okay.

General BOLDEN. There is no duplication between NASA and the U.S. Geological Survey in our Earth science programs. We do the satellites. We do the program management for development of the satellites and NOAA and the USGS, we recently signed a memorandum of agreement with USGS for them to take over Landsat. We do not spend any money on Landsat other than the administrative cost of managing the program of developing, building, and testing the Landsat satellite to make sure that it is okay before we hand it over to USGS. So I do not think there is any duplication, but I will take it for the record.

Mr. WOLF. Well, if you can. Maybe the staff can contact Senator Coburn's office to see what the range of the GAO study is. And they indicated that there were further reports about ready to release, so we should see if NASA was part of that.

The report that you referenced, what was the date of that?

General BOLDEN. Congressman, I think that was a 2000——let me take it for the record. I think it was a——

Mr. WOLF. Sure.

General BOLDEN [continuing]. 2009 GAO study, but I will have to——

Mr. WOLF. Okay. Why don't you submit it for the record.

General BOLDEN. I will do that.

[The information follows:]

DUPLICATION IN EARTH SCIENCE PORTFOLIO

In 2009, the GAO conducted a study to "determine whether NASA's programs . . . are duplicative with other activities of the federal government." [GAO–10–87R, Oct. 15, 2009] The GAO study reported "No Duplication Found in Earth Science Portfolio" and "NASA provides a unique role in Earth Science that is leveraged by other federal agencies."

NASA carefully informs and coordinates its Earth Science programs with NOAA and USGS both through regular bilateral meetings and through interagency coordinating groups such as the US Global Change Research program. NASA is vice-chair of USGCRP with responsibility for integrated observations. Broadly speaking, NASA conducts leading-edge research in Earth system science including climate change, while NOAA is working to expand its weather prediction capability to climate time scales and USGS is working to understand land surface change (including water and biota).

NASA and NOAA coordinate their weather and climate activities via regular meetings between NASA's Earth Science Division and NOAA's National Environmental Satellite Data and Information Services (NESDIS) office, including development of research to operations transition plans. NASA's Joint Agency Satellite Division oversees NASA efforts to develop and launch NOAA's satellites on a reimbursable basis. NASA and USGS coordinate their land surface change research activities at the analogous level, and NASA's Joint Agency Satellite Division is working with USGS as the latter assumes the lead role for the Landsat program.

Mr. WOLF. And then we ask the staff to be in touch with GAO and also with Mr. Coburn's office to see if NASA or NOAA or USGS were a part of that. We are not looking to take away. We are looking to see if there is a function of yours that someone else can do, not to take your money away, but to allow you to have more money to do what you think is important.

General BOLDEN. Congressman, if I can——

Mr. WOLF. Sure.

General BOLDEN. Just for Mr. Ringler, I think it is GAO 10–87R dated 15 October 2009. So that was the one specifically dealing with duplication between NASA and NOAA.

NEW EXPLORATION PROGRAM

Mr. WOLF. Okay. One other question, and then I will go to Mr. Fattah.

When the NASA authorization was signed last year, the Administration assured us that it would fully implement the new exploration program. Only five months later, however, NASA is proposing to fund the new exploration program more than $1.2 billion below its authorized level.

How do your reconcile your stated commitment to the program with the budget request?

General BOLDEN. Congressman, we have made an effort to stay within the budget as defined by the Authorization Act and the fact that we are operating under the 2010 funding level and expect that we will not be operating anywhere above that.

Again, safety to crews is critical, particularly safety of the crews on the International Space Station. So it required me to look at how I felt I could balance the portfolio in human spaceflight to continue the development of a viable, a realistic deep space exploration program while not putting at risk America's access to Low-Earth Orbit and the International Space Station in the time that I need that.

I need for commercial entities to be able to deliver cargo to the International Space Station by 2012. They are on target to do that right now. I have enough supplies on the International Space Station. Provided we successfully get the next two Space Shuttle missions off, we can go through 2013 and if, you know, if for some reasons, the commercial entities did not deliver, we would be okay.

I then need to get crew there and I want to get the crew on American-made rockets. I do not want to have to take them to the International Space Station on Soyuz through the life of the International Space Station through 2020. And so I think that by 2015, 2016, we will have active operating commercial entities that will be taking crews to the International Space Station. That is quicker than I could have gotten there had I done it the old NASA way.

Mr. WOLF. Okay.

General BOLDEN. So we are putting forth a genuine effort to produce a heavy-lift launch vehicle.

90-DAY PROGRESS REPORT

Mr. WOLF. In the 90-day progress report on the implementation of the authorized exploration program, NASA stated that it might not be able to meet the goals of the authorization within the schedule and budget parameters established in that bill.

You did not provide, however, an estimate of what you believe would be necessary. Using your standard budget and schedule estimating procedures, what does NASA believe will be needed to implement the authorization, and how does that compare to the budget plan put forward in your request?

General BOLDEN. Congressman, because the authorization was below the level that the President had proposed in his FY2011 budget and because we all realize that fiscal times have changed and we have got to live within our means, we decided that we would take a look at two things. One, can I transition existing Constellation contracts to the new MPCV and Space Launch vehicle; that is a legal and procurement question. I am pretty close to being satisfied that, yes, we can do that with maybe some limitations.

The second thing I had to determine, okay, if I can do that, is it affordable and is it sustainable. I could do it and get a vehicle the first time out, but then I have shot everything I have, and I cannot produce a second, third, fourth. I cannot produce a sustainable exploration program.

So I want to give you a realistic program that is affordable and sustainable, and that answer, we will have for the Congress this summer sometime.

Mr. WOLF. Mr. Fattah.

ADMINISTRATOR BOLDEN'S ACCOMPLISHMENTS

Mr. FATTAH. Thank you, Administrator. Let me join the Chairman in thanking you for your significant service to our country.

You flew over a hundred combat missions in Vietnam?

General BOLDEN. Yes, sir.

Mr. FATTAH. You led our Marines into Kuwait as the commanding general?

General BOLDEN. I did not do that, sir. I served with Marines in Kuwait between the two wars. I was happily flying space shuttles when my fellow Marine generals led our troops from Kuwait into Iraq in the Gulf War. I did not serve in the Gulf War.

Mr. FATTAH. Okay. But on the Marine Corps side, you were in the astronaut office?

General BOLDEN. Yes, sir.

Mr. FATTAH. And you were on the mission that launched the Hubble?

General BOLDEN. Yes, sir. Yes, sir.

Mr. FATTAH. So I just wanted to put those on the record because the Chairman had referred to your great bio, so I took a minute to take a look at it.

General BOLDEN. Sir, that is all history.

Mr. FATTAH. I got you. But history is important for us to reflect on.

I saw your appearance yesterday before the authorizing committee. And I could imagine that that was somewhat of a—reminded you of some of your previous duties, I guess, in some respects. So it is challenging to come up here to the Hill——

General BOLDEN. Yes, sir.

Mr. FATTAH [continuing]. And deal with the various committees of jurisdiction. Our committee has responsibility for money.

General BOLDEN. Sir, if I did not believe in what I am doing, I would be back in Houston.

IMPLEMENTING THE AUTHORIZATION UNDER THE BUDGET REQUEST

Mr. FATTAH. I understand. Our committee deals with money. The authorizing committee deals with the authorizing issues. And the Congress has passed an authorization bill that allows you to move forward on the President's new missions for NASA.

General BOLDEN. Yes, sir.

Mr. FATTAH. So the Congress has sanctioned the fact that we are going to now work towards human spaceflight and to space outside of Earth's orbit. And that is going to be a challenging moment. That is why you put together a set of programs to move in that direction.

Also, the Administration and the President and NASA have decided that you want to believe enough in American business to commercialize crew missions back and forth to the Space Station.

General BOLDEN. Yes, sir.

Mr. FATTAH. That is correct?

General BOLDEN. Yes, sir.

Mr. FATTAH. And so this Commercial Crew Program is a belief in American business that we could take what NASA has been doing for decades now.

General BOLDEN. That is a firm belief that American industry can do what I have been doing.

Mr. FATTAH. Right. The Shuttle mission is almost 300 flights, right, and you have 133 right now?

General BOLDEN. Right.

Mr. FATTAH. But that is still a lot.

General BOLDEN. Yes, sir.

Mr. FATTAH. Now, you were retired, though, and moved in this commercial area, right?

General BOLDEN. Yes, sir.

Mr. FATTAH. So the work that you see and the budget that you are presenting for next year would follow the path of what has been authorized by the Congress, the work that Senator Nelson and the authorizing committees did to come to an agreement to move forward.

And this reflects your best judgment about what the cost would be?

General BOLDEN. Sir, it does.

Mr. FATTAH. All right. Now, as we grapple with the allocation, because I think absent such a limited allocation, you would have broad-based support on this committee to do everything we could to help you move forward, the Chairman is interested and I am interested in where there may be opportunities to delineate more clearly missions between NASA and, for instance, NOAA, and

whether or not, particularly in the satellite area, there is some area to—and, you know, since you are operating in space all the time, I mean, you got a Shuttle mission up today, you got a launch tomorrow with—is it Glory?

General BOLDEN. It is Glory, yes, sir.

Mr. FATTAH. Right. And you still have, on Mars, Opportunity and Spirit moving around. You have a lot going on in space, that space-related things might be better suited at NASA, so that is the real question around I think what the Chairman was asking about satellites, because I agree that we want to look to see whether there is some synergy. We are not trying to weaken NASA or NOAA. We are just trying to see.

And for me, it is not a matter of saving money. I mean, it is really a matter of just trying to organize the government better because I think if we have to spend more money to have a superior scientific advantage in this world, we, as Members of Congress, we should be prepared to do that, that this idea that we are going to lead this world on the cheap, I think is a foolish notion anyway and that our ancestors and forebearers did not operate on that notion. They sacrificed.

So, needless to say, this is the area that we are interested in, and it is not a punitive matter between NOAA and NASA. We want to look and see what makes sense——

General BOLDEN. Yes, sir.

Mr. FATTAH [continuing]. And, you know, see whether or not there is some way to proceed. So if you would help us in that quest. You know, it is that exploration that we are involved in, and we want to learn and see how we can go forward.

Thank you.

General BOLDEN. Yes, sir. Thank you very much, sir.

Mr. WOLF. Thank you, Mr. Fattah.

And just for the record, I do not want to be unfair to anyone. We try to go according to how people come in but we will go to seniority if Members came in together.

Secondly, I kind of made a decision—and if Members would rather me not do it, I would like to hear from you—of not limiting any Member on the time that they ask questions.

I served on one committee once where they had a timer, an egg timer. And I felt that the witness knew the egg timer was there and could see it and felt "if I can keep talking, I can rope-a-dope this thing so nobody has to answer anything."

I apologize to Mr. Yoder because we did not get to you the last time, two times ago, but I think it is better that any Member can just follow wherever their heart takes them while still showing respect for other Members.

So we are trying to call people based on how they come in. If it is really close, we would go to seniority. I know Mr. Bonner chairs a committee, Mr. Culberson does, and we have ranking members on different committees, so we want to be sure that the witness cannot just take up the Member's whole time. So that is sort of the reasons we are doing this. And if there is a difference of opinion, somebody could just say something to me.

Mr. Culberson.

CHINESE SPACE PROGRAM

Mr. CULBERSON. Thank you very much, Mr. Chairman.

Mr. Bolden, we are really glad you are there, sir, and appreciate your service to the country, both in our military and in the Space Program.

And this committee is arm in arm in ensuring that we support NASA and do everything we can to ensure that you are able to continue to keep the United States Space Program on the cutting edge of the world and a world leader, particularly in an era when the Chinese are so aggressively moving to overtake us in space exploration, and in so many other ways; and becoming our banker.

The joint operating environment analysis prepared by the U.S. Joint Forces Command, and I know this will resonate with the chairman, that America's greatest strategic threat is our national debt and deficit spending. It is the greatest single long-term strategic threat to the Nation.

They also get into a detailed analysis of the Chinese and point out that the Chinese have—the People's Liberation Army has more students in American graduate schools than the U.S. Military.

Given that the Chinese are growing in understanding of America and our military, the Chinese are following their long-standing rule that if you know the enemy and know yourself, in a hundred battles, you will never be in peril.

The Chinese have, according to the—again, this is the most recent analysis for looking out into the future by the U.S. Joint Forces Command—that the Chinese have a sense that in certain areas such as submarine warfare, space, and cyber warfare, China can compete on a near equal footing with America. Indeed competing in these areas, space, submarine warfare, and cyber in particular seems to be a primary goal and the force development of the People's Liberation Army.

And, of course, as our chairman has pointed out many times, this committee is going to drive home the point that the entire Chinese Space Program is owned lock, stock, and barrel and controlled by the People's Liberation Army.

And I know the chairman has expressed grave concern and I know the committee is concerned. And I want to reiterate our concern, Administrator, that NASA not cooperate, it is not authorized by law, it was stringently opposed, this committee, in any shape, form, or fashion with the Chinese Space Program because it is owned lock, stock, and barrel, controlled by the People's Liberation Army.

And they are so aggressively working to steal technology, break into our computer systems. It is a real source of concern. And we are graduating I think a tenth of the engineers, Mr. Chairman, and scientists? The Chinese have vastly more engineers and scientists working on their Space Program than we do, sir.

And you are as vital a part of America's long-term strategic security as, in my opinion, any of the work that is being done, for the long-term, that is being done in the Pentagon. And God bless them, but you and I think NASA, all of us should think of NASA as a part of national defense, as a great strategic asset the Nation en-

joys and needs to protect. And I know the chairman feels that way and you have got our strong support.

NASA'S FUNDING CHALLENGES PRIOR TO THE AUTHORIZATION

However, this is often forgotten: you started out with an immediate disadvantage as soon as you came in because the Bush administration never fully funded the vision for space exploration, did they, sir?

General BOLDEN. No, sir, they did not.

Mr. CULBERSON. And NASA is self-insured, of course, right? NASA is self-insured for all intents and purposes, so the terrible loss of the Challenger and the irreplaceable loss of the astronauts in the 1986 disaster, that Congress did not appropriate funds to replace the spacecraft, correct?

General BOLDEN. Yes, sir.

Mr. CULBERSON. And in the terrible 2003 loss of Columbia and, again, the irreplaceable loss of the astronauts, no way to measure that, but Congress did not appropriate any funds to compensate NASA either to buy a new vehicle or to compensate NASA for all the hundreds and hundreds and hundreds of millions of dollars that were lost as a result of Columbia? You were never compensated for the loss of Columbia financially?

General BOLDEN. Congressman, I would have to take that for the record. I was not in the agency at the time. I was working on the periphery, but I think your assessment is correct. But I would have to take that for the record.

[The information follows:]

NASA COMPENSATION FOR LOSS OF COLUMBIA

NASA was never compensated for the loss of Columbia and the resulting cost for the Space Shuttle Return to Flight (RTF) effort. Prior to Return to Flight in 2006, over $1.2B of Space Shuttle funding was reallocated to cover RTF costs from funds that would normally have been spent on Space Shuttle operations (the Shuttle was not flying), Space Shuttle program reserves (intended to cover Shuttle contingencies), and the Space Shuttle Service Life Extension Program (no longer needed given Shuttle retirement). Another $930M was reallocated from other NASA programs—primarily Exploration and International Space Station—in FY 2004, FY 2005 and FY 2006, to also address RTF costs.

The only monies specifically appropriated to NASA by Congress for the loss of Columbia was $100M in FY 2003 specifically to respond to the Columbia accident investigation and recovery.

Mr. CULBERSON. And I know my friend from Mississippi, you were never paid for all that hurricane damage, right, Jo?

Mr. BONNER. But I am from Alabama.

Mr. CULBERSON. I am sorry. I am sorry. Isn't that terrible? Texans are just awful. I mean, if it is north of—isn't that awful? Isn't that terrible? I really apologize, Jo. Awful. I mean, because north of Red River, east of the Sabine, we just lose track. It is terrible. I apologize seriously.

But NASA was never compensated, all the facilities that were damaged by the hurricanes, you were never fully compensated, I think, for that either, right?

Mr. BONNER. I think you are right. And I think there was damage that we were not compensated for.

Mr. CULBERSON. Massive damage. So in addition to not fully funding the vision for space exploration, which—and I think Scott, if you give me—this is the same chart that Sean O'Keefe did.

Mr. CHAIRMAN, I want to make sure you all get a copy of this. This is essentially a sand chart that I know Sean O'Keefe prepared at the time the vision first was laid out that showed what was necessary in order to maintain not only the vision for space exploration, but to keep the american space program on the cutting edge for the world. And the, again, lack of full funding, loss of the Columbia, and the hurricane damage put you seriously behind the eight ball.

Now we move into the Obama administration and we are entering this new era, an age of austerity unlike anything we have ever experienced before. And Chairman Wolf has quite properly, and I admire him and support him strongly in his focus on the urgent need to reform our entitlement programs to deal with the urgent threat caused by the national debt, and the deficit.

The chairman of the Joint Chiefs of Staff has testified, when asked by the Senate, what is the greatest threat to the United States' long-term strategic security, he says the national debt.

So you have got all these difficulties you are going to deal with and we are going to do our very, very best to help you, sir, and the request that you have made. And the President has asked to freeze NASA. You have not reached the authorized level of funding in the authorization bill.

CONFLICT BETWEEN PRIOR APPROPRIATIONS BILLS AND THE AUTHORIZATION

One thing I know that we could do right out of the gate to help you would be to clarify immediately the conflict between the CR that we are under, which is the one passed under—when we were here all together under Chairman Mollohan, which says that you shall build Constellation, as I recall, essentially statutory language to that effect, right, or am I just—it's a prohibitive determination of Constellation.

And while we are under these CRs it is a continuation of that essentially statutory, it is in the statute, I think, requirement the—and then you have got the authorization bill which says build a heavy-lift rocket and a manned capsule.

One thing I hope we can do to one of these short-term CRs we are dealing with is get you some immediate clarification on what that would be—that would be helpful, wouldn't it?

General BOLDEN. That would be very helpful——

Mr. CULBERSON. That would be a big help.

General BOLDEN [continuing]. Congressman.

Mr. CULBERSON. And the work that you are doing on—I swear I will try to wrap this up. You guys are very gracious.

Mr. WOLF. Take your time.

Mr. CULBERSON. You are very kind. And we are all going in the same direction on this, guys.

Mr. HONDA. Probably.

Mr. CULBERSON. Yeah. Mr. Honda wants to clarify that. I do not want to get him in trouble with his folks back home. But we are all arm-in-arm in supporting NASA.

So if we get you some clarification on that right away so that you can comply with the authorization bill which says that you are to build a heavy-lift rocket, a manned capsule, and test it, right, is essentially——

General BOLDEN. The Authorization Act does not require me to test. And I will take it for the record, but that is the first I have heard that the authorization bill required me to fly a test flight on a Heavy-Lift Launch Vehicle. It stands to reason——

Mr. CULBERSON. Well, sure.

General BOLDEN [continuing]. That is what we would want to do, but I am trying to be very——

Mr. CULBERSON. I understand.

General BOLDEN. I will take it for the record, and we will come back and let you know if there is a requirement for me to fly a test flight, that adds more money. To go to the chairman's point, my hope is that I will be allowed to develop a heavy-lift launch system and an MPCV and then make the decision as to whether we need to fly a test flight or what. Otherwise, you have added another cost on top of what is already difficult.

[The information follows:]

TEST FLIGHT OF SPACE LAUNCH SYSTEM (SLS)

The NASA Authorization Act of 2010 does not require NASA to perform a test flight of the Space Launch System (SLS) prior to flying crew on the launch vehicle. NASA is still in the early stages of formulating the SLS program and as part of that process will determine the appropriate ground and flight tests to perform to validate the systems performance. The tests will depend on the architecture and systems selected for the SLS.

Mr. CULBERSON. Well, if it is not a statutory requirement, I know that when the bill was written, because we all participated in that and discussed it, that it would be common sense that you are not going to put human beings on a rocket without testing it.

General BOLDEN. Sir, it is——

Mr. CULBERSON. You all are going to do it.

General BOLDEN. We did not fly a test flight on the Shuttle.

Mr. CULBERSON. That is true. I remember reading about——

General BOLDEN. Sometimes you have to accept risk. What I have tried to tell everybody is the Nation is averse to risk.

Mr. CULBERSON. Yeah.

General BOLDEN. The American public, going back to what Congressman Fattah said, it is incumbent upon me as the NASA Administrator to help the American public understand risk, and that if we want to remain the greatest Nation in the world and the technological leader in the world, then we have to do some things differently than we have done before, and that means we have to accept risk, which means we——

Mr. CULBERSON. That is true.

General BOLDEN [continuing]. Have to think like we thought when we launched the first Shuttle.

Mr. CULBERSON. That is true.

General BOLDEN. Challenger changed everything. We would have never flown STS–1 again after Challenger.

Mr. CULBERSON. Right. I remember a visit with John Young and he said—I remember him telling me that. But to also drive home a point that you just made, I remember President Bush saying on

many, many occasions America has become risk averse. And it is——

General BOLDEN. But that is the Nation. That is NASA.

COMMERCIAL SPACEFLIGHT

Mr. CULBERSON. I understand. Let me pass the microphone on to my colleagues by asking about the amount of money that we are spending on commercial which all of us, and certainly I as a free market Jeffersonian conservative, support the idea of the commercial sector getting us to low earth orbit.

What percentage of the cost, for example, as envisioned by the budget request and the direction that the President is asking you to go, what percentage of the cost of a typical commercial flight will be paid for by U.S. taxpayers, 50 percent, 60 percent?

General BOLDEN. When we get to commercial crew or now presently under the COTS Program or——

Mr. FATTAH. When we get to commercial crew.

Mr. CULBERSON. Yeah.

General BOLDEN. When we get to commercial crew, I will have to again——

Mr. CULBERSON. Ballpark, just ballpark.

General BOLDEN. I cannot give you a ballpark figure because we have not gotten to the point where I will be this spring when I have a formalized acquisition strategy performed.

Mr. CULBERSON. Okay.

General BOLDEN. And then we can give you that answer.

Mr. CULBERSON. Okay.

General BOLDEN. Today I do not know that.

Mr. CULBERSON. I will follow-up on this in my second round, but I am deeply concerned at the dramatic increase in the level of funding for commercial spaceflight, I mean, from 39 to 612 is authorized and you got $850 million in this year's request, yet you just told the chairman and just reiterated that you cannot even afford a test flight and you do not even know if you have got enough to even sustain a heavy-lift rocket. So it is a real source of concern.

And, also, secondly, the President I understand is going to make a request, make an announcement sometime in Florida that I understand is—he is going to announce that they are going to try to move all the manned spaceflight preparation for commercial to Kennedy when all of that infrastructure exists in the Johnson Space Center, along with all the expertise.

General BOLDEN. I think there is a misunderstanding of the commercial crew program office at the Kennedy Space Center and where we train astronauts. That will not change. Astronauts will still live, train, work in Houston, go to wherever the vehicles happen to be, whether it is Vandenberg Air Force Base or Cape Canaveral or the Kennedy Space Center.

Mr. CULBERSON. Okay.

General BOLDEN. That is the way we have always done it.

Mr. CULBERSON. The last question on this. You will just—when the rocket lifts off the pad, the commercial will take over from—you will have the same structure you have today and that is all the training, all the everything before they lift off will be done at Johnson Space Center where we have got the expertise and the infra-

structure, but the minute they lift off the pad, they are under the control of Kennedy?

General BOLDEN. That has not been determined yet, Mr. Culberson. What I have asked the folks in the astronaut office and flight crew operations is to give me an operational concept: How do we want to do this. If I do it like the airlines, they send a pilot off and he or she goes somewhere and trains. The first time they fly an airplane, there are passengers in the back seat. I could do that or I could do my own training which is what I would prefer to do, but it may be more economical for me to allow the contractor to take my astronauts to their facility to train. That has not been decided yet. That is a part of the operational concept development and we are probably a year or so away from doing that.

Mr. CULBERSON. Well, I know we would encourage you to take advantage of the resources, the assets, the strategies. You know, you have got all the talent, the expertise, and the infrastructure at Johnson and we need to take full advantage of that, particularly in an age of austerity when there is no money. And we love you and we want to help you, so please do not——

Mr. BONNER. Will the gentleman yield for one question?

Mr. CULBERSON. Okay.

Mr. BONNER. Is Johnson in Arkansas?

Mr. CULBERSON. I deserved that. I deserved that.

Mr. FATTAH. I think we just heard an argument for government focused efforts versus the private sector from a conservative Jeffersonian Republican.

Mr. WOLF. Mr. Honda.

Mr. HONDA. Thank you, Mr. Chairman.

And, Mr. Chairman, I do appreciate your consideration of the time and allowing us to take the time. I think that that is a nice break from the past.

Administrator Bolden, being a Marine, I know that risk is not something you worry about. I mean, just being a Marine Corps person.

General BOLDEN. I do worry about it.

Mr. HONDA. Yeah. So I think in terms of training in outer space and astronaut training since you have done that, you know, I have greater confidence that, you know, you have control and oversight on that because I like to fly with pilots who are experienced. You know, getting off is important, but coming back down safely is important, too, so——

General BOLDEN. I agree.

IMPLEMENTATION OF FUNDING CUTS PROPOSED BY THE HOUSE

Mr. HONDA. And there has been a lot of questions around how we spend our money. It seems to me that you have been seeking ways to create synergy and make the dollar go further and still accomplish the mission.

I was going to ask you a question about the robotic precursors, the tension between technology and heavy-lift, human spaceflight interests, the space technology, NASA scientists versus outside grants. And I think that a lot of the stuff I will come back to later because the question had occurred to me as we were talking about more money, less money, and things like that.

We have spent almost 90 hours on looking at our CR in the past few weeks. And I want to ask a question about a near-term question. What would happen to the completion of the Space Shuttle manifest and the long-term need and to the Space Launch System and the Multipurpose Crew Vehicle development schedules if H.R. 1, the continuing resolution, is enacted and how would this impact other NASA activities? What would happen?

General BOLDEN. Congressman, we have not evaluated our operations against H.R. 1 because it is something that passed the House and still has to be determined. But we feel that we can fly STS–135 under the budget scenarios that we looked at which is the Continuing Resolution, the way we are operating right now, and I am confident that we will be able to fly STS–135.

Mr. HONDA. Based on your responses to previous questions then, my sense is that you are at the very bare minimum in terms of trying to get the best bang out of the bucks and trying to make everything work and meet some of the objectives that we have put out and the President has put out.

And my sense is that if we enact a $60 billion, $100 billion cut again, that that would negatively impact all the things that you have done and accomplished up to now in terms of planning and moving the NASA program forward.

Would that be an accurate statement?

General BOLDEN. Congressman, that is an accurate statement because we are working now to remain with the elements of the 2010 Authorization Act, signed by the President in November. I promise you that I will not exceed the budget, and I will do whatever I can not to do that. I have also told you that my number one priority is safety of my crews whether it is as we safely fly out the Shuttle or whether it is safety of the crews on the International Space Station. That is a triangle. If the budget comes down, that triangle gets smaller, and I am not going to jeopardize safety of the crew, so naturally something would have to give. But that is not something that I am anticipating. I am hoping, as I mentioned yesterday in my testimony, that reasonable people can agree to disagree, but come to what is best for the country.

Mr. HONDA. And that is, I guess, our role as policymakers, but taking into consideration the advice of our experts, that we should take that into consideration heavily before we make any fiscal decisions again.

General BOLDEN. Congressman, I would agree very strongly with that. If I lose money for construction of facilities or operations and maintenance, then the natural fallout is that either I have got to lay people off or I have got to close facilities. I do not want to have to deal with that. I would plead with everyone as I have done in my visits with many of the Members of this committee prior to the hearing to just be cognizant of the fact that there are positions you can put us in where the only alternative is to lay off more people or to close facilities. That is not a decision that I have even considered.

INTERNATIONAL PARTNERSHIPS

Mr. HONDA. And so we have discussed a variety of scenarios in terms of partnerships, international partnerships, level of trust. The International Space Station, you have been there.

General BOLDEN. No, sir, I have not. I wish I had. I am an old guy.

Mr. HONDA. Okay. So have you had interactions with folks who had gone to the International Space Station?

General BOLDEN. Yes, sir, I have.

Mr. HONDA. Have you had relationships with those astronauts from the other countries?

General BOLDEN. Yes, sir, I have.

Mr. HONDA. Has those interactions and the cooperation, has that been positive and has there been learning on all sides where the contributions towards spaceflight knowledge has been positive?

General BOLDEN. Congressman, I have not served on the International Space Station, but when you ask that question, my last flight in 1994, I was the commander of the first mission to involve a Russian cosmonaut as a member of the crew, and on the day that I was told that I was going to be made that assignment, I was the assistant deputy administrator here at NASA, and I told them to find somebody else. I had no interest in flying with any Russian because as a Marine, I trained all my life to kill them and I thought they had done the same for me. A wiser person at the time said, "calm down." At least meet them, have dinner with them, and find out whether you really believe that, and I had dinner with two cosmonauts, Sergei Krikalev and Vladimir Titov. Vladimir was a veteran cosmonaut fighter pilot and Sergei was an incredibly talented engineer. That night we talked about families and kids and stuff like that, and I said, "this is going to be good."

Mr. HONDA. Uh-huh. Have you had experiences with other countries that had astronauts up at the Space Station?

General BOLDEN. I have probably dealt with maybe not every astronaut who has been aboard the International Space Station, but most of them in different form and they all—if they sat here before you today, they would engage you in the same conversation I have had with the Chairman every once in a while.

Mr. HONDA. Sure. How about China?

General BOLDEN. I have had dealings with the Chinese.

Mr. HONDA. Reaction?

General BOLDEN. Sir, you know, my job is running NASA and I am intending to do that to the utmost. My focus right now is on the crew that I have on orbit and I want to make sure they stay safe. I am going to do that.

It is for the President and the Congress to decide what our relationship is with other countries. The President is one who believes in international engagement and so when you tell me and the President tells me what to do, when the President signs his name, I am going to do that.

Right now I do not deal in "what ifs." I am concerned to keep my crew safe, make sure that they are safe for the duration of the International Space Station, and I think I can do that. I believe with my heart that we can do what you have asked me to do.

Mr. HONDA. Mr. Administrator, I appreciate your depth of response and I believe that working together on common projects like the International Space Shuttle where people from different backgrounds and have different histories have a chance to work together find that the project and the goals sort of become the important thing and our history fades, you know, in the past and we create new futures and new expectations. And scientists, teachers are probably the ones that are the cutting edge with our young people.

General BOLDEN. Exactly.

Mr. HONDA. Us politicians are probably the ones that have the hardest time letting go. I know I am one of them. But I just wanted to say for the record that I believe you when you say that we have a system right now that is tightly knit and set up so that we get the best bang for our bucks. And the kind of cuts that we are looking at right now only drive us backwards and become less efficient and fall further behind on our goals.

And on the national debt, the debt is a result of the way we take care of our fiscal picture and so, you know, if we do not do that right, some things we have to make an investment for the future. And I think at times, we are our own worst enemies in many ways. And the history has proved that out.

So with your experience and your background, I take your judgment and your plans and your admonitions seriously. And I do appreciate that and I appreciate your service to this country, a man who has proven himself both as a military person, as a civilian, and as an administrator for NASA which is, you know, aeronautics is a big word in NASA. I do not want to see that leave. I do not want to see the Administration leave either, but you have provided the best direction that I have seen in the ten years I have been here and knitting the things together and being diplomatic to folks like myself in your responses. So I just want to say thank you for your service and your work.

General BOLDEN. Thank you.

Mr. WOLF. Mr. Dicks.

SHUTTLE DISPLAY SITES

Mr. DICKS. I deeply appreciate my good friend from Alabama returning the favor.

Mr. Bolden, you and I have had several discussions over the phone on the future, what is going to happen to the Discovery, Endeavour, and Atlantis when they end their service. And we know that the Enterprise is at the Smithsonian. I used to chair the Interior Appropriations Committee. I have a very strong feeling for the Smithsonian.

But we also have a great place out in the State of Washington at the Museum of Flight which is run by Bonnie Dunbar, a former astronaut. And the museum is the largest nongovernmental, nonprofit air and space museum in the country, hosting 450,000 visitors a year. The museum serves more than 120,000 K-through-12 students each year and has 22 programs that are aligned with state and academic standards. The museum is fully accredited by the American Association of Museums. And their geographic consideration is supposed to be taken into account.

I also urge the White House to take into account the geographic diversity in selecting Shuttle display sites. The western United States I hope will not be overlooked. And you know, of course, about the Boeing Company out there, and the northwest is home to more than 25 astronauts. Two Washington State astronauts, Commander Dick Scobee and Colonel Mike Anderson, gave their lives in service to their country.

And I would just like you to give us an update on where we stand on this, what is going to happen to these shuttles and it is very important to our State.

General BOLDEN. I would be very glad to, sir. There is an ongoing process. It has actually been underway since before I became the Administrator, and I kind of tweaked it when I came in, a process by which I have a team that is evaluating the 29 requests that came in to get an orbiter. I have asked that team to bring that to a head, to a focus so that I can announce a decision on the 30th anniversary of the flight of STS–1, Columbia.

Mr. DICKS. When is that?

General BOLDEN. April 12th.

Mr. DICKS. Coming right up here.

General BOLDEN. Coming right up, sir. The chairman is smiling. I hope that is good.

Mr. DICKS. So are we still operating under the criteria that the recipient has to come up with, like, $26 million? Is that still——

General BOLDEN. That is correct, sir. I should explain the funding required to get an orbiter was arrived at by looking at how much it costs NASA to perform the safety on the vehicle. There are a lot of volatile components in the Shuttle, a lot of dangerous components. We have to remove main engines, put simulated main engines on, remove the Orbital Maneuvering System engines, put simulated engines on, and all of that means that NASA has to produce replicas of real things, and that costs money. So when I asked what it was, it is about $28 million or somewhere in that neighborhood, so that is including the cost of transportation. So I think if I am not mistaken, it is in the neighborhood of $10, $11 million for transportation and then the rest for preparation of the vehicle.

Mr. DICKS. Thank you very much.

Thank you, Mr. Chairman.

Mr. WOLF. Mr. Bonner.

Mr. BONNER. Mr. Administrator, Alabama has already given our friends from Washington State a big gift last week, so I do not know if we are on that 29 list of cities or states, but I would just say probably for Ohio and for Kansas and for Pennsylvania and Arkansas and Texas and all of the others, we just want to make sure that decision is fair.

General BOLDEN. That decision will be fair, sir.

Mr. FATTAH. Mr. Administrator, if the gentleman would yield, I think the fairest way to do this would be any State that does not already have a NASA facility of any kind might be, like, at the first cut on these lists.

Mr. BONNER. I was hoping we would go in alphabetical order, but regardless——

Mr. FATTAH. I am trying to build public support for space funding, you know.

NASA OVERALL MISSION AND VISION

Mr. BONNER. Mr. Chairman, if there is no objection, I have got a few questions I would like to get in the record for the Administrator. He was generous enough to visit our office the other day and I appreciated that visit so much.

Appreciate as everyone does your patriotic example for the rest of us, young and old alike. You are truly an American hero and we are grateful that you are serving your country again at this important time at NASA.

We talked earlier. We had a chance to visit briefly about NASA's overall mission and vision. And I confided that some of us are getting of age where we remember all sitting around the TV set in our living room and everyone gathering with great interest in what NASA was doing and whether it was the moon or the early days of Shuttle.

I think we are in the Ag hearing room. I have been in this hearing room, but it looks like from the pictures on the wall that that is where we are.

And one of my requests has been frequently with your predecessors as well back when I was on the Science Space Subcommittee of the Science Committee was we need to make sure that the American people understand what NASA's mission is today, what NASA's relationship to food safety or to medicine or to chemical breakthrough or the other wonderful things that NASA has played a role in in terms of science and healthcare.

We need to make sure that the citizens of this country, the taxpayers of this country, and the people who have a soft spot in their heart for NASA that they understand what NASA 2011 is doing as opposed to NASA in the 1960s or 1970s.

So just two questions and the others will be in the record. But the first one is, could you restate, and forgive me if you did it in your opening testimony, what in your view is NASA's core mission today? Does that differ from your goals for NASA as it relates to the Administrator or from your perception of what the President and those in Congress who support NASA might be?

General BOLDEN. Congressman, I believe NASA's core mission is unchanged since the 1958 Space Act, and that is to enable the Nation to reach beyond the bounds of Earth into deep space, so that we understand more about our planet and that we can make life better for people here on Earth.

As you and I talked about your concern for Red Tide and other kinds of things, and I mentioned the fact that in our Earth science programs, while we go to space to look back and learn things about our planet. We are on the International Space Station now, and some of the experiments that are ongoing that you and I did not have an opportunity to talk about, we are doing plant growth experiments that will greatly improve our ability to produce food for people here on Earth in places that right now it is very difficult to do that.

We sponsor with the Agency for International Development a program that is called Servir. It is located in three countries

around the world. The first one was in Panama, second in Nairobi, Kenya, the third I opened in October in Kathmandu, Nepal. These take Earth science data from a 30-year archive and put it together with current Earth science data and help people in those three regions of the world do what NASA does for people here in the United States. It helps with crop planting, developing flood and drought models, and that is being done for East Africa, for Central and South America, for eight nations in Eurasia. That is really important. NASA does the same thing.

When I look around, you talk about water purity. We hosted a conference at the Kennedy Space Center last fall that was just on water purity where people were there from all over the world, and NASA can do that.

That may not be considered to be a core mission, but interestingly when you go back to the 1958 Space Act and you read what it says NASA is to do, the first thing is to perform Earth science. I mean, it is Section 102(d)(1) in the National Space Act, and the first thing is not flying humans to space. It is to steward the Earth, and we do that, we have found that we do it better when we are able to put humans outside earth's environment and help us look back so that we can interpret what we see better.

MATH AND SCIENCE EDUCATION

Mr. BONNER. And as a follow-up to that, since there is probably no agency in government that is more closely identified with leadership in math and science and inspiring young children to grow up to want to be an astronaut or to want to be an engineer or doctor or physicist, than NASA, can you tell us a little bit about how your budget this year delves into the area of math and science education as it relates to the country itself?

General BOLDEN. Sure. Our budget which this year is $138 million or so or proposed to be tries to focus on three levels of education: postgraduate, collegiate, and then secondary and primary school.

When I became the Administrator, we decided we would also try to really focus like a laser as people say on intermediate school, middle school. That is the summer of innovation that we brought about which is really trying to get students and teachers in middle school to fall in love with math and science and technology.

I had the privilege of visiting with the Chairman. He is big in education, and he puts his treasure into a school that is in the region of the district, and we went there and I was able to do something as an astronaut or former astronaut. I was able to go with the chairman and present the kids with something that they would not otherwise have an opportunity to do.

We are not the Department of Education. I do not want to be the Department of Education, but I have incredible content. I have incredible employees who ask me every day how we can find a way to justify their going out to a school. Because of restrictions that we have and how we account for their time, they are frustrated because they know that they can help encourage kids to become interested in math and science. And we do that a lot.

The Marshall Space Flight Center is incredible in what they do. They have a worldwide competition that is called a "Moon Buggy

Competition" and I know you know about it. We are about to be overrun by foreign teams because they get into this stuff.

Mr. Culberson read the assessment that came from an old friend of mine, General Mattis, who is now the commander of U.S. Central Command. But that study was done when General Mattis had U.S. Joint Forces Command and he is an intellectual and a person who understands the importance of education.

What we do at our NASA center is I have the most incredible workforce, so let's try to use it.

Mr. BONNER. I just think that as we go through this gap of where we will not be taking Shuttle up for or will not be taking Shuttle up and we are going to be waiting until the next opportunity comes for us to once again be in the driver's seat on this, knowing the challenges that we have been presented and that then we are going to in turn present to you in terms of squeezing that dollar farther and farther, anything you can do, and I think this would be consistent with the chairman and probably other members of this committee's view, is there anything we can do to make those investments so that children today can see a brighter future through the lenses and the opportunities of programs like what you are talking about with middle school?

I do not want to sacrifice the collegiate or postgraduate or the other areas, but that is important for us, I think, to give our children and our grandchildren what our forefathers gave us.

But thank you again for your great service to our country.

General BOLDEN. Sir, thank you very much.

Mr. BONNER. Thank you, Chairman.

Mr. WOLF. Mr. Schiff.

PLANETARY SCIENCE

Mr. SCHIFF. Thank you, Mr. Chairman.

Thank you, Administrator, for being here. Really appreciate the fine work you do. And as my colleagues have said, we have just great respect and admiration for your long career and it is a pleasure to see you again.

I want to raise a couple issues that first concerns a decrease over the next five years in funds for planetary science. We are awaiting the planetary science decadal results next week. That will provide priorities from the scientific community.

Several of us on the committee including my colleague, Mr. Culberson, have an interest in ensuring that the exploration of the solar system continues to be a focus at NASA. And I know this has been a tumultuous time. We want to make sure that programs that provided some of NASA's greatest successes like the Mars Exploration Program, the missions to the outer planets continue to receive attention and support.

How do you plan to continue that tradition given the decreases in the planetary science budget?

General BOLDEN. Congressman, we are anxiously awaiting the outcome of the planetary science decadal survey as are you. That will help us define where we go in the next two decades in terms of planetary science.

We have a number of missions that are on the book right now that we intend to fly. We think that they are adequately funded,

those that are far enough along, we have them well planned, but we will be challenged to do everything that the decadal survey asks us to do as we always are.

But, we have the Mars Science Laboratory which I know you are very familiar with. It is scheduled to launch the end of next year and should get to Mars in 2012. That will be an incredible step forward because we will be able to then take samples and analyze them on the surface of Mars.

It is a big thing for NASA. It is the largest vehicle that we will have ever sent to another planet other than the Lunar Lander. It is the size of a small house or a big car. And then we have GRAIL and Juno, two other missions that are going to go in the planetary science series that are on cost and on schedule. So we are confident that we will be able to manage with the budget that we have put forth.

Mr. SCHIFF. Well, I just want to express my continuing support for that investment. Through some of the darkest hours of the Manned Spaceflight Program, these planetary missions have provided continued inspiration. The number of visits online to view some of the images from Mars, for example, are in the billions and it is just extraordinary.

One of the things that I think unifies us around the globe is watching these exciting discoveries that come out of the planetary sciences. So I want to encourage our continued investment in that area.

COMMERCIAL SPACEFLIGHT, CONTINUED

The budget submission has $850 million for commercial crew. That is a bit more for commercial crew than was authorized in the authorization bill last year, but far less than the commercial crew funding proposed in the budget submission last year.

My understanding is that the current budget is designed to get crew flying the Space Station by 2015 which would keep our dependence on the Russians to a minimum. I know I am not alone in here in wanting to return flying American crew on American rockets as soon as possible.

If the Congress rejects this budget or cuts commercial crew funding down to $500 million a year, how much longer will it be before we can tell the Russians and their increasing fares that we no longer need their services?

General BOLDEN. Congressman, any reduction in spending means that we have to accept more risks. My idea would be that we end up with at least two companies that have produced vehicles that we can rely upon to get crews to Low Earth Orbit so I have some redundancy. With less funding, it jeopardizes the chance that I will be able to have multiple companies providing that service so it increases the risk.

I do not think it would take away our capability of having commercial capability to get to Low Earth Orbit, but it increases the risk of having that capability be sustained and reliable, if you will.

Let me correct one thing that I may have said earlier that might be a little bit confusing.

Mr. SCHIFF. Mr. Administrator, in addition to increasing the risk, wouldn't it also very potentially result in an increased delay in the

sense that if you are not willing to accept the additional risk to the crew, it may take longer to meet the safety standards that you set if you cannot make this investment?

General BOLDEN. Congressman, I do not worry about it increasing the risk in terms of safety. What I do worry about it doing is increasing the cost because if I have to rely on one provider, I am now back into a monopoly and so just as I would be with my international partner, the Russians. If there is only one provider, that one provider sets the price and then, I do not have anywhere to go.

That is not the cost savings that we look for in going to commercial entities. The reason that I want to go to commercial entities and I wanted to put a minimum of $850 million forward is because it takes multiple candidates forward, so that it stays competitive. You take the competition out and maybe they will be very patriotic, but that is unlikely. So the cost will go up.

LEVERAGING PRIVATE INVESTMENT

Mr. SCHIFF. Let me ask you something related. This December, we saw an amazing achievement in Florida with the successful launch of SpaceX's Falcon 9. For less than $600 million, the company designed and built a rocket and capsule, flew them into space, returned the capsule successfully to the earth.

Of the $600 million, only 298, less than half, came from NASA. The rest was raised privately. So this was accomplished for about $300 million which is a pretty amazing bargain for NASA. And obviously that leveraging the private investment was pretty key.

Can you talk a little bit about how much private investment you expect to leverage in the future and what greater capabilities that will give NASA by virtue of the fact that if you are able to leverage private funds for certain missions, you can devote more of NASA's resources to doing other things.

General BOLDEN. Congressman, you stated it better than I could. My total investment as a partner with SpaceX and Orbital in the COTS Program and in SpaceX's first demonstration, I am investing less than $300 million, and we will get a capable system that can carry cargo to orbit as opposed to anything that I could have produced.

So it was a fixed amount based on a Space Act Agreement that we signed with Orbital and SpaceX. That is not like a cost-plus contract or anything where the cost varies for me. I know how much I am going to pay. In the future, when we go to commercial crew, once we have an acquisition strategy in place, that will help us to decide what type of contract we will enter into with the commercial entities, whoever they are.

Ideally, I would like to have a fixed-price contract so that I know how much money I am going to pay up front. If I end up paying $3 billion for one of the two carriers to go, that is a great savings on what it now costs me to own and operate a system that takes people back and forth to Low Earth Orbit. So it frees up money for exploration.

The reason I am so confident that we can do what we say we can do with the 2012 budget is because of the ability to leverage on the partnership with commercial entities, where it is their responsi-

bility to go out and raise additional funds to supplement what the government has to pay as a part of the partnership.

SPACE TECHNOLOGY

Mr. SCHIFF. Let me ask you a little bit about NASA as a technological agency. All of us have reaped the fruits of NASA's technological prowess in our lifetimes. Unfortunately, as an excellent editorial in *Space News* last week pointed out, NASA's investment in space technology has shrunk from ten percent of its budget in the 1970s to two percent today. That is not enough for NASA to stay an agency focused on the future.

Let me just pull one of the most pointed quotes from the editorial. "We spend billions of dollars on launch vehicles and capsules, but without immediate investments in space technologies, they will have nothing to launch and no place to go."

Do you agree with that sentiment? How important is the space technology research budget to NASA's mission to explore the solar system?

General BOLDEN. Congressman, the space technology research budget is vital. The reason that is a billion dollar increase over what was in the Authorization Act is because that is almost bare bones.

We have a technology roadmap. Congressman Fattah referred to it earlier. We have a technology roadmap that Bobby Braun, my chief technologist, has laid out and it is now under evaluation by the National Research Council. We think that is very viable. That roadmap has been in place for decades. The reason it has been in place for decades, as you cited, the Nation has not chosen to make that investment.

NASA took money away from space technology and technology development every time we needed a source of funding. We are not going to do that in the future. That is a commitment I made to the President. That is a commitment I made to this Congress. If we are going to be able to explore beyond Low Earth Orbit, then we need to have certain capabilities that do not exist today, and they will come from space technology.

DESDYNI RADAR SATELLITE

Mr. SCHIFF. I just have one last question I wanted to ask you. NASA's previous budget projections had NASA's science programs increasing, particular Earth sciences. That was similarly an important investment in our future. But I want to talk about one particular satellite that is delayed in the budget proposal consistent with the recommendations of the National Research Council's Earth science decadal.

NASA's DESDynI Radar Satellite was an essential component of top priority tier one research and recommended for launch this decade. This will, once launched, contribute support to mitigation assessment response after catastrophic natural hazards like earthquakes, volcanos, floods, fires, et cetera, which is obviously a very important topic to my State of California as well as my colleagues on the Gulf Coast.

Given the critical importance of these measurements to scientists, first responders, and governors, how can NASA ensure

there is sufficient funding allocated to keep DESDynI Radar Satellite on an appropriate development path for launch this decade based on the phase one studies occurring in 2011 and subsequent developments in 2012? How much funding would we need in 2012 to meet the next milestones in project development as well as solicit support from international partners on the mission?

General BOLDEN. Congressman, I will get back to you. I will take it for the record. But if I can get a budget for 2011, that keeps the Earth Science Program on a course to intercept what we have said we need in 2012.

[The information follows:]

DEFORMATION, ECOSYSTEM STRUCTURE AND DYNAMICS OF ICE (DESDYNI)

The more constrained fiscal environment has necessitated hard decisions by the Agency. The DESDynI radar mission is currently in the pre-formulation phase and has completed the Mission Concept Review. The FY 2012 budget request provides sufficient resources to engage potential international partners on the radar mission, and NASA will evaluate whether contributions from partners can allow development for launch near the end of the decade within the overall Earth Science Division budget constraints. In addition, NASA will work to identify an international contribution of the lidar portion of the mission.

So, when all of you ask me what is the impact of decreased funding in 2011, we really need a definitized budget for 2011 because everything in 2012 is contingent upon what the Congress finally appropriates for 2011. If the amount appropriated in 2011 is significantly less than where I am right now at the 2010 levels, then 2012 becomes very problematic.

DESDynI right now is back to its original projected launch date which is after 2020. You may remember when I talked to you when I became Administrator and we submitted the President's 2011 budget request we were really happy because it was going to enable us to pull DESDynI, CLARREO, a couple of other Earth science satellites forward by as much as a year or two. Now that we are living under the 2010 Continuing Resolution and it looks like the funding level is not going to be better than that, then we are back to where we were when I became the NASA Administrator and not trending well, if you will.

Mr. SCHIFF. Thank you, Mr. Chairman.

Mr. WOLF. Mr. Austria.

Mr. AUSTRIA. Thank you, Mr. Chairman.

And, General Bolden, thank you for your service to our country. Thank you for your service as Administrator to NASA and for being here today.

I was not going to put this pin on, but after Mr. Dicks' comments, I had to put a pin on here that says land a shuttle in Ohio so Ohio is properly represented. We have got a million foot exhibition area called the National Museum of the Air Force as you are well aware of and over a million visitors in the Midwest and we would like to see the Midwest represented. So I had to get my two cents in on that.

But thank you for being here today.

MODIFICATION OF CURRENT CONTRACTS

And, General, let me ask you first, as you are probably aware, the NASA authorization calls for the modification of current con-

tracts. Specifically the language I am referring to in here, and I will read it, is, "In order to limit NASA's termination liability costs and support critical capabilities, the administrator shall, to the extent practicable, extend or modify existing vehicle development and associate contracts necessary to meet the requirements."

My question is, do you plan to continue to modify the current launch vehicle and crew capsule contracts as directed by the authorization bill or do you see where this scenario of these current launch vehicle contracts would not be modified?

And I know there has been a significant investment over the last six years in moving forward this. Is there a scenario where that would not move forward? And I am concerned specifically about the tens of thousands of highly skilled positions that are involved there and closing hundreds of vital aerospace facilities. Those are positions that you just cannot go back and replace with that skill level.

General BOLDEN. Congressman, we are working under the direction of the Authorization Act, and we are remaining within the fundamental elements of the Authorization Act. We are still looking at whether or not the existing contracts under the Constellation Program for both what will become an MPCV and what will become a Space Launch System whether existing contracts for the rocket itself and the crew carrier can be transitioned over to these new programs.

I may have misled some earlier. I think I led you to believe that we were closer to this determination than we actually are. We are relatively comfortable that the Orion contract could be transitioned over because Orion version whatever it is was built, was designed as a deep space exploration vehicle.

The Constellation Ares Launch System is not as clear cut and so we are still evaluating from two perspectives. One, the legal standpoint and, two, the procurement regulation standpoint. So it is left to be determined whether we can make that transition.

If it is determined that those transitions are possible, then my second hurdle is to determine whether it is affordable, and that is where I am presently working with industry to help them understand and help me determine how, if we are going to convert those contracts, can we do it within the limits of the existing budget, within the limits of the 2010 Authorization Act and the President's proposed budget for 2012.

Mr. AUSTRIA. Administrator, when do you see that determination?

General BOLDEN. I should be able to bring a report to the Congress this summer. We provided the 90-day report which was an interim report. In that report, we said we would be back to the Congress by the summer with a determination as to whether or not those contracts can be converted if it is affordable and, if not, how are we going to go through a competitive process to determine where we go. We are just not there yet.

GLENN RESEARCH CENTER AND PLUMB BROOK STATION

Mr. AUSTRIA. Administrator, let me ask you also as far as what do you see is the future for NASA's Glenn Research Center in Ohio and also the Plumb Brook Station. You know, they play a very im-

portant role and where do you see the future as far as your plan moving forward with those type of facilities?

General BOLDEN. I think Ray Lugo, the Director of the Glenn Research Center, has probably met with you on a number of times and Ray and I both agree. Glenn is postured very well under the funding levels of 2012 budget.

One of the things that adds confusion to the mix is we recently announced, two days ago, we announced three major program offices, that for the SLS at Marshall Space Flight Center, the MPCV at Houston's Johnson Space Center, and commercial crew at the Kennedy Space Center.

There is a common misconception that where the program office lies is where the money is spent. That is not the case. Glenn does not have a program office for any of these programs, but Glenn actually sees a healthy input of funds that will go into their community for technology development and for other programs. It is to be determined now that we have a program office for these three major programs, they can begin to decide what is needed to support a program and that is where the centers will find out what their level of work is, what their task orders are under a particular contract for a program. We could not do that prior to actually making these program office assignments. So that was a critical step for us as we did day before yesterday.

DUPLICATION IN CLIMATE CHANGE PROGRAMS

Mr. AUSTRIA. And let me, General, ask you also, we talked a little bit earlier, I know the chairman brought it up as far as duplication of services with different agencies, and you said the reports that you have seen that there is no duplication as far as climate research as far as Earth science programs, weather research.

And I want to just get a better understanding of this, if I can, because when you look at, you know, NASA's involvement in weather and climate change, you have also got the Department of Defense, for example, mainly through the Air Force Weather Agency spends a considerable amount of resources on weather forecasting, gathering significant intelligence on space, and the climate global environment. And then this data is provided to their joint warfighters, DoD, decision makers, national agencies, and allied nations. Similarly you have got NOAA that is spending a significant amount of resources on weather satellites, atmosphere research, and climate change research.

I guess whose mission is this? Is it NASA's mission or is it NOAA's mission to do this type of research and how do we go back to the taxpayers and explain that this is efficient? You know, what specifically are you doing different that we need a third government agency to be involved in this type of weather data collection or research?

General BOLDEN. Congressman, NASA and NOAA have had a 40-year partnership where we handle the program management responsibilities for their satellites. We produce them. We fly them to orbit. We check them out and then we give them to NOAA because NOAA establishes the technical requirements, and it comes out of NOAA's budget, not NASA's budget.

Earth science is NASA's responsibility. The things that I talked about earlier with Mr. Bonner about climate, drought and flood models, crop planting and those kinds of things, that is Earth science that falls under NASA's purview in cooperation with other agencies of the government.

So that is why I continue to say there is no duplication in what we do. I do a lot of program management for satellites, but I do not pay for those satellites. They do not come out of the NASA budget. We will produce Landsat satellites for the U.S. Geological Survey. That will not come out of NASA's budget. That will be reimbursable work.

When you talk about DoD, NOAA, and NASA were involved in a partnership on something called NPOESS that was supposed to be a global weather satellite for DoD and the civilian entities. That has now been broken into two. But NASA had no money in NPOESS. NASA was the provider of instruments and the satellite for the DoD and NOAA, and that has now been broken off, and we are still partnered with NOAA to try to produce the JPSS, the Joint Polar Satellite System, but that is a NOAA project paid for and budgeted in the NOAA budget.

Mr. AUSTRIA. Sure. And, you know, from where we are sitting, we are trying to provide the best efficiencies for the taxpayers to their dollars. And when you have three agencies out doing this, I appreciate your explanation because it is important that we are not duplicating services, that you are working together, and that it makes sense from a taxpayer standpoint that we are being efficient with their dollars by having three agencies doing this type of research.

General BOLDEN. You are exactly right, and we are even making an effort inside NASA. All this happens because government is so stovepiped, always has been. The President has told us, not asked us, has told us through the National Space Policy that came out last summer that we are going to knock down the stovepipes and agencies are going to begin to work together. Interagency collaboration is a really, really big part of the National Space Policy that the President released last summer, and so we are trying to do that.

Inside NASA, we are trying to do the same thing. If you looked at us several years ago, the science directorate, may not even talk to the human spaceflight people because they jealously guarded what they had. Today that is not the case.

Ed Weiler, Bill Gerstenmaier, Doug Cooke and Bobby Braun, the chief technologist, sit together quite a bit and they collaborate on, okay, we do not have the money we used to have and we are not going to get the money we used to have. How do we optimize the amount of money we are going to get so that science, human spaceflight, and technology development can all provide some input and get the best for the American public? That is where we are going. That is how we based our funding or our funding request in the 2012 budget.

Now, if you make me do things the way we have always done them, then the 2012 budget does not stand a chance of working. The big premise in the 2012 budget was we were going to do things differently. We were going to rely on commercial entities to take

people and cargo to Low Earth Orbit, not NASA. We are going to rely on technology development to define the way that the heavy-lift launch vehicle and the crew vehicle evolve over decades actually until we finally put humans on Mars, at some point in the future.

The vehicle that takes humans to Mars is not going to be the vehicle that takes humans to an asteroid in 2025 because we will learn, we will develop new technologies at every increment and we have to be able to do that or we are not going to get anywhere.

Mr. AUSTRIA. Administrator, thank you very much. And if you would like to wear a pin, I have got extra pins here, you are welcome.

Thank you, Mr. Chairman.

Mr. WOLF. Thank you, Mr. Austria.

Normally we would go back and forth, but Mr. Serrano was kind enough to let us go to Mr. Yoder. Mr. Yoder was the first person here. And two hearings ago, he never even got any time. So I appreciate that José. Mr. Yoder.

JUSTIFICATION FOR SPENDING MONEY ON NASA

Mr. YODER. Well, thank you, Mr. Chairman. I am happy to learn from the questions of my colleagues, so I appreciate the opportunity to ask a few myself today.

Administrator, thanks for your service. I have been reading your bio here during the questioning and you have a long, lengthy history of service. And certainly I would expect your return to work with NASA probably is not only from your deep-seated passion for service but your belief in the mission. And I assume it is a very exciting position for you as you can envision where we want to take this program and the possibilities. I just would believe that is a very exciting place to be.

With that then, I wanted to ask you a couple questions about, maybe some macro questions here if you can help me out with a couple things. When we go home and visit with our constituents and they talk about the national debt and they talk about the overspending in Washington, and we have heard comments this morning regarding the greatest security threat to our country, can you help me with some points on how we justify spending money with NASA? There ought to be something I know you can share with us.

And beyond that, how do we justify as we deal with competing efforts to capture resources in this city, not just from a perspective of, well, this is why our mission is important, but this is why it may be more important than other things we are doing in the budget because that is really the essence of what we need to be doing in Washington is not only just talking about what is good about certain programs but how we prioritize?

I have been in Washington seven or eight weeks now and I am one of the new Members of Congress. And this is the only experience I have been in where we can sort of spend as much money as we want and there is really no concern over time, over decades and decades for the bottom line.

And so we got to get away from this idea of this is why our program is important and move towards a this is why it is more important than other things we are doing in the budget. And do you

feel that if we have to fight for resources that money should come out of other programs into your budget and why?

General BOLDEN. Congressman, first of all, I do not think money should come out of any other programs into my budget. I am not encroaching on anyone else. I do not want to go there. But I would say if you want examples of things that you can tell your constituents on what their tax dollar is going for, let me give you two areas.

Aeronautics is one that I do not get to talk about very often, and Glenn Research Center is key. The Boeing 787, which I think everybody knows about the Boeing 787, if you look at it and you look at the engines, the GE engines have a funny looking cell on it. The back end of it is what is called a Chevron nozzle. That was developed in the early 1990s at the Glenn Research Center, and they just were persistent. They kept letting industry know it was there. General Electric and Boeing decided for the 787 that they would pick that up and use it. It decreases pollution. It decreases noise. It increases the efficiency on the engine.

We are working through the Ames Research Center and Langley Research Center with the FAA on NextGen, the Next Generation Air Transportation System. We have developed software and programming for something that is called constant descent and arrival. We have run tests in the Denver Airport, Continental and United Airlines, where they have demonstrated that the cost savings to them following the NextGen system is in terms of millions and maybe even billions of dollars.

When I talk about these concepts that save fuel usage, for example, my Associate Administrator of Aeronautics told me that based on what we have seen in our tests, the amount of fuel that would be saved in some of our new systems, if we got one percent of that savings to industry reimbursed to NASA, it would take care of my aeronautics budget.

So those are the kinds of things that I would, if I came to your area, I would tell your constituents.

If I looked at Earth science, which is always questioned, we do water monitoring in the western United States. Water is a critical commodity. We have fought wars in that part of our country, you know, among ourselves over water. Water is a valuable commodity and we are doing water research for the western United States. There is an alliance of states out there and we are contributing to that.

So those are the kinds of things that I would offer to constituents who said what I am getting back for my dollar to NASA.

Mr. YODER. Well, and I think those are helpful for a couple good examples. I do want to suggest, though, that one of the things we have to do in this town is decide what our priorities are going to be and we do have to decide whether our dollar is going to go into your program or whether it is going to go into many of the other priorities of this government. So I encourage you to not only pitch why.

I mean, we hear from folks every day. They come into my office. They come into committees. This is an important value to our country. Very few folks come and argue that it is not an important value.

So how do we grade our dollar invested into NASA versus our dollar invested into education or to highways or to social services? And that is the challenge I think that we have to engage in here. And so that is difficult and uncomfortable because your drill is to pitch NASA.

But it is helpful to us if you can pitch it, at least to me, if you can pitch it in a way and why and a dollar invested here is maybe not perceived as a short-term benefit as getting, you know, food to hungry people, but long term, the value is so great that we cannot ignore the mission.

So we have got to be able to—because I think it is an incredible mission and the mission statement, you know, reach for new heights and the unknowns so that what we do and learn will benefit all mankind. That is a pretty all encompassing statement. That covers a lot of ground benefitting all humankind. And so we need those tools, or I do at least, to be able to pitch how we are doing that.

NASA'S LONG TERM GOALS

And I guess my second question would be, again on the macro, what is the vision? We have talked a lot about specific things we are doing in the 2012 and you mentioned 2025 being able to go to an asteroid a second ago. What is the 50-year, 100-year vision? I know that is really hard to do, but I assume when you get up in the morning, one of the passions is seeing where this could go.

And recently, in recent years we have seen new satellite or I guess new data related to planets and other solar systems. You know, I cannot speak for the rest of the committee. When I grew up, you know, we talked about the planets in our own solar system and tried to learn, you know, the ordering and all those things. But now it is so broad.

And how expansive does this get and where do you see things going in 50 years?

General BOLDEN. Congressman, space is the ultimate high ground. If I go to where Mr. Culberson is, I am not interested in controlling that high ground, but I want to be there so that whoever is there with me is there as a partner or at least I can keep them from doing something untoward.

If I have the capability of putting humans on another planet, if I have the capability of putting humans on Mars, I can look even deeper into our solar system and even beyond. To some people, they say, okay, but that does not feed little kids. It does. Everything we do in order to reach these new heights brings about some technology that we did not have yesterday.

I love to give people the example of something very simple. An emergency medical ambulance, an EMT and an ambulance that goes to Anacostia to get a gunshot victim, if you will, if you want to be stereotypical, which I hate, but that is what you see on the news. That gunshot victim gets, one little patch put on his or her chest that has no wires to it. By the time that gunshot victim gets into whatever hospital they take him, the doctors have all the vital signs. They know what kind of condition they are in. They know where to put him in triage and they can save a life.

The same thing on the battlefield. Because of things we have done to go to the Moon, we are able to save soldiers, marines, coast guardsmen and sailors because we have technologies that were developed for other reasons, but they come back to Earth.

That is what we mean when we say we reach for the unknown. We do not have a clue what we are going to find when we explore. If we did, it is not exploring. We could decide, okay, there is no value there, I am not going there. We are not that smart yet. So we explore, and every time we explore, we discover something that we did not have a clue.

When I took my flight on STS–60, I discovered a lot about me as a human being with other people. That is why we do it.

INFRASTRUCTURE PLANNING

Mr. YODER. Yeah. I can see your passion for it and I appreciate it. And I think it is one of those things that inspires Americans to great heights and it is more than just being a consumer-driven society where we consume products on this planet. It is about finding our ultimate destiny.

And so it is pretty amazing and I appreciate the fact that you are leading that effort. And thanks for sharing your vision in doing that.

I want to ask you some micro questions now, just a few things that in reading some of the materials. We had the inspector general in some weeks ago and I was just reading through his report. And I am sure you have seen it. I just want to get some of your response to these things so we know how these things are being resolved.

There was an issue, and one of the things we are trying to figure out in Washington in saving money is, is there unneeded property or unneeded land, buildings, things that we could sell, I think the President even spoke about this in the last few days, that we could sell to try to save the country money.

And I noted here that it says NASA is the ninth largest Federal Government property holder, controlling a network of 5,400 buildings and structures, that the 2008 management plan shows that 10 to 50 percent, that is a pretty big range, 10 to 50 percent and 30 to 60 percent, 10 to 50 percent of warehouses and 30 to 60 percent of laboratories are underutilized. And it says that there is agency-wide deferred maintenance.

And I guess I would ask you just to comment on that. And are there things we can do to consolidate?

I was in the state legislative process and appropriations process there and we found if we do a little auditing, we could take agencies that had multiple buildings and convince them that they could operate things under less buildings, save money, even though it was uncomfortable for the agency to do that.

Are there some uncomfortable things that we are avoiding here? How do you resolve this?

General BOLDEN. Sir, because of our system of government, there are always uncomfortable things that we avoid. However, we have a facilities master plan that is being developed where we are looking across the agency at all of our infrastructure and trying to determine what is excess, what is underutilized. We are trying to

look for partnerships within industry. We are looking for partnerships with other agencies so that we get the best of the facilities available and optimize their use.

We have the first iteration of that facilities master plan that has been completed, but it is work ongoing. And it will go on forever probably. We will never be ideally sized, but we keep working on it.

Mr. YODER. Well, do you think there are some buildings that can be sold in order to try to save money in order to fund some of these larger destiny functions we are trying to focus on so we are not wasting money?

General BOLDEN. I am hoping that when the facilities master plan is completed, the first iteration of it, that I will know whether there are some facilities that can be closed.

We have already taken one step, one small step. We had an ARC Jet Facility at the Ames Research Center and an ARC Jet Facility at the Johnson Space Center. An ARC Jet Facility for somebody who may not know generates a lot of heat. So, if we want to evaluate the effect of a hole on a tile on the Space Shuttle, we put in an ARC Jet Facility and simulate what it is going to be like during reentry, and we have had to use that in the last few years.

We felt we did not need two ARC Jet Facilities. So we went in and did a study and we determined that, yes, that is true. So, I have directed that we close down the ARC Jet Facility at the Johnson Space Center, transfer those capabilities or those assets to the Ames Research Center out in Mountain View, California so NASA will have one ARC Jet Facility. That is an example.

Mr. YODER. I appreciate that example. And for me, it shows me that you are interested in trying to find savings within the agency. And so I would encourage you to do things like that as I consider how I would vote on measures and where we would prioritize things.

I want to spend money with agencies that are being very efficient with the resources we are already giving them and reward good behavior and good efficiency and not reward folks who are not.

So as you go down that road, I think if you can find ways to show Congress that you are finding savings internally and becoming more efficient because I know you do not want to waste dollars either, you want folks on mission.

COST AND SCHEDULE ESTIMATES

And then, finally, and I appreciate the chairman's indulgence to have some time this morning, the final question I had for you is something that I see a lot of reports we get and it is something that is really hard to explain back home.

It is very frustrating, in fact, when we talk to folks at home about government spending. They assume that there is a lot of bureaucratic waste, that there is a lot of abuse, that there is a lot of opportunity for overruns and expenses.

And one of the things I noted in the inspector general's report, it says that NASA has historically struggled with establishing realistic cost and schedule estimates for its science and space exploration projects. And it shows an example of the Webb telescope. And it says that its estimated cost of $1.6 billion scheduled for

launch in August of this year. The plan launch date is now June 2014. The estimated cost has exceeded now $5 billion.

And the independent review of the program released in November 2010 cited problems with budgeting and program management rather than technical performance. And that sounds like a management failure from our own people in terms of how we are managing these programs.

And so I would ask you just first are you concerned about that reputation?

General BOLDEN. Sometimes I think there is a conspiracy to make me continually say how angry I was when I found out about James Webb Space Telescope (JWST). And I will repeat that: nobody was as angry as I was. However, that is, I cannot do anything about where we were when I found it.

Mr. YODER. Absolutely.

General BOLDEN. However you are absolutely right, and when we discovered the condition that JWST was in from a budget standpoint and a management standpoint we made some changes in the management structure. Not only did NASA make changes in the management but we got together with our prime contractor and they made changes in their management. Because it was agreed there were problems on both sides.

We are doing a bottoms up review right now. James Webb was baselined just before NASA turned to something that we now call Joint Confidence Level (JCL) process, where we take a look, we have independent assessments on our cost and schedule. GRAIL and Juno are two satellites that we talked about a little bit earlier. GRAIL and Juno are coming in on cost and on schedule because they were subjected to the JCL process, where we had independent assessments as to what our real cost is going to be.

We have a habit in NASA of falling in love with our plan and our estimate. We are finding that the worst person to ask that is the principal investigator or the program manager, and so we now go outside and we get independent assessments. I am confident that we are going to find that our track record on cost and schedule containment is going to rapidly improve as we see more and more projects fall under the JCL.

Mr. YODER. Well I appreciate your focus on that. And certainly as we continue dialogue over the years and your service continues I hope that when we have a chance to do this again you will see good progress in this area. And it is just so frustrating to read things like this and try to explain those back home. And when an article comes out, you know, it appears that Congress is not doing its job on oversight. And so it is one of those things that I think really challenges the trust that this country has in that its tax dollars are being spent wisely. It makes——

General BOLDEN. If I can ask your indulgence for one, thirty seconds, what I do need for people to understand is the critical importance of the James Webb Space Telescope. I do not want to leave anyone with the impression that it is a bad project. It is, as all the independent assessments have said, technically it is very sound. We are taking actions now to contain cost and schedule so that we can launch James Webb. The promise that it has for the world, not just the nation, is absolutely incredible.

If you look at what Hubble has done in terms of publications, changing textbooks, everything, the curve went like this. We project that JWST will just jerk it to the inside. It is going to be ten hundred times better than Hubble.

Mr. YODER. Well and I, that is all good, and I appreciate that, and I am glad that project is moving forward. But the concern related to the actual management of our own people and our effect on causing things to be mismanaged and therefore costs raised, it is tough to explain outside of this building.

General BOLDEN. Yes, sir. I understand.

Mr. YODER. So keep doing, keep working hard on that. And your efforts to improve quality and management of the dollars we are giving is so critical to reinforcing support for your agency. And I appreciate your comments. And Chairman, I appreciate the time this morning.

General BOLDEN. Thank you.

Mr. WOLF. Mr. Serrano.

Mr. SERRANO. Thank you, Mr. Chairman. I apologize for being late, but like so many members I was at another hearing. Where I will just say that the EPA Administrator was not being treated with the same kind of respect——

General BOLDEN. She is a regulator.

SHUTTLE TRANSITION

Mr. SERRANO. Exactly. Besides NASA, like NOAA, have a reputation of being agencies that people like and are excited about. And notwithstanding budget cuts and the needs for balancing budgets, we know the importance.

Let me ask you a question. With the cancellation of the space shuttle program there will be folks unemployed, there will be folks moved to other areas, will those folks be absorbed? And Mr. Chairman, a reminder of something you and I, you know well because I have asked this question over the years. But one of our country's best kept great secrets is the fact that every time one of our space flights go up, you know, there are a lot of folks on the ground who are recruited from the University of Puerto Rico at Mayaguez. And I single out Mayaguez because that is where I was born. You know, I have got to do a little shout out. So it is a two-pronged question. What happens to the folks that are there now? And secondly, what happens to that great recruiting program that you have had there for so many years which has really made an impact on how those folks view the federal government, NASA, their role within the United States. When you live within a territory, and I do not want to get into that issue, sometimes I think you ask, you know, where am I? Well the folks you recruited out of Mayaguez have always known where they are, and their families know where they are and what role they play in the greater good of our country. So what happens to folks in general? What happens going forward to the recruitment program?

General BOLDEN. Congressman, the best news story on the shuttle is it was not cancelled. It was a close-out that was an orderly close-out that began in 2004 after the Columbia accident, the President decided that we should phase the shuttle out and move on to a next generation to access to space. So, we have had a very rigid

transition program in place for people to move from the space shuttle program into newer programs, or other programs.

When you talk about young people from Puerto Rico I have had the privilege of meeting many of them. A lot of them come to the Goddard Space Flight Center. So, they are still as excited as they ever have been because a lot of them are in the Earth science arena. A lot are in our science and technology arena. Some of them are working for Dr. Bobby Braun.

Mr. SERRANO. Right.

General BOLDEN. So they, they would push me to go faster than I am going in the development of commercial crew for access. They would push me to go faster than we are going in exploration, human exploration, but they are patient because they recognize that we are limited by budget. But they are incredible.

Mr. SERRANO. Right.

General BOLDEN. Every time I meet them I have always asked them, why do I have so many young people from Puerto Rico here in this place? They said, "because we want to explore."

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM)

Mr. SERRANO. It is interesting how sometimes recruitment, it reminds me of something Mr. Fattah and I have discussed on a totally different subject but one of my favorite subjects, baseball. There was a camp in Puerto Rico once, and some kid got up, this is the truth, thirty years ago. And said, "What is the quickest way to the major leagues?" And the coach says, "Do not ask that silly question." And the American, the scout from the States said, "Catching. Nobody wants to catch." And then you have got Posada, and Pudge Rodriguez, and Benito Santiago, and it was on, and on, and on. And everybody became a catcher.

In the States and in the territories NASA does a wonderful job in STEM education. And it is so important. I have seen it in the schools in the South Bronx, I have seen it in other areas, it is just wonderful. Not only the educational programs but the visits also from NASA are always so important to our community. With budget cuts in that area already seen, what is the future of those programs? What is the future of that involvement? Because it is really key. And I have been listening to Presidents, and Governors, and Speakers for 37 years of public life making statements at the beginning of the year. I have never heard a speech where one piece stuck to me so much as when the President said this year we need to continue to be innovative. We need to continue to invent. Americans do that well. And we know that NASA has played a major role in that. Where do you see that going?

General BOLDEN. Congressman, I see us continuing to be as energetic about education as we always have been. And you know, the President makes an incredible point that the nation that outeducates wins. If you do not do that then you become second, third, fourth. I listened to something this morning, I think we are fifteenth in reading, seventeenth in science, and twenty-fifth in math. You know, not many of us would stand for our local baseball team being at that category, and yet we are willing to let our kids fall to those levels. NASA will continue to do what we do.

I cannot say enough about my employees. We are so good in education because they give of their time and their talent, and they do not get paid for it. We are the biggest supporter of the FIRST Robotics program in the nation. No one does as much for FIRST Robotics as does NASA. We have, I will get the number wrong, but it is probably three hundred and some odd teams around the country. This is international competition. I mentioned the Marshall Space Flight Center sponsoring the World International Dune Buggy Competition. These are things that employees do out of their own pockets.

So we have budgeted to a level that we believe will help sustain the President's Educate to Innovate program, will help in the Race to the Top, will help in the First Lady's program of education. Everything that we know we need to do for education NASA is going, we are going to be able to support with the budget that we have put forth.

NEAR-EARTH OBJECTS

Mr. SERRANO. Let me for my last question bring you back to the Island of Enchantment, and that is with the Arecibo Observatory. As you know, in some cases it has almost been scheduled to close. And then you have folks who write about this issue who say it is a vital service, we need to continue to make sure that we study the possibilities of foreign bodies hitting Earth, and what that would mean at that moment or for the future of our planet. And so there seems to be a contradiction, whether with those folks who would want to close it down and those folks who claim that it is not just something you close down, it is something you grow because it is that important.

Obviously to the folks there, not only the actual observatory, but the symbolism of it being there, has always been important. What is the state of the Arecibo Observatory, do you know?

General BOLDEN. Congressman, at the present time Arecibo is incredibly valuable in helping with our assessment of Near-Earth Objects (NEOs) and threats to the planet. The future, I cannot tell you what it will be because people who are really serious about the threat from NEOs would tell me that our money might be better spent if we put something in orbit around the planet Venus and let it look back across Earth because we would pick up more NEOs that way. WISE, which we recently finished collecting data on found thousands of previously unknown Near Earth Objects. So Arecibo is an important part in that network of instruments that look for near Earth objects. So, you know, we continue to use it.

Mr. SERRANO. Okay. Well thank you for your honest answer. Thank you. Thank you, sir.

COOPERATION WITH CHINA

Mr. WOLF. Thank you, Mr. Serrano. We have a whole lot of questions going. But I wanted to address the China issue that came up. The CR that passed the House carries language that says, "none of the funds made available by this division may be used by the National Aeronautics and Space Administration or the Office of Science and Technology Policy to develop, design, plan, promulgate, implement or execute a policy, program, order, or contract of any

kind to participate, collaborate, or coordinate in any way with China or any Chinese owned company unless such activities are specifically authorized by a law enacted after the date of enactment of this division."

Some people say, "Well, you know, what are you talking about?" I just want people to know what I am talking about. I think there is an economic issue. There is a moral issue, because man does not live by bread alone. And there is a national defense issue.

I quoted Simon and Garfunkel, "a man hears what he wants to hear and disregards the rest." When you are getting sort of warm feelings about China, keep in mind the People's Liberation Army has a program that will, for $55,000, execute someone in a prison and sell you a kidney. That is a reality. We have the pictures, we have the facts. If you are Catholic, there are about 30 Catholic bishops that are in jail or under house arrest. To me that is pretty significant, but maybe some people have different views. There are hundreds of Protestant pastors in jail, as well as house church leaders. I went to China two years ago before the Olympics. We had a dinner set up. Every house church leader who was scheduled to come was arrested that night except for one, and he was arrested the very next day, and pummeled, and beaten.

Hu Jintao, who President Obama gave a state dinner for, is the one who put together the program for cracking down in Tibet. I have been to Tibet. We snuck in with a trekking crew years ago. They have destroyed the country, they have bulldozed the country. So as you get your warm feelings about China, keep in mind they have the Nobel Peace Prize winner in jail, and his wife cannot even get out of her apartment to move around town.

In addition, there are cyber attacks. The IG testified a couple of weeks ago, and there are a number of cyber attacks attributed to China. For the record, could you furnish how many cyber attacks by China there have been against your computer system?

[The information follows:]

CHINESE CYBER ATTACKS

NASA does not specifically associate incidents on the basis of country of origin. Of the thousands of incidents tracked in 2010, a much smaller number of incidents (less than 100) involved cyber attacks specifically targeting sensitive NASA assets. Of those, roughly 15–20 included gross indicators suggesting a foreign China association.

The NASA Office of Inspector General does seek prosecutions for general computer crimes and has worked in concert with other Federal agencies to bring cases to the attention of the foreign governments when they are able to be identified.

NASA is implementing enhanced cyber security processes and tools to better identify and mitigate specific targeted cyber attacks against the Agency. We believe these efforts will not only improve our security posture but will assist in collaborating across government to defend against cyber attacks.

Next there is Darfur. The President cares. The Congress has spoken out against the genocide in Darfur. I was the first member of Congress to go to Darfur with Sam Brownback and China has been the number one supporter of the genocidal government there. The Antonov bomber is funded by China. The Soviet HIND helicopter is funded by China. The weapons that the Janjaweed carry when they come into villages and kill the men, rape the women, take the kids away, come from China. China has the largest embassy in Khartoum.

I love the Chinese people. The fact is, when most of the dissidents come into the country, they come through my office. I personally believe that this government in China is going to fall. I believe that what you are seeing taking place in Tunisia, and Algeria, and Egypt has so frightened China that they are blocking the Jasmine Revolution on the internet. They are so spooked in China that they are blocking Ambassador Huntsman's name from showing up. They are frightened. Because they know they are running a dictatorial government, and they know that the Chinese people want freedom, and love freedom, and are going to rise up. In 1986 very few people thought that the Berlin Wall was going to fall. Ronald Reagan did. He said, "Tear down that wall," and he did certain things. I think this government is going to fall. And I think in my lifetime we will see freedom and democracy for the Chinese people. Then, when we see that and the administration comes up and says, "Let us have this exchange program with the democratic people of China," I will be at the top of the list. I will say, "Let us get them on. Let us be involved."

But we cannot forget the kidney program, Catholic bishops, Protestant pastors, the plundering of Tibet, what they are doing to the Muslims and the Uighurs. What they are doing to the Uighurs in China is brutal. The leading Uighur dissident, Rebiya Kadeer, who lives out in northern Virginia, her two kids are in prison. No one says anything.

And so that is why we have this language. And I will fight to the death for this language. We do not want these joint programs because I know what they are doing and they are spying against us. And so when we get all warm and fuzzy about China, remember how in Nazi Germany during the 1936 Olympics they took down the signs. They did not let people know the Holocaust was taking place, and not many people wanted to speak out about it. Bad things are happening in China now, too.

Even if we are talking about jobs, I saw in the *Wall Street Journal*, that General Electric just signed a contract with the avionics operation in China to develop an avionics program that will put Boeing out of business in a few years. So that is why, as long as I have breath in me, I will speak on this issue of China. I think it is a moral issue, I think it is an economic issue, I think it is a national security issue. And I love the Chinese people. I am looking forward to, when the revolution begins, getting on an airplane and flying over there and being with them. Then China would be our friend as Germany is currently our friend, and Japan is currently our friend, and Russia is becoming our friend. But until we see China stopping the spying and cyber attacks, and the crack downs, and the torture of the Chinese people, we cannot participate. We can't give their government that opportunity whereby they can compete with us and do some of the things that hurt their own people.

So that is why this China issue is so important here. But, let me get to some of the other issues on the questions.

MULTI-PURPOSE CREW VEHICLE (MPCV)

The members of the contracting community who will develop and build the launch system and the crew vehicle have told us that the

program goals are achievable within the parameters set in the authorization. Have you looked at the data they are using to reach this conclusion? And if so, what assumptions are they using that differ from your own?

General BOLDEN. Are you talking about the Orion conversion to MPCV? Congressman, we are actually working with the contractors even as we speak to help determine whether or not we can make the transition from the Orion contract to the MPCV, and then how do we make it affordable if that can be done? So we are working with them. Hopefully the data is the same because that is where we get it through our program office from the contractor. So I would hope that we are all citing the same data.

CONSTELLATION SPENDING UNDER THE CR

Mr. WOLF. Okay. The NASA IG issued a letter in January stating that the provisions of the current CR are causing NASA to spend hundreds of millions of dollars on aspects of the Constellation program that might otherwise have been cancelled or scaled back. Many people have interpreted this letter to mean that NASA is wasting that money. NASA has not made the final architecture determinations yet for the new exploration program, so is it premature to say that any particular program element is definitely unnecessary? Could you please state for the record whether you agree with the characterization that the current CR is causing NASA to waste money? Do you agree or disagree with the IG?

General BOLDEN. Congressman, I disagree that we are wasting money and I think we sent a letter to that effect. However, I do agree with the IG that the soonest possible relief from the restriction of terminating the Constellation program, then the better off we would be because it causes difficulty in managing how you control assets.

Mr. WOLF. Now there is language that is in the CR, that is still pending, because it did not——

Mr. CULBERSON. Prohibition, it is cancelling Constellation.

Mr. WOLF. But does the fact that there is House-passed language to address this not give them any flexibility at all? Would there be, and I am just asking, a way of doing the language in the next CR extension that could give you the ability to do what you think is appropriate, even though it is not a final CR? I will talk to the staff.

General BOLDEN. Yes, sir. Congressman, whenever the language is changed, and I am freed up to terminate the program, we will do so wisely and in an orderly manner. But right now, the money that we spend under the Constellation contracts are money that—it is the way that I directed, that we spend money on things that are useful for future programs. Programs that we see we will need for heavy-lift launch vehicle, for MPCV, for technology development. If they fit that category, then we have asked that we continue to spend the funds on that. But not spend it on something that we know has no use, and that is what we are trying to do to the greatest extent possible.

COMMERCIAL SPACEFLIGHT, CONTINUED

Mr. WOLF. Okay, I have a number of questions on commercial crew, which we will submit for the record. One you have covered with regard to the $350 million requested over the authorized level. With the requested fiscal year 2012 money, NASA expects to fund a third round of proposals to advance potential commercial vehicles to the preliminary design review stage. While this is significant, it is still a long way from having a functional vehicle that can serve as our primary transport to the Space Station. When do you expect the first commercial crewed flight to take place? Will this require NASA to extend its current contracts with the Russians to provide interim transportation? And in addition, what is it costing us per flight with the Russians? What was the negotiated price? How did we reach that? I think you made a very good point earlier. If they are the only car dealer in town, you have got to buy your car from them. And so do you expect the cost to continue to escalate the longer it goes? Do you see any sign that they are moving to change that? Is it a fixed contract? Can you just sort of wrap all that into an answer?

General BOLDEN. Congressman, I am not at liberty to talk about the specific dollar values because there is ongoing work right now to finalize the agreement that would take us out to 2016 to be able to buy seats on Soyuz if necessary.

My belief, going back to your first question, the commercial entities have told us that three years from the date of signing a contract to produce a human, a commercial crew vehicle, then they would have the ability to deliver. So, that would mean if we are able to go on the schedule we are on right now, we are talking 2015-ish before we have our first crew vehicle. That is about four years from now, four, five years if you go to the end of it, which is significantly less than where we were before. I am confident we can do that, provided we get the funds to keep a competitive process going. When I say I had to stay within the budget, and I want to keep my crews safe, and I want to live within the constraints, the major elements of the Authorization Act, I looked at what I needed to do to buy down risk on commercial crew, and that was invest some money over the amount that was in the Authorization Act. And that is where the $850 million estimate came from. That allows me to keep at least two contractors in the competition when we finally get to the end.

Mr. WOLF. I do not want you to share your cards necessarily with regard to the Russians, but what is the cost of the first trip?

General BOLDEN. Congressman the present, I think, let me take it for the record. Because I think, I know the present contract is in the neighborhood of $50-some-odd-billion a flight, a seat. But that includes training, facilities——

Mr. FATTAH. You mean $50 million a seat.

General BOLDEN. What did I say? Did I say——

Mr. FATTAH. You said billion.

General BOLDEN. Oh, no, no, no. Not billion. I am sorry. No, we do not, but I will take it for the record, sir. Because we need to let you know what it is that we are paying for.

[The information follows:]

CONTRACT COST FOR SEATS ON SOYUZ

The most recent modification to NASA's contract for Russian services, including crew transportation and rescue using the Soyuz spacecraft, was signed in March of 2011. The modification had a value of $753M, and provides services through June 30, 2016. The modification covers comprehensive Soyuz support, including all necessary training and preparation for launch, flight operations, landing and crew rescue of long-duration missions for 12 individual space station crew members. The contract will provide for the launch of six people in calendar year 2014 and six more in 2015, as well as their return to Earth in the spring of 2016 after a six-month stay aboard the station. This results in an average cost of about $62.7M per seat, which also includes other associated services and some minimal cargo on Soyuz.

Mr. WOLF. Do we have to pay luggage, like in the commercial airlines, less for carry on?

General BOLDEN. No, sir. But we do, but it does, there are costs that we have that we pay when we pay the Russians that we would not pay a commercial entity because we would be paying them for seats and some other services. The contract that we have with the Russians is for an extensive amount of support——

Mr. WOLF. But what about the second and third? How does that quite work out for the next time?

General BOLDEN. We are still living under the agreed upon amount through—I need to get back to you, sir. I do not want to give you a date. It is like 2014 or so we are under——

Mr. WOLF. Okay.

General BOLDEN [continuing]. We are under an amount that is defined already. The contract that we are working on with the State Department, and if we get approval, will go through 2016. But I will get you——

Mr. WOLF. Okay, if you could have——

General BOLDEN. I will get you that information.

[The information follows:]

SEATS ON SOYUZ

The most recent modification to NASA's contract for Russian services, including crew transportation and rescue using the Soyuz spacecraft, goes through June 2016.

Mr. WOLF. If you could have your staff——

General BOLDEN. But we are not, I can tell you that unless something changes we will not be able to give you the negotiated amount right now because the contract has not been finalized. I am told that it is just not available.

Mr. WOLF. Is this a positive thing for the Russians, too, though? Sometimes somebody in a business deal can become so greedy that they are holding out, and all of a sudden the other person walks away. Do they not also need this revenue to continue to do certain things that they are doing, too? Is there an equal benefit in some respects?

General BOLDEN. The Russians are a valuable partner, and they have been a valuable partner throughout the life of the International Space Station. They have provided access to Low-Earth Orbit in the International Space Station when we had none, after the Columbia accident. So there is great value in remaining in this partnership, all of the partners, all five of the major partners. When you talk about the European Space Agency, fifteen growing to twenty-some-odd, everyone benefits from this partnership. Ev-

erybody wants to remain a member of the International Space Station partnership. So there is value in it for everyone.

Mr. WOLF. Much of the flexibility in the development schedule for commercial cargo has been eroded over the past two years, and there is a strong likelihood that more problems and delays will arise as work continues. Given this likelihood, how confident are you that the remaining milestones will in fact be completed on time? And what are your contingency plans for a delay in the commercial resupply capability? How is this risk reflected in your budget?

General BOLDEN. Congressman, the budget is good as it stands right now. We sized that budget so that we would be able to have available cargo delivery under the CRS system by early 2012. That does represent some delays along the way, but we are confident that we will have cargo availability from two carriers by early 2012.

Orbital still has to fly their first flight. But Orbital, I must remind everyone, is a very reputable, very experienced company. Has been around since the 1980s, 1990s, has flown 155 successful missions with satellites of all kinds. They have flown 100 percent successful missions for NASA, in the Minotaur vehicle which we hand to them for processing after we get it surplus from the Department of Defense.

SpaceX has had one incredible flight when they launched Falcon 9 and Dragon back in December. So everybody right now is marching along at a pace that makes me comfortable that we will have commercial capability to deliver cargo reliably to the International Space Station in the early 2012 timeframe.

SPACE STATION SUPPORT

Mr. WOLF. Okay. Leading to the Space Station in the next question, the decision to continue supporting the Space Station through 2020 costs about $3 billion a year. This is money which could otherwise be used to meet exploration goals, increase aeronautics research, or do other important activities. If we are going to sacrifice those opportunities in order to support the Station, we need to be sure that we are getting our money's worth, and that means making sure that the Station is being fully used for its intended research purposes. What is the current research utilization rate of NASA's share of the Space Station? And how do you expect that rate to change as we progress through fiscal year 2012?

General BOLDEN. Congressman, I would have to go back to my opening statement and remind everybody of one thing. I think I used the term yesterday. The Station is the new Moon. The International Space Station is the anchor for all future exploration on the part of not just the United States but our international partners. So, if we lost the International Space Station we are dead in the water. We do not have a place in microgravity that is available for us to do the types of research and development that we need for new capabilities that enable an exploration program. So that is how valuable the International Space Station is.

That was what caused me to change my mind about the size of distribution of funds. I have to have an exploration program. But if I do not have an International Space Station that is crewed and

supplied, and by the commercial entities. Because that is the decision that was made, it was actually made in 2004. And I would have to say, I generally do not complain about the past because that is water under the bridge. The decision was made in 2004 to rely on commercial entities for access to Low-Earth Orbit and it was ignored. There was no money put toward it. My predecessor was, to my knowledge, was the first to really start putting money toward a commercial entity, but it was half-stepping.

President Obama has said, "Look, we cannot get there unless we carry out what previous administrations decided was necessary." So we are going to get there, and the commercial entities are going to be a vital part of that partnership that gets us there. But, if I lose the International Space Station that will set up exploration, any type of exploration, human exploration for decades.

CREW TIME FOR RESEARCH

Mr. WOLF. Following up on that, astronauts on the Station have a variety of demands on their time, including daily operation and maintenance work and crew health sustaining activities. While these are clearly necessary, they reduce the amount of time available for actually conducting research. When we talk about reaching a goal of 100 percent research utilization, what does that actually mean in terms of the number of hours spent per day on research?

General BOLDEN. Congressman, let me take it for the record to give you the hours per day. But the balance of crew time, at least the last time I was talking to somebody about it, was two of the crew members are generally considered to be the "maids", if I can use that term. They will not like that, but they will rotate duty in maintaining the Station. The other four will be totally involved in research, and that is the way we will operate the Station.

CREW TIME FOR RESEARCH

Background on how NASA tracks crew time for research

Because the planning and execution of space missions is complex, crew activities are tracked in great detail, including their personal time and break time. A normal crew day includes 6.5 hours of scheduled work tasks, 1 hour for lunch, 2.5 hours for exercise and hygiene, 50 minutes for daily planning conferences, and 70 minutes for work and plan familiarization and procedure review, 2 hours of pre-sleep (including 1 hour for dinner), 8.5 hours of sleep, and 1.5 hours for post-sleep (including 50 minutes for breakfast). When NASA reports "crew time for research," this only counts those scheduled work tasks from the 6.5 hour block that is for research activities. Important research data collected during the exercise period, and much of the 70 minutes of work familiarization and 50 minutes of daily planning conferences, is also part of conducting research each day.

Scheduled work tasks include research and facility work; assembly work; maintaining life support systems; vehicle traffic operations, such as docking, undocking, loading and off-loading; internal and external maintenance; medical operations; onboard training; and other routine activities such as news media interviews, equipment audits, computer maintenance, inventory management, tag-ups and communications system testing. Crews generally work five days a week, but on weekends they have many housekeeping duties, so they effectively receive only 3.25 hours of unscheduled time on Saturdays, and 7 hours of free time on Sundays.

Crew time reporting is also split among the three NASA and international partner astronauts (called U.S. Operating Segment, or USOS, crew members), and the three Russian cosmonauts. NASA integrates and plans the time for the USOS crewmembers, though the entire crew works as a team in maintaining and operating the ISS.

Amount of crew time for research

The strategic target for research crew time during "full utilization" is an average of 35 hours per week for the three-person USOS crew, with a similar target for the Russian segment cosmonauts. As ISS shifts from assembly to the research mission through 2011, the Program is approaching this target and expects to reach it in 2012. This is equivalent to 7 hours per day of a 5-day workweek for formally scheduled hands-on USOS research activities; the Russian segment has a similar target. Research activity in future years should continue to increase as ISS operations grow more efficient through activities funded within the ISS functionality budget, part of the FY 2012 President's request.

It also should be recognized that crew time is just one component of research, since much of the research is being accomplished by facilities working automatically being tele-operated from control centers around the globe. Experiments on the Station are designed specifically to minimize the amount of crew interaction required. For example, one recent physical sciences experiment used 9.5 hours of crew time for installation, but supported more than 6,000 hours of experiment operations.

What will change in the near term, as soon as we are able to announce a non-governmental organization (NGO) that will assume responsibility for the evaluation and selection of research and experimentation to be flown on the Station, some time no later than this summer will be that NASA will get out of the business of evaluating and selecting the experiments that go on board. That will be handled by a nongovernmental organization. And at some point down the road——

Mr. WOLF. Who will that be?

General BOLDEN. We do not know yet. It is a competition right now that is underway. And so someone will take that over. Ideally where we would like to get will be to the point where even NASA experimentation and research is folded into the evaluation——

Mr. WOLF. What is an example of that?

General BOLDEN. Oh, what would be an example?

Mr. WOLF. Yeah.

General BOLDEN. For example, the salmonella vaccine that is under development right now is about to enter human test. That would have been, if we had a non-governmental organization, that research would have been selected by this non-governmental organization.

Mr. WOLF. But when you say non-government, just give me an idea of——

General BOLDEN. Oh, the Hubble Space Telescope, the Space Telescope Science Institute is an NGO. It is, if you go up to the campus of Johns Hopkins there is the Space Telescope Science Institute, and they handle the scheduling, they handle everything for the Hubble Space Telescope. We have NASA astronomers who vie for time, but we do not physically run the operation of Hubble. That is a, I would classify that as an example of——

Mr. WOLF. Okay.

General BOLDEN [continuing]. Sort of a non——

Mr. WOLF. Who is going to make that decision?

General BOLDEN. Bill Gerstenmaier, who is the Associate Administrator for the Office of Space Operations, is the selecting official.

Mr. WOLF. And when is that expected?

General BOLDEN. I talked to him as late as yesterday and he told me probably early summer.

Mr. WOLF. And who is competing for that?

General BOLDEN. Who is competing?

Mr. WOLF. Yeah.

General BOLDEN. Sir, let me take that for the record. I do not——

Mr. FATTAH. Open solicitation, Mr. Chairman, right now.

Mr. WOLF. It is?

General BOLDEN. Yes.

Mr. FATTAH. Online——

Mr. WOLF. How many have applied?

General BOLDEN. Congressman, let me get back to you. I do not have that information.

[The information follows:]

COOPERATIVE AGREEMENT NOTICE (CAN)

NASA posted the Cooperative Agreement Notice (CAN) for the ISS National Laboratory non-governmental entity on February 14, 2011. Due to the competitive nature of the selection process, NASA is not able to provide the names of respondents, but by March 4, when notifications of intent were due, the Agency had received eight responses.

Mr. WOLF. If we could just know, if it is public record, who has——

General BOLDEN. Oh, it is a matter of public record now. Who the, I will get back to you because I do not know whether the bidders, you know, the competitors are known publicly. It is like any competition that we do.

Mr. WOLF. Sure.

General BOLDEN. It is like any competition. But we will get that to you.

Mr. WOLF. Okay.

The authorization act requires NASA to provide initial financial assistance to the nonprofit lab manager. Does your budget request include funds for that?

General BOLDEN. The budget request for 2012 includes the funds to start the nonprofit——

Mr. WOLF. And how much is that?

General BOLDEN. Congressman, let me get back to you. I will take that for the record. I do not know exactly what that is.

Mr. WOLF. And do all the entities competing know what that is? How do you make a bid if you do not know what the budget will be?

General BOLDEN. Congressman, the way that contracts are generally handled is that we look at a reasonableness factor so that we let the bidders know what we think the range is for pricing. We give them that range. And I, you know, my guess is we have done the same thing here. So anybody that bids outside that range probably——

Mr. FATTAH. Mr. Chairman, the solicitation indicates about $15 million a year would be available for an entity to manage this laboratory on——

Mr. WOLF. Now where did that $15 million come from? Or was that in just sort of a——

General BOLDEN. Congressman, I will get back to you. I will get back to you on the specifics of that. That was developed in the Office of Space Operations Mission Directorate.

[The information follows:]

NATIONAL LABORATORY

NASA is currently conducting a competitive acquisition for a cooperative agreement with a non-profit organization to manage the ISS national laboratory component of U.S ISS utilization. In accordance with statutory requirements under the NASA Authorization Act of 2010 (P.L. 111–267), 50 percent of the U.S. share of ISS utilization capacity will be made available for use by organizations other than NASA under the National Laboratory initiative. The President's FY 2011 and FY 2012 budgets for ISS include $15M per year for this ISS National Lab non-profit organization. The $15M per year level was determined during development of a reference model for the organization. NASA believes this is an appropriate level to both operate a small non-profit organization and set aside approximately $3M of the $15M for strengthening of the basic research grants. It's important to note that this was a reference model for cost-estimating and scope determination purposes. While the $15M per year remains the current funding allocation for the cooperative agreement, the proposals and final award will determine what portion remains available to strengthen the grants component. After the final award, NASA will assist to identify areas to reduce overhead costs as appropriate. In addition, NASA will encourage the non-profit organization to become a self-funded organization as it matures in future years.

Mr. WOLF. Okay. Well we have a number of other questions. Mr. Yoder asked about James Webb, and we have a number there, too. We will have a number of questions on the launch vehicle also.

AERONAUTICS

On aeronautics, I looked at your chart here. Aeronautics is really almost an orphan. Has anyone ever thought you ought to change your name?

General BOLDEN. Congressman, the reason that I have opted to put as much into aeronautics as we have, and it is not nearly enough, is because I want to return the big "A" to NASA. NASA is the National Aeronautics and Space Administration.

Mr. WOLF. No, I agree with you. Believe me, you have my total and complete support. The aeronautics program is not as highly visible as many of NASA's other missions, but it has an outsized impact on the American economy and on the everyday air travel experiences of regular Americans. Have you done any economic impact studies to measure the return on investment provided by the aeronautics program to the American aviation industry?

General BOLDEN. Congressman, I have, and one of the ones I attempted to cite for you, was our new airplane engine concept that we have been working with American industry. That is where we have found, and industry agrees, that there is potential to reduce about 40 percent of the fuel consumption in the engines that we are, engine technology that we are helping them develop. That is where I got my number.

We looked at 19.6 billion gallons of jet fuel were used in 2008. If you take that at $3 a gallon that is $58.8 billion just for jet fuel in 2008. If I got back, so if they realize a 40 percent savings on that and you gave me 1 percent of it I could run my aeronautics budget right now at $588 million.

Mr. WOLF. Well they are talking about $4 a gallon by the end of the——

General BOLDEN. Then that makes it even better, sir. But that is an example of the economic return on NASA's minimal investment of taxpayer dollars.

Mr. WOLF. Could we get more of that? Because I am a strong supporter of doing what we can. It would pain me to see GE sign

the contract with the Chinese to develop their avionics system, and to take jobs away from Boeing. In essence, they are selling the rope that they are going to use to hang Boeing. And yet, the President picked Immelt, head of GE, to be his big jobs man. This was a jobs program for China. So I want aeronautics to be here. I want it to be more American.

Which leads to the next question. Where are the jobs? That is the mantra of everyone in both parties. Where are the jobs? Jobs give men and women dignity and money for their families, but also keep America number one economically. We seek no domination of power, we seek freedom and liberty. Ronald Reagan said the words in the Constitution were a covenant with the entire world. I want American to be number one for those reasons. Not for money, but for freedom and liberty and democracy.

So when NASA develops new aeronautics technology, and matures it into the point that it can be transferred to the industry, how do you ensure that the benefits of that technology go first to American aviation companies?

General BOLDEN. Congressman, the best way we can do it is to continue our cooperation with U.S. industry the way that we do.

Mr. WOLF. Have you ever thought about bringing all of the aviation industry people together for a conference to say, "Okay, where are you going? And where would you like to be? How can we participate to develop a partnership?" I know there are some in this Congress that say there can be no partnership between government and the private sector but other countries are doing it. Have you ever thought of bringing everyone together, or maybe you do, and saying, "Where are we today? What would you like to be doing? What should we be doing? Maybe we are going to plus this up. Maybe we are going to do more."

General BOLDEN. Congressman, that is the way we determine what our aviation portfolio is. Dr. Jaiwon Shin, who is my Associate Administrator for Aeronautics, goes to the industry and asks them what is it that NASA should do for you? That is how we know that they want us to work on engine technology. They do not, for example they do not want us to work on development of alternative fuels. They want us to work on the development of engines that can use anything. Water, junk——

Mr. WOLF. In the interest of time, I am going to go to Mr. Fattah. Could you have Dr. Shin come by?

General BOLDEN. Yes, sir.

Mr. WOLF. I do not know that we can do this. But I would like to almost write every avionics and aviation company and say, "What is NASA doing that you like? And what is NASA not doing that you would like to see them do?" Because they technically are your customers, but they are also the people that pay taxes. And so you ought to be doing what puts America first. I want to know that there is a connectivity, and not because there was a congressman one day that pushed this or pushed that. So if he could come by and he could talk to me——

General BOLDEN. I will have him do that, sir. He can give you background on something, for example, like the continuous descent and arrival program that we developed that represents a cost sav-

ings of about $1.2 billion to the airline industry. We had Continental and United participate in tests at Denver——

Mr. WOLF. Do you think if I asked the people in the aviation industry they would say enough money is being spent to do what you——

General BOLDEN. Oh, they would tell you no way. I hope they would. If they tell you that enough money is being spent on aeronautics research then I would be very disappointed in the industry. I would hope that they would be my biggest proponent and my biggest cheerleader, saying that we need to spend more——

Mr. WOLF. You know, you might tell your friend at the White House, Dr. Holdren, that he ought to tell me what he was doing in China for twenty-one days. What do you do in China for twenty-one days? Who is he meeting with? We do not want the Chinese aeronautics industry to surpass Boeing or EADS. So maybe we can informally ask a couple of trade associations, "what would you like to see NASA doing that it is not doing?" Therefore we are not just taking your person's word.

I saw the other day, did you see the story, that a Chinese company was going to bid to do Air Force One, the helicopter?

General BOLDEN. The helicopter?

Mr. WOLF. Yeah.

General BOLDEN. Marine One?

Mr. WOLF. Yeah, Marine One.

Did you see that, Mr. Fattah?

Mr. FATTAH. No, I missed that, Mr. Chairman. I would be beside myself if we were going to have a situation where Air Force One, or Marine One, would be developed by anything other than an American company.

Mr. WOLF. Well I tell you what we should do, then. Maybe the Committee ought to carry language prohibiting that. And I will tell you——

Mr. FATTAH. I would be in support of that, Mr. Chairman.

Mr. WOLF. I am on a resolution with another member from your side, which I will talk to you about later, to kind of prohibit that. The thought of Marine One being made by a Chinese company just would not be good. So I appreciate Mr. Fattah. We are both from Philadelphia, we were both raised in Philadelphia. What high school did you go——

Mr. FATTAH. Overbrook, the best in the world.

Mr. WOLF. I went to Bartram. In fact, that was the big competition, Bartram and Overbrook.

CONTRACTING PRACTICES

We have some other questions. Let me cover the contract issue. And I am going to go to you after this, Mr. Fattah. A review by GAO last year found that more than half of NASA's biggest development projects had exceeded their baseline estimates. The average cost growth was 19 percent and the average schedule delay was fifteen months. You instituted a new cost-estimating policy in 2009 that was intended to address NASA's problem with inaccurate baselines. But due to the recentness of the policy change we have not seen evidence that it is working. Do you feel confident that this policy will noticeably increase the accuracy of your baselines?

When will you have sufficient data to actually demonstrate that improvement? And one other question, so you can round it in—under the policy, projects need to be budgeted at a level that ensures a 70 percent chance they will be completed within budget and schedule parameters, but there is a provision allowing exemptions from this rule. In what circumstances would you make an exception to allow a project to move forward with less than 70 percent confidence in its budget and schedule?

General BOLDEN. Congressman, we work under what is called a JCL, joint confidence level, that was instituted in 2009. I gave the example of Juno and GRAIL being two of the earliest projects that were run under that concept, and I am told, are coming in on cost and schedule. I am cautioned, however, by my experts that we need five, six, seven years to tell whether we really got what we said we were going to get. Because operating costs is a part of a contract and everything.

So, but if you look at where we are in development and progress to launch for those two projects which came in under the JCL, it is working.

Mr. WOLF. Well your contracting practices have been on GAO's government-wide high risk list for more than twenty years. And so——

General BOLDEN. Congressman, you are absolutely correct.

Mr. WOLF. Well I guess the question would be, as I go to Mr. Fattah, when do you think you will get off of it? Twenty years is pretty——

General BOLDEN. Congressman, may I, please do not misinterpret what I am about to say. My Deputy and my Chief Acquisition Officer, who is my Chief Financial Officer, look at this every single day because they have to talk to GAO. But we are probably never coming off the high risk list because we build one-of-a-kind things. Almost every time we build something, it is a new experience. What we hope to do with the JCL is prove that we can effectively and accurately project what cost and schedule are going to be. So, if that is successful, you will find us come off the——

Mr. WOLF. Okay.

General BOLDEN. I hope that that would be sufficient for GAO to take us off the high risk list. But I am not sure how we get on there, to be quite honest. So, other than the fact that we do risky stuff.

Mr. WOLF. Okay. Well, I have other questions on that.

General BOLDEN. Yes, sir.

Mr. WOLF. Mr. Fattah?

Mr. FATTAH. All right, let me thank the Chairman. And when these questions of international human rights come up, it is a pretty lonely area because a lot of people want to focus on more important things, or more business. And I really want to make sure that the Chairman understands that the fact that he is unrelenting on this question of improving human rights in China is not lost on me, and is appreciated I am sure by many even if it is a lonely pursuit. So I want to thank you.

And I am going to go out and visit the Jet Propulsion Laboratory later on this month, and I am also going to go to the Dryden facility. I think it is important, I am a politician, so I really do not

know much about rocket science, you know? And I think that when we have to make these decisions it is helpful, it is helpful at least for me to try to get my arms around some of the challenges that the agency faces. But when I look at this just from a political standpoint and I see a little small country like Singapore, they are investing over $5 billion this year in their national science foundation. Now this is a country with less than five million people in it, in the total population. Here we are, we are a nation of 300 million people. We are trying to win a competition against countries, you know, China is, what, a couple of billion people? India with a billion people. And, you know, when we get to our science foundation we are going to be in the single digits, in terms of billions, in terms of the level of investment.

I do not want to join in any of the pursuit around trying to round out the numbers, and the cost cutting here and there. I think that the argument we need to be making is that the country cannot afford to lose this race. That America cannot afford to concede space or science to others anywhere in the world even if it actually costs us money. That is, even if we have to pay to do it, that as American citizens we would have to pay taxes so that we do not position ourselves as a nation fifty years from now, and a lot of us will not be around, that the position, the curious situation for our children and our grandchildren, a situation where they are being victimized by these human rights abuses that the Chairman is talking about because we refuse to make the investments.

Now we need to be clear about this. We have a situation within our schools in terms of earning doctoral degrees in the hard sciences, two-thirds of those who earn those degrees in our country will not be, they will not be American citizens and they will not be staying here. That is to say, they will not be applying for citizenship and hanging around. They are going to take these intellectual tools and they are taking them some other place.

So I just want to say, I heard the comments from the gentleman from Georgia. I am not a Member here who has a NASA facility in their state, even though I think we have members on the panel from California where there are a number of NASA facilities. I know about the important work of the Glenn Center in Ohio, and in Texas, Johnson, and all this. My interest in this is, and even if I had a parochial interest, I think all of our interests have to be focused on the nation's interest. I mean, investment in space is not a jobs program. This is a question of the survival of our country and prosperity of our country.

So I just think that we have to get focused on what are the needed investments. We talk about estimates and, you know, when you looked at the estimates for the Capitol Visitors Center, what we priced to build something in brick and mortar that has now come in two or three times that amount, right? You know, we are not trying to put somebody on the moon. I mean, this is just a basic brick and mortar structure and we could not get close to what it would cost. And Vice President Cheney said that the Iraq War was going to pay for itself.

So I think we ought to be mindful that as we go forward, and I think that the Chairman has talked about this in very important ways, that we need to be focused on, to the degree that we are fo-

cused on fiscal restraint we need to be focused on the areas of the budget where we are spending money. This is not an area where we are spending a great deal of money, even though it may sound like a lot of money. But in comparison, it is not. I just think that we have to think in longer terms about what we are doing, make the needed investments we need to make, and we need to get competent administration. And obviously you, and the President in his selection of you to lead this agency is, you know, is an extraordinary gift for the nation, given your background and your leadership policies. But we need to give you the tools so that you can function.

And I am happy to hear that the Chairman says in the next CR we are going to try to work out the problem that we created between authorizing you to proceed past the Constellation, but at the same time requiring you to spend a couple of hundred million a month on Constellation. It puts you in a bind. And it does not help us make the investments that we need to make. So I want to thank you for your testimony.

SPACE STATION

I have a couple of questions in particular about the Space Station. So now we have built this over the last ten years. We have had continuous human astronauts on the Space Station for ten years, right?

General BOLDEN. Yes, sir.

Mr. FATTAH. Over 200 people have been on the Space Station, rough number?

General BOLDEN. I will get you the exact number. I am not——

[The information follows:]

INTERNATIONAL SPACE STATION

There have been 198 different visitors to the ISS, representing 15 countries.

Mr. FATTAH. All right. And now it is going to be a national lab?

General BOLDEN. Yes, sir.

Mr. FATTAH. But it is also the kind of, you say it is the platform for our further efforts, and I am interested in that part of this. How we see the Space Station, which is about the size of a football stadium right?

General BOLDEN. Yes, sir.

Mr. FATTAH. Okay.

General BOLDEN. About a hundred——

Mr. FATTAH. I tell you I am, you know, and now the Mars Rover was about this size, right?

General BOLDEN. Yes, sir. Now Mars Science Laboratory (MSL) is going to be a lot bigger.

Mr. FATTAH. The first one.

General BOLDEN. But Spirit and Odyssey are, Spirit and Odyssey are little things.

Mr. FATTAH. Right, I got you. And Spirit we have not heard from for a few months, but I bet NASA that it is still going to function. So I am in total agreement. So I am just saying in terms of perspective, we plan on using the Space Station as the base from which NASA would go in terms of its further efforts. If you could expound on that for a minute, that would be helpful. And I was fig-

uring out about the $3 billion that you want to spend. Now $3 billion sounds like a lot of money. We are spending that amount, we are spending that in an average week in Afghanistan. Just so we are clear as a nation about putting these things in some perspective. So if you could help us think about what you are trying to do on the Space Station?

General BOLDEN. Congressman, let me give you just three examples if I can. The first one would be one of the, the seventh crew member on Discovery, on STS–133 last week was Robonaut 2, a humanoid robot. And Robonaut 2 will——

Mr. FATTAH. Now that was done in partnership with GM?

General BOLDEN. That was done in partnership, I was going to say, that was a Space Act agreement with General Motors that is ongoing. It is not over. And General Motors came to us and said, "We have a need." And NASA said, "We have a need." And so we came together, collaborated with industry. I was telling Congressman Clark, who is from Detroit, yesterday, when he said, "I do not have a NASA center. I do not have anything that has anything to do with NASA." I said, "Congressman, let me send you some stuff because you need to go back into Detroit and make people in Detroit proud that they are now on the International Space Station." Because they are, in the presence of Robonaut 2.

R2 is going to start working this spring to see how we can collaborate, how a robot, a humanoid robot, can collaborate with astronauts on board. At some point we are probably going to, you know, I do not know when, but we will probably put R2 outside and see how much R2 can do to alleviate putting astronauts at risk by having them do space walks. Eventually we would like to demonstrate the fact that we do not have to put a human on the surface of Mars to build the infrastructure. That by the time we send humans there the village will be built, because robots will have done that.

I have got to be able to integrate science, aeronautics, human exploration, and technology into one big thing. That is what we are trying to do in NASA now. We are looking at an integrated picture. We are not doing things the way we used to. And that is the message I am not getting across to people very well. Because when you asked me why do I believe in my budget, and why do I think we can do what I say we can do, it may take us longer to do aspects of it. It may take me longer than 2016, for example, to have a heavy lift launch vehicle and an integrated crew exploration vehicle. I do not know that yet, it may, but we are going to get there. Because these are difficult fiscal times. And we have had to adjust the budget to fit within these difficult fiscal times.

While, you know, my job, the President has asked me to lead the greatest civilian organization in the world, bar none. Keep astronauts safe: I am doing that. Explore: we are doing that. We do that every single day. We are going to launch another satellite called Glory on Friday and it is going to do great things.

I get emotional about this because it is important. And it is important for me to be able to articulate how important we are to the nation, and how important it is for us to carry out the President's plan for education. Because everybody on this committee has said this all day long, you know, we are so close. As I said in my open-

ing statement, we are all in synch. Believe it or not. We may be different parties, or you all may be different parties because I am apolitical. But we all talk about the same things we want to do. It is just how we get there. And because these are very difficult times and we have to make very difficult choices I need your support when I make a hard choice.

HUMAN-LIKE ROBOTS

Mr. FATTAH. So let me see if I can put this together. We do not have the technology yet to take a human being to Mars. We know we can take an object to Mars, right?

General BOLDEN. Oh, yes. Yes, sir.

Mr. FATTAH. We have done that a couple of times.

General BOLDEN. We have done that. Right. Hard to do it, but we have done it.

Mr. FATTAH. So when we take an R2 and put it on the Space Station in part we are thinking about a humanlike robot that at one point we may be able to put on Mars to build out an infrastructure so that when we deliver a human being there, there would be the protection of the infrastructure because——

General BOLDEN. Yes, sir. I do not want a human to have to go build something.

Mr. FATTAH. Right. And plus the, once you get out into deep space there are the radiation challenges, the other challenges are much more significant.

General BOLDEN. That is human physics.

Mr. FATTAH. So you build, this is like a stepping stone——

General BOLDEN. Yes, sir.

Mr. FATTAH [continuing]. To where we are going. Now we do not have the technology yet, but four years ago we did not have the technology to go to the Moon, or do any of these other things, or——

General BOLDEN. Well we did at one time but we forgot about it.

Mr. FATTAH. Yeah. Or to build a Space Station.

General BOLDEN. Yes, sir.

Mr. FATTAH. It took some ingenuity, right?

General BOLDEN. Yes, sir.

SUPERIORITY IN SPACE

Mr. FATTAH. That is why we know that we are an exceptional nation, because we have done exceptional things. So now the President has set a much deeper goal for you and we are trying to build to getting it done. I just want to conclude with a question that gets to the different programs. We have got earth science, we have got space exploration, we have got a lot of different pieces here. I want to focus a little bit more on the purpose of this, right? So I want to just conclude if you could help the Committee understand and the country understand what it will mean if we forfeit or concede this race for superiority in space to others who have untoward interests to our own as a nation? What the costs will be to our country?

General BOLDEN. Congressman, we are fifteenth, seventeenth, and twenty-fifth in reading, science, at math. And I may have the numbers not precise. We will fall further behind. We, right now

every nation looks to us for leadership when I go to the International Space Station. Whenever I go to a meeting of my international partners, the heads of agency, everybody says, "We need for you to lead." If we give that up they will turn to somebody else and it may not be somebody we like.

So, you know, my job is to lead this agency. As I said, make sure we do what you and the President tell us to do through appropriations and authorizations and that is what we are doing. Stay within budget, which is something that people, you know, do not think we are serious about but we are really serious about it. And make difficult choices. And we have made some difficult choices but there will be much more difficult choices. When you talk about infrastructure, these kinds of things, and then everybody is going to run away from me. I do not want you to do that. I want you to help me stand up to the scrutiny and, the way you all always do. But I, you know, we have got difficult choices ahead.

Mr. FATTAH. Well I want to thank you again. When we finish voting today, I am going out to visit a couple of our national labs. And I think that this whole area of the country's work is vitally important. You cannot disconnect it from educating our children, or making sure that we have the agricultural capability to feed our population. Running the greatest country on Earth costs money.

General BOLDEN. Yes, sir.

Mr. FATTAH. I know we have some very well-meaning people in the Congress and in the country who want us to cut costs. You know, we need to be wise about what we are doing here. Because we do not want to cut costs that end up creating a circumstance for our nation in which we have cut off our nose to spite our face.

General BOLDEN. Congressman, may I say one thing? And it is just because I have been, I have cut one partner out, and that has been industry. We have not had an opportunity to talk to them a lot, and I know some of them are here, some of them will hear this. I have the best partners in the world in American industry, and I have faith in them. And I need to have, I need to have other people in positions of leadership have faith in them. They once, several of their leaders told me, and I wrote it down, a piece of something is better than all of nothing.

Industry is coming together now. And companies that in the past in terms of our contracts would not even think about talking to each other, they understand——

Mr. FATTAH. Well let me just say this, because I know we have to wrap up. I am for us working with American industry.

General BOLDEN. Yes, sir.

Mr. FATTAH. There are cross currents here, though. We have to be very careful. And we are going to have to be a little different than we have been. Because all this open source information, if we are taking American taxpayers' money and we are developing technology, I do not necessarily think that that technology should then be made available to people who have not invested around the world, and then used against American industry in competing against us and going after an opportunity to build Marine One. I think we do not want to work against our own purposes as a nation at the end of the day.

So we need to have American industry. We also need to have some proprietary control over the technology that American taxpayers are investing in, in ways that do not put our own country at a disadvantage at the end of the day.

General BOLDEN. Yes, sir.

Mr. WOLF. Mr. Culberson?

LONG TERM PLANNING

Mr. CULBERSON. Thank you, Mr. Chairman. I could not agree with you more strongly, Mr. Fattah, and I will absolutely be working with you arm in arm on that. I wanted to, we are apparently going to have votes here in a few minutes. And Administrator, I really appreciate you being so patient and staying here with us. We are really devoted to you, and really want to find ways to help you in every way we can to get you the money you need to do your job better and also give you some longer term support. I was just talking to Chairman Wolf about perhaps us getting together to do sort of a joint hearing after we get through the appropriations process to talk about the long term. How do we make sure, we for example, I know and my dear good friend Mike Coats, the Director of Johnson Space Center tells me, and that you all are dear good friends. And you may be able to tell me more precisely, Administrator. But in the time that you have been an astronaut, worked with NASA, Mike tells me, because I think your careers are very similar, and the time that you have been together——

General BOLDEN. We have been together for forty, more than forty years. We came together in the summer of 1964.

Mr. CULBERSON. 1964?

General BOLDEN. In the Class of 1968 at the Naval Academy.

Mr. CULBERSON. At the Naval Academy?

General BOLDEN. Yes, sir.

Mr. CULBERSON. So you were both in, both then saw service in Vietnam?

General BOLDEN. Yes, sir.

Mr. CULBERSON. And then joined the space program, and the time that you have been with the space program, did Mike tell me that you all have seen the Congress create and then cancel over twenty different, major——

General BOLDEN. My deputy right now is looking at a study that we asked for on programs that were started and stopped and it is more than twenty-some-odd. But I would say if you want to look at one thing that we did to the end, it is important for the American people to note that their investment in the International Space Station came to fruition day before yesterday. Because we have completed construction of the American elements of the International Space Station. So if somebody says we cannot do something and finish it, we have completed construction of the U.S. element of the International Space Station.

Mr. CULBERSON. And we are immensely proud of that achievement. I want to make sure that Mr. Fattah catches that. I was just getting for the record, Mr. Fattah, that the, NASA, could you be sure that you repeat that——

General BOLDEN. The space walk that we did day before yesterday——

Mr. CULBERSON. No, before that.

General BOLDEN. Oh, before that?

Mr. CULBERSON. Yeah, how many programs, how many——

General BOLDEN. Oh, there is some twenty-plus programs. When we finish the study we can make it available.

Mr. CULBERSON. The point is that NASA——

General BOLDEN. We are trying to find out why we did it. You know, how does it happen?

Mr. CULBERSON. We did it to you. Congress did it to you.

General BOLDEN. Well, I am not pointing fingers.

Mr. CULBERSON. No, I know you are not, I know. But these wonderful people that devote their lives to, what is it Captain Kirk says? To explore brave new worlds? To explore new worlds and go where no one has gone before. We have over the years, Mr. Fattah, created and then canceled over twenty——

General BOLDEN. Twenty-some-odd programs.

Mr. CULBERSON [continuing]. Major rocket programs, space exploration programs. Well no wonder you all have had so much difficulty over the years, and then inadequate funding. Plus they get their hopes up, boom, get their hopes up, boom, work on a program, boom. That has got to stop. And you are absolutely right about thinking in the longer term. And I want to work with you and the chairman after we get through our appropriations process. Let us think about having a joint hearing in great detail to talk about how we get NASA on a predictable, stable funding and planning path that does not subject these wonderful people to this up and down. It would really, I think, help them immensely. Would it not?

Mr. FATTAH. Sure, that would be great. That would be a worthy thing for us to spend some time doing.

Mr. CULBERSON. It really would, after we get through all the appropriations cycle.

General BOLDEN. That would be an incredible gift to the nation. I tell everybody what we want to do is something that is affordable, sustainable, and realistic.

Mr. CULBERSON. Bingo, we are there.

General BOLDEN. And if we can do that—

Mr. CULBERSON. Well we will help you with that.

Mr. FATTAH. Mr. Administrator, what I want to do is beat everybody else. All right? I want to make sure that America is Number One. Even if we have to spend beyond what we might feel comfortable at a particular moment.

General BOLDEN. Yes, sir.

Mr. FATTAH. I still like to be in the lead. I think the view is always better from the top, right?

General BOLDEN. Yes, sir.

Mr. CULBERSON. Absolutely. And I will certainly help you with that. *National Journal* just ranked me as the tenth most conservative member of Congress. I am still trying to figure out what I did to screw up and only get number ten, but I am with you on this. I mean, I voted against the RSC budget for that reason, because it severely cut NASA. Law enforcement, Chairman Wolf, you and the staff protected NASA in the proposal that was submitted. The amendment, there was only one adopted that really cut, was Mr. Weiner's that shifted I think cross agency money, $300 million over

to the COPS program. And we are going to work to help make sure to protect that in the CR.

ORION PROGRAM

Let me ask you a couple of specific questions and then some broader ones. Will the Orion program, sir, be canceled or transferred into the Multi-Purpose Crew Vehicle? Just simply renamed into the Multi-Purpose——

General BOLDEN. Congressman, what we are looking at is trying to find if we can transition the contracts for Orion into the Multi-Purpose Crew Vehicle.

Mr. CULBERSON. And so——

General BOLDEN. And we will know that and we will know, we will have an assessment as to whether it is affordable by the summer when we give——

Mr. CULBERSON. Okay.

General BOLDEN [continuing]. Our next report to you guys.

Mr. CULBERSON. With this up and down in mind I do not want to lose that talented workforce, those wonderful people that have put their heart and soul into building the next manned space capsule. You are going to keep all those folks? You are not talking about any layoffs, or——

General BOLDEN. Congressman, I wish I could say that. I do not control, and I have told my center directors, do not get involved in the business of our contractors. I do not make those decisions.

CONFLICT BETWEEN PRIOR APPROPRIATIONS BILLS AND THE AUTHORIZATION, CONTINUED

Mr. CULBERSON. And the thing that is fouling you up is of course you cannot, you have this language, one of these things that is fouling you up is the language and the statutory requirements. You cannot cancel Constellation, which of course includes Orion. And that was signed before the December 10th CR. The CR language that Mr. Mollohan did that predates the authorization. The statutory language in our appropriations bill from last year that Mr. Mollohan put together with all our support that says you cannot cancel Constellation, that is statute, right?

General BOLDEN. Yes, sir.

Mr. CULBERSON. And then after that in December there was a continuing resolution signed in December that was silent. Oh excuse me, the authorization was then signed in October which says you are going to build a heavy lift rocket and a manned capsule. And the old rule, the statutory interpretation is the last statute signed controls. I think this is where you all wrapped around the capsule. So we have got to get you some clarification pretty quickly.

General BOLDEN. Yes, sir.

Mr. CULBERSON. And the chairman, I am delighted we are going to work on that with the help of Mr. Fattah, all of us together, to get you some clarification. What you need is clarity so you can follow the authorization, right?

General BOLDEN. Yes, sir.

Mr. CULBERSON. Okay. That would really help you a lot? Immensely?

General BOLDEN. Sir, it would. The authorization act postured us very well. The President's proposed budget for 2012 postures us very well. So——

Mr. CULBERSON. But you need to follow that authorization. It is hard for me as a lawyer to explain how it works.

General BOLDEN. Yes, sir.

Mr. CULBERSON. I mean, it got me tangled up.

General BOLDEN. If I can get relief from the restriction on terminating Constellation, that will help.

Mr. CULBERSON. And all of those, all that research, all that work that you are doing on Constellation to develop a heavy rocket, to develop a manned capsule, that all transitions very easily into the authorization language to develop a heavy lift rocket and a manned capsule, does it not?

General BOLDEN. No, sir.

Mr. CULBERSON. They are pretty much——

General BOLDEN. I am not able to say that. That is what I am, I do not want to be boxed into a corner. I am still looking at the contracts for Orion and the contracts for the rest of Constellation to see if we can legally and within procurement regulations move them. If that is the case, then they have to be affordable. So——

Mr. FATTAH. Maybe we could clear this up. I think it would be safe to say that you see it as being desirable to have the least disruption to this workforce——

General BOLDEN. Absolutely.

Mr. CULBERSON. There you go.

General BOLDEN. That is so vitally important as humanly possible, but you have to operate within the law.

I have to operate within the law.

Mr. FATTAH. And with what budget is available.

General BOLDEN. Yes, sir.

Mr. CULBERSON. And we need to give him some statutory clarification as soon as possible.

General BOLDEN. Yes, sir.

NASA'S IMPLEMENTATION OF DECADAL SURVEYS

Mr. CULBERSON. That would be great. Okay. The decadal survey is about to come out, very soon. We are about——

General BOLDEN. That is correct.

Mr. CULBERSON. Throughout the history of NASA, the United States being the leader, and number one, we have throughout history until very recently always flown the top priority mission in the decadal survey in each one of the categories. I think, and it is my recollection as an avid student of the space program and history, I think that is an accurate statement. Until recently NASA——

General BOLDEN. Congressman, let me get back to you on that. I do not know because when I left NASA in 1994 I did not know what a decadal survey was.

[The information follows:]

Status of Missions Identified in NRC Decadal Surveys

Survey	*Class*	*Mission Concept*	*Status* Planned launch years in ( )
Astrophysics: **New Worlds, New Horizons (NRC, 2010)**	Large-scale	Wide-Field Infra-Red Survey Telescope (WFIRST)	Initiation of WFIRST development awaits completion of JWST. WFIRST Science Definition Team selected; report expected end of CY2012.
		Augmentation to Explorer Program	Separate Explorer program established in Astrophysics Division and augmented in FY12 budget request to enable flight rate recommended by the Survey
		Large Interferometer Space Antenna (LISA) (50% share with ESA)	Due to lower priority in this decadal survey, NASA cannot initiate development in this decade, and ESA is discontinuing its LISA program
		International X-ray Observatory (IXO) (60-40 share with ESA)	Due to lower priority in this decadal survey, NASA cannot initiate development in this decade, and ESA is discontinuing its IXO program
	Medium-scale	New Worlds Technology Development Program	Technology development funds included in FY12 request
		Inflation Probe Technology Development Program	Technology development funds included in FY12 request
	Small-scale	Astrophysics Theory Program Augmentation	Augmentation included in FY12 request
		Definition of a future UV-optical space capability	Augmentation included in FY12 request
		Intermediate Tech Dev Augmentation	Augmentation included in FY12 request
		Laboratory Astrophysics	Augmentation included in FY12 request
		Space Infrared Telescope for Astronomy and Astrophysics (SPICA) (US contribution to Japan's SPICA mission	Possible competed opportunity; depends on Japan's plan to proceed with SPICA
		Suborbital Program	Augmentation included in FY12 request
		Theory and Computation Networks	Augmentation included in FY12 request

Survey	*Class*	*Mission Concept*	*Status* Planned launch years in ( )
Earth Science: **Earth Science and Applications from Space** (NRC, 2007)	Foundation missions	Landsat Data Continuity Mission	LDCM (2012) in development
		Global Precipitation Measurement	GPM (2013) in development
	Tier 1	Soil Moisture Active-Passive	SMAP (2015) in formulation
		Ice, Cloud and land Elevation Satellite - II	ICESat-II (2016) in formulation
		Climate Absolute Radiance and Refractivity Observatory	CLARREO engineering studies underway prior to development for launch NET 2020
		Deformation, Ecosystem Structure and Dynamics of Ice	DESDynI engineering studies underway prior to development for launch NET 2020
		Venture class line of small, innovative missions	1st Venture class solicitation issued in 2009; planned for release every 2nd year thereafter, alternating between airborne and space missions. 1st space mission solicitation in FY2011 for a FY2017 launch. Venture program will include an annual instrument of opportunity solicitation beginning in FY2011.
	Tier 2	Hyperspectral Infrared Imager (HyspIRI)	The FY12 budget request funds the development of two Tier 2 missions (ASCENDS, SWOT) for launch by the end of 2020; the pace for implementation of the others to be determined based on out year funding profile.
		Active Sensing of CO2 Emissions Over Nights, Days, and Seasons (ASCENDS)	
		Surface Water & Ocean Topography (SWOT)	
		Geostationary Coastal and Air Pollution Events (GEO-CAPE)	
		Aerosol-Clouds-Ecosystems (ACE)	
	Tier 3	Lidar Surface Topography (LIST)	Technology development underway
		Precipitation and All-weather Temperature and Humidity (PATH)	Technology development underway
		Gravity Recovery and Climate Experiment (GRACE-II)	Technology development underway
		Snow and Cold Land Processes (SCLP)	Technology development underway

Survey	*Class*	*Mission Concept*	***Status*** Planned launch years in ( )
Planetary Science: **New Frontiers in the Solar System (NRC, 2003)**	Large missions	Europa Geophysical Explorer	Europa Jupiter System Mission chosen from among Outer Planets candidates in 2009 to be implemented along with ESA's Ganymede Jupiter System Mission, subject to new (2011) decadal survey. Identified as second priority flagship mission in 2011 decadal survey.
	Medium missions (Candidates identified by NRC report *Opening New Frontiers in Space: Choices for the Next New Frontiers AO* (2008); all solicited thru New Frontiers AOs)	Kuiper Belt-Pluto Explorer	New Horizons mission launched in 2006; 2015 arrival at Pluto
		South Pole-Aitken Basin Sample Return	New Frontiers 3 mission candidate
		Jupiter Polar Orbiter with Probes	Juno mission (2011) in development
		Venus In-situ Explorer	New Frontiers 3 mission candidate
		Comet Surface Sample Return	Future New Frontiers mission candidate
		Network Science	Future New Frontiers mission candidate
		Trojan/Centaur Reconnaissance	Future New Frontiers mission candidate
		Asteroid Rover/Sample Return	New Frontiers 3 mission candidate
		Io Observer	Future New Frontiers mission candidate
		Ganymede Observer	Future New Frontiers mission candidate
	Small missions	Discovery missions at a rate of one mission every 18 months	MESSENGER, Dawn (2007), Kepler (2009), Deep Impact/EPOXI (2011) , Stardust/NExT (2011); ASPERA-3 on ESA's Mars Express, M3 on India's Chandrayaan); GRAIL (2011); next solicitation in 2010
		Cassini extended mission	Cassini Solstice mission underway; ends in 2017
	Large Mars missions	Mars Sample Return	Mars Astrobiology Explorer-Cacher (MAX-C) is the first priority large mission in the 2011 decadal survey provided it is the first segment of a Mars Sample Return mission
	Medium Mars missions	Mars Science Laboratory	MSL in development as a flagship mission for launch in 2011
		Mars Long-lived Lander Network	Candidate for future New Frontiers opportunity
	Small Mars missions	Mars Scout line	Phoenix Polar Lander completed mission in 2008; MAVEN (2013) selected in 2008. Future via Discovery.
		Mars Upper Atmosphere Orbiter	MAVEN (2013) selected in 2008; Mars 2016 in definition with ESA will include trace gas observations

Survey	*Class*	*Mission Concept*	*Status* Planned launch years in ( )
Heliophysics: **The Sun to the Earth and Beyond (NRC, 2003)**	Large missions	Solar Probe	Solar Probe-Plus (2018) in formulation, with a science AO issued in December 2009
	Medium missions	Magnetospheric Multiscale	MMS (2014) in development
		Geospace Network	Partially met by RBSP (2012) in development
		Jupiter Polar Mission	Juno (2011) in development
		Multispacecraft Heliospheric Mission	Candidate for prioritization in 2012 decadal survey
		Geospace Electrodynamic Connections	Candidate for prioritization in 2012 decadal survey
		Suborbital Program	Restored to health in FY2009
		Magnetospheric Constellation	Candidate for prioritization in 2012 decadal survey
		Solar Wind Sentinels	Candidate for prioritization in 2012 decadal survey
		Stereo Multispheric Imager	Partially met by TWINS (2008)
	Small missions	Solar Orbiter (U.S. instrument contributions to ESA mission)	Four instruments selected by NASA in 2009; downsized to two instruments due to cost reasons in 2011 (primarily increase in projected launch vehicle cost)
		Endorsed Explorer-class missions	Explorer program active at a reduced flight rate; IBEX launched in 2008; IRIS (2012) selected in 2009
		Endorsed University-Class Explorers	Program cancelled due to lack of launch opportunities
	Endorsed approved missions	Solar Dynamics Observatory	Launched in February 2010

Survey	*Class*	*Mission Concept*	*Status* Planned launch years in ( )
Astrophysics: **Astronomy and Astrophysics in the New Millennium** (NRC, 2001)	Major Initiatives	Next Generation Space Telescope	James Webb Space Telescope now in development
		Constellation-X Observatory	Candidate for prioritization in Astro 2010
		Terrestrial Planet Finder (TPF)	Candidate for prioritization in Astro 2010
		Single Aperture Far Infrared (SAFIR) Observatory	Candidate for prioritization in Astro 2010
	Moderate Initiatives	Gamma-ray Large Area Space Telescope (GLAST)	Launched in June 2009
		Laser Interferometer Space Antenna (LISA)	Candidate for prioritization in Astro 2010
		Solar Dynamics Observatory (SDO)	Launched in February 2010
		Energetic X-ray Imaging Survey Telescope (EXIST)	Candidate for prioritization in Astro 2010
		Advanced Radio Interferometry between Space and Earth (ARISE)	Candidate for prioritization in Astro 2010
	Small programs	Endorsed continuation of vigorous Discovery and Explorer programs	Kepler Discovery missions launched in March 2009; Discovery now solely a Planetary Science program. Explorer program active at a reduced flight rate; WISE (2009) and NuSTAR (2012) in development, GEMS (2014) selected.
	Reaffirmations from previous decadal survey	Stratospheric Observatory for Infrared Astronomy (SOFIA)	Early science flights began in fall 2010; working toward full operational capability in 2014
		Space Interferometry Mission (SIM)	SIM-lite a candidate for prioritization in Astro 2010
		Hubble Space Telescope Fourth Servicing Mission	Completed in May 2009
	From Quarks to the Cosmos (NRC, 2003)	"wide field telescope in space…to fully probe the nature of dark energy"	Joint Dark Energy Mission a candidate for prioritization in Astro 2010
		"measure the polarization of the cosmic microwave background"	Inflation probe a candidate for prioritization in Astro 2010

Survey	*Class*	*Mission Concept*	*Status*
Astrophysics: The Decade of Discovery in Astronomy and Astrophysics (1991)	Large	Space Infrared Telescope Facility (SIRTF)	Launched August 25, 2003 and renamed Spitzer
	Moderate and Small	Far Ultraviolet Spectroscopy Telescope (FUSE)	Launched June 24, 1999; operated until October 2007
		Stratospheric Observatory for Infrared Astronomy (SOFIA)	First science flight in Nov/Dec 2010. Science flights continue during progression toward full operational capability in 2014.
		Astrometric Interferometry Mission	Space Interferometry Mission (SIM) development terminated in 2010 due to lack of priority in the 2010 Astrophysics decadal survey

Survey	*Class*	*Mission Concept*	*Status*
Astrophysics: Astronomy and Astrophysics for the 1980's (1982)	Large	Advanced X-ray Astrophysics Facility (AXAF)	Launched on July 23, 1999, and renamed Chandra
	Moderate	Explorer Augmentation	Augmentation to the Explorers program of medium and small Explorer missions. Explorer funding rose, but then declined in FY2006 due to funding constraints, and now rising again due in part to 2010 Astrophysics decadal survey
		Far Ultraviolet Spectrograph in space	Launched June 24, 1999; operated until October 2007 (also recommended in 1991 survey)
		Space Very Long Baseline interferometry antenna	Concept developed in 1990s and 2000s as LISA (see table above on 2010 Astro survey)
		Advanced Solar Observatory	Largely fulfilled by the Solar Heliophysics Observatory (SOHO) launched on December 2, 1995
		Series of advanced cosmic ray experiments	Implemented via a number of instruments on various missions such as the Cosmic Ray Isotope Spectrometer on NASA's Advanced Composition Explorer (ACE) spacecraft
	Endorsed missions in development	Space Telescope & 2nd generation instruments	Hubble Space Telescope launched on April 4, 1990; serviced with new instruments 5 times
		Gamma Ray Observatory	Launched on April 5, 1991 and renamed Compton GRO

Survey	*Class*	*Mission Concept*	*Status*
Astrophysics: Astronomy and Astrophysics for the 1970's (1972) This was the first decadal survey to prioritize space missions.	(Identified four new space program priorities not distinguished by size)	A series of four High Energy Astronomical Observatories	High Energy Astrophysics Observatory HEAO-1, -2, -3 launched in the 1970s
		Increased observations from aircraft, balloons, rockets	Vigorous suborbital program conduced, including operation of the Kuiper Airborne Observatory until 1995
		Continuation of Orbiting Solar Observatories, OSO-L, -M, -N	Beyond OSO-I, orbiting solar observatories shifted to more diverse platforms including the Apollo Telescope Mount on Skylab, the Solar Maximum Mission, ESA's Ulysses solar polar mission, and the ESA/NASA SOHO mission at L1.
		Program of optical astronomy in space, leading to a Large Space Telescope after the next decade	Hubble Space Telescope launched on April 4, 1990; serviced with new instruments 5 times

Mr. CULBERSON. I have researched it personally and I can tell you that we have——

General BOLDEN. Yes, sir. I am just, you asked me for an answer and I cannot give it to you. Right? I do not know.

Mr. CULBERSON. Sure. I can tell the committee I have researched it personally. This is near and dear to my heart that we——

Mr. FATTAH. That could almost qualify you to be a member of Congress——

Mr. CULBERSON. Yeah. And it is, the reason I am bringing it up, sir, is that I am concerned that, I want to make sure that you have got the funding that you need to pursue those top priority missions in each one of those categories. Are you satisfied that the funding level that the President has recommended, that you have in front of you, is sufficient for you to fund and fly each of those top priority missions in each one of those categories?

General BOLDEN. Are you talking about——

Mr. CULBERSON. Just the number one missions.

General BOLDEN. You mean the one that is coming out——

Mr. CULBERSON. Yes, sir.

General BOLDEN. Congressman, since I do not know what the decadal survey is going to give me I cannot say that. I do not know. The FY 2012 budget was put together without any knowledge of the decadal survey. So they, provided they come out without something that is reasonable, and they use the FY 2012 budget in their prioritization, then I would be able to say yes. But I have no idea whether they took the the 2011 budget. It used to be that the decadal surveys did not pay any attention to the budget, and they did what the science community wanted and expected us to eat it. At least nowadays, I am told that the decadal surveys, the teams are generally pretty judicious about looking at where they think the budget is going to be.

Mr. CULBERSON. Mm-hmm.

General BOLDEN. Now since this one was convened when the President, I think it was convened maybe even before the 2011 budget. But I will get back to you on when it convenes.

[The information follows:]

NASA requested the NRC conduct the new Planetary Science decadal survey in a letter to the NRC dated December 5, 2008. The Survey steering committee held its first meeting in July 2009 and its final meeting August 2010. The President's 2011 budget request with its outyear funding projections through FY 2015 was the information on budget availability the NRC had in hand when planning its approach.

Mr. CULBERSON. But what I am driving towards, Mr. Administrator, is for the committee, for Mr. Fattah, and Chairman Wolf, that for all of us to recognize that we are entering an age of austerity unlike anything we have seen before. We have got to protect NASA's ability to make sure that America has the world's premiere, number one, manned space program and unmanned programs. We are all committed to that. I want to make sure that we are, as a Nation at least funding the top priority missions of the decadal survey. The best source for us to look to if we are going to try to prioritize planetary missions, missions like Hubble looking beyond the solar system, it would be the decadal survey, would it not? I mean that is really——

General BOLDEN. That is the voice of the community.

Mr. CULBERSON. Absolutely.

General BOLDEN. Whether it is astrophysics, planetary, or whatever, we put a lot of stock into the voice of the community. What the community may not know is where NASA sits budgetarily.

Mr. CULBERSON. Mm-hmm.

General BOLDEN. So, that is where we have to prioritize.

Mr. CULBERSON. So if we as a committee wanted to build a firewall around, of course, only the manned program to make sure that we protect it, whether it be Mr. Weiner, or Mr. Jordan, our friends on both sides trying to come after NASA. If we wanted to build a firewall, the committee, this subcommittee wanted to build a firewall around NASA's manned spaceflight capability and your unmanned capability, talking about the unmanned missions first and robotics. Would not a good firewall be to say that NASA needs to, we need to make sure this committee preserves the ability of NASA to fund and fly the top priority mission designated by the decadal survey in each one of the categories?

General BOLDEN. Congressman——

Mr. CULBERSON. Would that make sense?

General BOLDEN. It makes sense. But if you wanted to build a firewall——

Mr. CULBERSON. That is what I am looking for.

General BOLDEN [continuing]. I would say empower the NASA Administrator to work with the Congress and the White House each year once the budget is established so that we can reestablish priorities or readjust priorities——

Mr. CULBERSON. No, I understand.

General BOLDEN. [continuing]. In accordance with fiscal constraints.

Mr. CULBERSON. It makes sense.

General BOLDEN. If you put a firewall around the results of the decadal survey today and the Congress changes everything next year, then I am back where I am——

Mr. CULBERSON. No, I understand. We would protect you statutorily as well. I am talking about protecting you for the long term. And we really are going to dive into this, and I am going to do my best to work with this subcommittee and the authorizing subcommittee so we can flesh this out with NASA's input and guidance to figure out a long term glide path that is predictable, stable, consistent. You do not have to worry about these year to year struggles and you can actually, all of you magnificent people that work in the space program, can predict with some certainty that you can pay the mortgage, send the kids to school, and still go where no man has gone before and discover brave new worlds and new civilizations.

EUROPA

Okay, the Europa mission in particular is a big flagship mission. It was in the last decadal survey. It is probably going to—almost certainly going to—be the top priority of the decadal survey in this mission, in this decadal survey. And I mention it to you because I have also found out, you know, Europa first of all has more saltwater than the Earth, liquid saltwater. They have confirmed that. It has got tidal flexing, like when you bend a credit card, that

means there is a lot of heat down there in the bottom of that ocean where the pressure is equivalent to the deep ocean on Earth where we have already shown that the plate boundaries have got incredible colonies of life. So Europa is almost certainly going to have life. If you are going to find life anywhere it is going to be on Europa. So the decadal survey has made it a top priority—there is the vote. I want to be sure to point out to Mr. Fattah and Mr. Wolf, and you may not be aware of this either, sir, that apparently in a very recent study that I read in *Science*—or I forget, maybe the journal of *Nature*—discovered that the water ice on Europa being bombarded by the radiation from Jupiter all these billions of years, the radiation strips away the hydrogen and leaves the oxygen. And then the oxygen is churned back down into the liquid saltwater ocean. So the saltwater ocean of Europa not only has heat but it has been oxygenated for billions of years. Which makes it an even higher priority.

That is going to be an expensive mission. It is a flagship mission. And I wanted to ask you about it. Are you guys planning for that, to make sure that we are flying that flagship mission to Europa that needs to include a landing——

Mr. FATTAH. If the gentleman would yield for one quick second?

Mr. CULBERSON. Sure.

Mr. FATTAH. Because you just announced within the last two months, right, that you found a number, five or so, Earth-like planets——

Mr. CULBERSON. Right, beyond the solar system——

Mr. FATTAH. You might want to just respond in general to this point and——

Mr. CULBERSON. But it would start with Europa.

General BOLDEN. Well Congressman I was just going to say that the decadal survey when it comes out

Mr. FATTAH. Is that in Texas?

Mr. CULBERSON. No, and it is not even flown out of Texas.

General BOLDEN. When the decadal results are announced next Monday then we will take a look at what they said and we will look at how we prioritize it based on where we are in our planetary budget.

Mr. CULBERSON. But the Europa mission is built in, is it not? Have you built in——

General BOLDEN. No, sir. You know——

Mr. CULBERSON. It was in the last decadal, it is going to be in this one.

General BOLDEN. Let me get back to you. Because you are asking me to verify that we are flying——

Mr. CULBERSON. You are upsetting me, dodging that. That is a big one. We are really going to be short of money. And we are going to need to build a firewall, Mr. Chairman, around these decadal survey missions. We cannot cede either the manned program leadership to China or anybody else, and we certainly cannot cede the leadership in flying these big missions, whether it be to the sun, or Mercury. We are about to go into orbit around Mercury any day now, right? Is it Messenger?

General BOLDEN. Messenger? Yes, Messenger is due to get to Mercury——

Mr. CULBERSON. In the next couple of weeks.

General BOLDEN. It is.

Mr. CULBERSON. I think, it is going to go into orbit around Mercury. And of course the Webb is, I am glad you got those cost overruns, and Mr. Fattah when you visit the Jet Propulsion Laboratory——

General BOLDEN. We are not there yet, sir. I do not want you to overstate what I said.

Mr. CULBERSON. Right, right, right. But——

General BOLDEN. We are trying. We are going to get them.

Mr. CULBERSON. You are doing your best. But it is an extraordinarily important mission. And when you go to JPL you will meet Charles Elachi, who is another national treasure. They do great work out there. But one of the problems they have had over the years is they will give, they think by giving, over the years giving us low estimates at the beginning of a big mission that maybe we are going to fund it. And then the estimates, boom, the reality comes in higher. Dr. Elachi has told me that they are working hard from their end, and I know you are on your end, to give this subcommittee more realistic estimates of what these big missions are actually going to cost on the front end.

General BOLDEN. That is the joint confidence level process that I——

Mr. CULBERSON. Right.

General BOLDEN [continuing]. That I talked about a little bit——

Mr. CULBERSON. That is critical. That is where a lot of these cost overruns come from. I know we are in the middle of this vote. I can submit a lot of these for the record because we are short of time. And you have been very generous, Mr. Chairman, and Mr. Administrator, with your time, sir. Thank you.

ASTRONAUT CORPS

Mr. WOLF. Thank you. We have a number of questions we will submit for the record. I just wanted you to make one comment on one issue. How are you adjusting the size of the astronaut corps, and the programs that support the corps, to reflect reduced flight opportunities between the end of the Shuttle and the first flight of the new exploration program? And the missions being contemplated under the new exploration program are significantly different than the missions executed by Shuttle astronauts. How will the requirements of future members of the astronaut corps differ from the requirements of the current members?

General BOLDEN. Congressman, we have a study that was instituted through the National Research Council that we expect to get back within months that is going to help us answer that question. So I do not have, the study is not complete yet. We are looking at what should be the size of the astronaut office, what type of support apparatus, whether it is airplanes or other things. We are looking at what we need to have to support the astronaut office of the future. And I do not have that——

Mr. WOLF. And when will that be ready?

General BOLDEN. Let me get back to you, sir. I am, it just escapes my mind right now.

Mr. WOLF. Okay.

[The information follows:]

ASTRONAUT CORPS

The National Research Council (NRC) study on the future of the Astronaut Corps is due to be delivered in August 2011.

General BOLDEN. But I would remind everybody, we just named three, the crews for three more increments to the International Space Station. So, we are continuing to assign astronauts to go to the International Space Station for six month increments for the next ten years. So, we still have astronauts who are going back and forth to Russia to train and spending these two years of their lives investing in getting ready to go to the International Space Station. And we just named three new crew increments.

Mr. WOLF. Okay.

Mr. CULBERSON. Can I do one more, real short?

Mr. WOLF. Okay. Sure.

ALPHA MAGNETIC SPECTROMETER

Mr. CULBERSON. Just real short. I want to ask about the final shuttle flight. Administrator Griffin had put on the manifest that it was a high energy observatory——

General BOLDEN. That is the next flight is AMS——

Mr. CULBERSON. And that will be flown?

General BOLDEN. That is STS–134.

Mr. CULBERSON. And that will be flown?

General BOLDEN. And that is the Alpha Magnetic Spectrometer. It is now mated in the VAB. I think we did that yesterday. So we will launch AMS on the Shuttle Endeavour, let me make sure I have got the right one.

Mr. CULBERSON. Is that the last flight?

General BOLDEN. No, sir. The last flight will be on Atlantis in June.

Mr. CULBERSON. Okay, thank you.

Mr. FATTAH. Mr. Chairman?

Mr. WOLF. Go ahead.

EDUCATIONAL BENEFITS

Mr. FATTAH. Just to conclude, and I want to thank you, Mr. Chairman. We have to go vote. You are relieved of duty. But when you led the first Marine Expeditionary Unit into Kuwait, you know, there were Kuwaiti kids who were here at American universities when Kuwait was overrun by Iraq. And they were here studying. You know, the Kuwaiti government provides unlimited educational support. These kids can go, if they want to get a doctoral degree in nuclear physics, or aeronautics, or whatever. So they were here studying. And our young people, you were leading them in——

General BOLDEN. Congressman you, I do not want to get in trouble with General Boomer. I was not there.

Mr. FATTAH. No, no, you were there.

General BOLDEN. No, I was not there then.

Mr. FATTAH. But you were leading the First Expeditionary?

General BOLDEN. I led the First Marine Expeditionary Force forward in 1997. But that was, that was between wars. I was——

Mr. FATTAH. I got you. My point is that these kids from Kuwait——

General BOLDEN. Yes, sir.

Mr. FATTAH [continuing]. The country our young people were protecting——

General BOLDEN. Yes, sir.

Mr. FATTAH [continuing]. Have a benefit, and had a benefit, an educational benefit that allowed them to pursue their God given——

General BOLDEN. That is correct.

Mr. FATTAH [continuing]. Intellectual talents.

General BOLDEN. Yes, sir.

Mr. FATTAH. That is not a benefit we provide to our young people in this country. And I just want us to be clear, we need to get our priorities in order as a nation about what we need to be doing to prepare ourselves to compete in this world. And it is an unfortunate paradox that we could provide the resources to protect their country with our young people while they provide their resources to educate their children.

Mr. WOLF. Thank you for your testimony. The hearing is adjourned.

General BOLDEN. Congressman, thank you so very much.

Chairman Frank R. Wolf
Questions for the Record

Human Exploration Capabilities

1. NASA completed a basic estimate of its costs to implement the newly authorized exploration program in accordance with standard NASA project management practices. This estimate became the basis for NASA's conclusion that the authorized budget and schedule were unachievable without significant changes to the program management plan. What was NASA's original estimate for the cost of implementing the Space Launch System (SLS) and the Multipurpose Crew Vehicle (MPCV)? How does that compare to the budget plan put forward in your request?

Answer: NASA has been engaged in detailed deliberations to define the next transportation system that will carry humans into deep space in accordance with the NASA Authorization Act of 2010, the FY 2011 Full-Year Continuing Appropriations Act, and Administration policy. In January 2011, NASA submitted an interim report to Congress regarding the Space Launch System (SLS) and Multi-Purpose Crew Vehicle (MPCV), and identified reference vehicle designs for both vehicles. On May 24, the Administrator decided to accept the Orion-based reference vehicle design as the MPCV. In the coming weeks, NASA will be making further decisions with regard to transportation architecture, and is currently refining the SLS concept and defining strategy alternatives based on detailed Government analysis and completed input from industry through Broad Agency Announcement study contracts. Further details about NASA's analysis and decisions regarding SLS and MPCV and their path forward will be provided to Congress in a follow-on report in the late spring/summer timeframe. Following that report, NASA will finalize development plans and acquisition decisions through the normal Agency processes in the mid-to late-summer. The development of the SLS/MPCV and supporting capabilities must be planned by developing an integrated budget and schedule to understand how these programs collectively fit within budget profiles and to determine when preliminary flight dates are possible. In the current timeframe, costs and schedule estimates are preliminary, based on pre-formulation information for these new programs.

NASA recognizes it has a responsibility to be clear with the Congress and the American taxpayers about our true estimated costs and schedules for developing the SLS and MPCV, and NASA is committed to keep Congress informed about our planning efforts. To this end, NASA will acquire independent (outside of the Agency) cost and schedule assessments for SLS and MPCV design options as part of its decision process this spring or summer, and will make these assessments public.

In the meantime, work to date on developing working / preliminary cost estimates has been based on historical cost history on the Orion and Ares Projects; however, new affordability initiatives are being considered. NASA continues to explore all possible means of reducing costs while still achieving a reasonable schedule to reduce the gap in U.S. human spaceflight capability.

Much work remains to be accomplished over the next few months, such as in-depth planning to synchronize the schedules and budgets for SLS, MPCV and Ground Operations efforts such that their developments are coordinated in order for each to deliver its capability in a planned timeframe. Since an integrated schedule for the SLS and MPCV vehicles is an essential product of our planning efforts, NASA required additional time to gain reliable information from ongoing system trade studies, obtain a better understanding of budget requirements and constraints, and develop acquisition strategies that can put development on an affordable and sustainable path. By summer, NASA expects to have completed several key analytical steps – information that will be contained in our follow-on report to Congress:

- the basic framework for a capability driven architecture and concept of operations that provides the strategic context for exploration of multiple destinations, a plan that applies the principles of affordability, sustainability, commonality, and interoperability, and a framework for expanded partnerships with the international, interagency, industry, and academic communities;
- analysis of the current Ares and Shuttle contracts for their applicability to the future development program;
- analysis of the cost and benefits of the Reference Vehicle Designs for the SLS and MPCV and alternate vehicle designs; and, analysis of potential initial acquisition approaches (in the case when contract changes or new procurements are indicated, NASA will follow applicable procurement regulations, including the March 4, 2009, Presidential Memorandum on Government Contracting).

In summary, NASA is committed to developing programs and plans that are executable, both in terms of schedule and cost, and we will provide those details to Congress as soon as we are able.

2. Any difference between the original cost estimate and the budget plan must presumably be covered either with additional appropriations or through significant changes in NASA's acquisition and project management approach. Do you believe that acquisition and management changes alone can make up such a huge funding gap? If so, how will you accomplish this?

Answer: Given these challenging fiscal times, it is clear that NASA must reduce the development and operating costs (both fixed and recurring) for human spaceflight missions to sustain a long-term U.S. human spaceflight program. We must plan and implement an exploration enterprise with costs that are credible and affordable for the long term under constrained budget environments. As such, our development efforts also will be dependent on a realistic budget profile and sufficiently stable funding over the long term, coupled with a successful effort on the part of NASA and our eventual industry team to reduce costs and to establish stable, tightly-managed requirements for the SLS and MPCV programs.

In moving forward on the SLS and MPCV, we will ensure that we have efficient contracting and management approaches so as to ensure affordability in the near term and over the long run. We will also build an evolvable and interoperable human spaceflight transportation system that will serve us for decades to come as we explore multiple compelling mission destinations. In a constrained budget environment, NASA understands how important it is to look for ways to

make our programs and projects more efficient, so finding and incorporating these efficiencies is a primary goal. Therefore, NASA has embraced the challenge to deliver human spaceflight systems for lower cost, and the opportunity to become more efficient, innovative and agile in our programs. For example, we are revising the management of our requirements, contracts, and projects and incorporating approaches to ensure affordability in the near term and over the long run. This includes the use of focused insight/oversight, specifying, where appropriate, to industry what we need instead of how to build it, designing for cost-effective operations, increasing the use of common components and parts, and smartly consolidating infrastructure.

More specifically, the SLS Program will continue to examine ways to increase efficiency and agility so as to be able to deliver an affordable and achievable heavy-lift system as soon as possible. Examples being considered in formulating SLS plans:

- consolidating infrastructure smartly;
- using common parts and common designs across the Government, so as to encourage bulk buys of heavy-lift vehicles;
- ensuring requirements are appropriately specific and also that requirements applied to NASA crew launch vehicles are similar to those provided to our eventual commercial crew partners, thereby ensuring that NASA vehicles are not required to meet more substantial requirements than commercial crew vehicles and vice versa; and,
- conducting insight/oversight activities of our contract partners in a smarter way, thereby using our resources more appropriately to focus on the high-risk items, rather than on more mundane tasks.

Additionally, the MPCV Program will continue to examine ways to increase efficiency and agility so as to be able to deliver an affordable and achievable crew vehicle as soon as possible. Given that MPCV work is building upon the work performed as part of the Orion Project, numerous innovative affordability initiatives are already underway, including:

- streamlining government oversight and insight activities to ensure we are focusing on the key-risk items;
- implementing an incremental approach to building vehicle capabilities; and,
- planning a more innovative and cost-effective vehicle qualification plan, utilizing distributed test labs, for example.

Lastly, NASA will continue to review affordability initiatives proposed by our current Constellation partners, and where possible, we will incorporate those potential savings into SLS and MPCV development efforts. We will provide the outcome of these combined initiatives as they become available.

3. Members of the contracting community who will develop and build the new exploration system have told us that they can complete the SLS and the MPCV within the authorized levels. They have cost estimates (including projected funds for NASA oversight activities) showing how they would achieve this. Have you looked at their cost estimates? If so, what assumptions are they using that differ from NASA's?

Answer: As part of evaluating NASA's Reference Vehicle Design and other alternatives for SLS, the results of industry studies are being incorporated from solicitations earlier this fiscal year. This includes identifying innovative concepts from industry and ensuring cost estimates are complete and consistent.

4. Are you still actively considering alternatives to the Ares/Shuttle- and Orion-derived architectures of the reference designs? To what extent would the savings provided by an alternative design be offset by the costs of canceling and re-competing contracts that support the current reference designs? What would be the schedule impact of making a significant change to the reference design?

Answer: To date, the Agency has selected a Reference Vehicle Design for both the SLS and MPCV, giving us a baseline from which to start developing schedule, budget and requirements, as well as acquisition plans. NASA will evaluate the Reference Vehicle Designs and other alternatives this spring through in-house analyses and maturation of concepts and will incorporate results of industry studies that the Agency solicited earlier this fiscal year. In particular, one of the greatest challenges for NASA will be to reduce the development and operating costs (both fixed and recurring) for human spaceflight missions to sustain a long-term U.S. human spaceflight program. We must plan and implement an exploration enterprise with costs that are credible and affordable for the long term under constrained budget environments. As such, our development efforts also will be dependent on a realistic budget profile and sufficiently stable funding over the long term, coupled with a successful effort on the part of NASA and our eventual industry team to reduce costs and to establish stable, tightly-managed requirements.

As noted in our response to Questions 1 and 2, much work remains to be accomplished over the next few months. Therefore, at this time, we cannot provide more specific responses to your questions about cost and schedule.

5. The authorization directs NASA to develop the core and upper stages of the SLS in parallel, if possible. This would result in higher upfront costs but would provide long-term efficiencies by taking advantage of some common costs and reducing testing and integration risks. How would you evaluate the trade-offs between proceeding with the core and upper stages simultaneously versus sequentially? What is NASA's recommended approach to developing the two stages?

Answer: The NASA Authorization Act of 2010 directs NASA to develop an SLS that is capable of accessing cis-lunar space and the regions of space beyond LEO. The Act also states that the SLS must be capable of lifting the MPCV, and that the SLS must be able to initially lift 70-100 mT to LEO, while ultimately being evolvable to 130 mT or more. For the initial capability, the Authorization Act set a goal of achieving operational capability for the core elements no later than 2016. (Note: The Authorization Act specified vehicle performance in terms of "tons" but NASA develops vehicles with lift capability measured in terms of "metric tons." Therefore, lift capability references are referred to in this answer in terms of metric tons.)

NASA's SLS development effort is focusing initially on the 70-100 mT lift capability, so as to get as close to 2016 as possible in terms of initial operational readiness. We also are seeking ways to capitalize on synergies between the lower-range and upper-range lift capabilities, thereby allowing us to develop some of the upper-range capabilities at the same time as we are focusing on the 70-100 mT capability. This approach is an evolvable progression in terms of developing these capabilities. However, before making any final decisions, we must first understand how our approaches to heavy-lift will fit within the budget profile, how they will fit into a future exploration architecture, and how they might benefit other agencies to maximize the investment for the taxpayer. It is very helpful that appropriations for SLS and MPCV development efforts in FY 2011 have been finalized as part of the FY 2011 Full-Year Continuing Appropriations Act (P.L. 112-10). Gaining increased clarity regarding future budget profiles will also be an important factor in helping NASA to finalize plans for the SLS and the MPCV.

Recently, NASA concluded the first iteration of a Requirements Analysis Cycle (RAC), which was established to complete a preliminary analysis of high-level system requirements, to include initial development planning, design concept maturation, and preliminary programmatic requirements. By using techniques such as design-to-cost, the teams considered a balanced set of trades between capabilities and the price tag to implement them. The RAC teams also brought in ground processing and launch expertise from KSC so that the long-term operational expenses of various designs could be assessed. The results will be informed by NASA analysis of the direction in the NASA Authorization Act of 2010, SLS safety and performance, existing national capabilities and stakeholder priorities for SLS.

The RAC team is now preparing to brief its findings to the NASA Administrator, and they will also be preparing to incorporate the findings of several independent, industry-led trade studies into their analysis. Thirteen of these six-month studies were initiated in November 2010 in order to provide a "fresh look" at innovative launch vehicle concepts, propulsion technologies, processes and affordability initiatives that can be infused into the development of the new human exploration missions – information that will be used to help inform the overall selection and development of the final SLS vehicle detailed design.

One of NASA's goals is for the RAC teams and the study contracts teams to develop ideas to come as close to the goal identified in the NASA Authorization Act of 2010 as possible, given budget realities and the need for the program to be affordable over the long-term. Our commitment will be to determine a flight date that has a reasonable probability of being achieved. Additionally, NASA believes that, all else being equal, utilizing heritage systems may help expedite the development process and flight dates, even though launch vehicle integration challenges will still exist as a schedule threat. On the other hand, starting with a clean sheet may provide a lower lifecycle cost. This is the subject of the current studies.

Cooperation with China

6. Have there been any new developments in the scheduling or planning of a reciprocal visit by Chinese space agency officials to NASA since February?

Answer: No, there have been no new developments in scheduling or planning a reciprocal visit by Chinese space agency officials to NASA since February.

7. What scientific or technical benefit would NASA gain from bilateral cooperation with China's space program?

Answer: In general, NASA's long history of civil space cooperation with other nations has demonstrated numerous and significant benefits to the United States, including: insight into the space-related capabilities of foreign governments and foreign aerospace industries; unique capabilities and expertise; enhancement and broad dissemination of scientific results; collaborative research and the opportunity to collect additional data for correlation and validation purposes. Specifically regarding China, future bilateral cooperation between NASA and Chinese organizations could offer the following potential opportunities and benefits:

Earth Science:

- NASA collects and analyzes Earth observation data from a variety of U.S. and international space missions to develop a scientific understanding of Earth's system and its response to natural or human-induced changes, and to improve prediction of climate, weather, and natural hazards. U.S. researcher access to the data generated by China's growing constellation of Earth observation satellites (including the *HY* ocean series, *HJ* environmental monitoring series and *FY* atmospheric series satellites) could improve our analysis of complex global phenomena and enhance our understanding of the Earth as a system.

- Scientific collaboration between NASA and Chinese scientists using in-situ atmospheric and aerosol data collection instruments such as those of the global Aerosol Robotic Network could provide enhanced calibration and validation measurements for NASA's Earth observation satellites, and improve our models of atmospheric dynamics.

- In general, data sharing and cooperation on geodynamics research with international partners provide insight into the dynamics of the Solid Earth and are providing new insights into natural disaster forecasting, response and recovery applications. Regarding China, the space geodetic data that China previously provided were an important contribution to the global geodetic reference frame that is used to position our satellites, guide our telescopes and interplanetary probes, and track the displacement along earthquake prone fault zones, the motion of ice sheets and glaciers. We understand that China is significantly expanding its space geodetic investments. We would benefit from enhanced access to these data through an existing bilateral agreement (under which all activities are currently suspended) in order to strengthen and improve our geodynamics research and its many applications.

Space Science:

NASA's space science missions collect data that enable scientists to make reasoned, evidence-based analyses of the origin, evolution and fate of the universe. These data are collected by robotic lunar and planetary, astrophysics, and heliophysics missions. China has successfully orbited two lunar satellites, and announced multiple future missions to the Moon (*Chang'e*) and Mars (*Yinghuo*). Furthermore, China has announced plans to launch astrophysics and heliophysics missions in the near future. Access to Chinese data from these missions could

expand the existing body of research and enhance our knowledge of the solar system and universe.

8. The Chinese are actively working to advance their human spaceflight program. How would you assess their progress? With the level of resources proposed in your budget request for 2012 and the associated outyears, how will our achievements in human spaceflight compare to theirs over the next 5 years?

Answer: The Chinese have made significant strides in the development of their human spaceflight capability. They have successfully demonstrated a number of key technologies, including placing a human into orbit (*Shenzhou 5* mission), conducting scientific experiments while in orbit (*Shenzhou 6*), and performing an extravehicular space walk (*Shenzhou 7*). The Chinese have stated that they will begin the next phase of their human spaceflight program later this year, to include a demonstration of rendezvous-and-docking maneuvers and the construction of an in-orbit space laboratory prototype known as *Tiangong*, capable of short-term astronaut habitation.

It is difficult to compare China's proposed human spaceflight objectives with NASA's likely accomplishments over the next 5 years. The current development path of China's emerging human spaceflight program appears to mirror the progress made by the U.S. and the former Soviet Union in the 1960s and 1970s, marked by historical technological milestones, but China remains behind the capabilities of the United States and Russia today. In contrast, as a mature space program, NASA's likely achievements in the next five years will reflect more consistent innovation and progress across a broad range of space exploration and science activities that currently include about fifty active missions. NASA's FY 2012 budget request and the associated out-year budgets will allow NASA's human spaceflight program to maintain its status as a global leader in the science, engineering and technology of human spaceflight. The International Space Station (ISS) will continue its strong role in showcasing the advantages of long-term international human presence in space for microgravity based research. The ISS has been assembled and the partnership will now focus on full utilization of its capabilities with operations through at least 2020. According to public presentations by Chinese officials, China plans to establish its first domestic space station with continuous operations capability by 2020. NASA's efforts to foster commercial crew and cargo capabilities to low-Earth orbit (LEO) will allow U.S. industry to conduct many of the same activities being undertaken by China's governmental program. In parallel, NASA will continue to focus its efforts on the development of the next generation of heavy lift launch vehicle and a multipurpose crew vehicle for use beyond LEO.

Commercial Crew

9. What is the date of the last Soyuz flight for which NASA has already negotiated specific prices for the American seats? When will negotiations begin for the pricing of the next round of seats, and what period of time will those negotiations cover?

Answer: In March 2011, NASA signed a $753M modification to the current International Space Station (ISS) contract with the Russian Federal Space Agency for crew transportation, rescue and

related services from 2014 through June 2016. The firm, fixed-price modification covers comprehensive Soyuz support, including all necessary training and preparation for launch, flight operations, landing and crew rescue of long-duration missions for 12 individual space station crew members. The contract will provide for the launch of 6 people in calendar year 2014 and 6 more in 2015 (the final launch being in the fall of that year), as well as their return to Earth in the spring of 2016 after a 6-month stay aboard the station.

With this contract modification, ISS crew members may launch on Soyuz vehicles during a 24-month period. The extended contract ends June 30, 2016. As a point of clarification, NASA buys Soyuz seats, not specific flights. Payments for a single seat occur over multiple years and the purchase of Soyuz seats requires an approximate three-year lead time. This contract modification does not include crew transportation beyond the scheduled Soyuz crew landings in spring 2016.

The current exception to the Iran, North Korea, and Syria Non-Proliferation Act (INKSNA) for extraordinary payments to Russia for the ISS only allows NASA to purchase or barter for Russian seats and other services through June 30, 2016. The goal is to have U.S. commercial crew transportation services available as soon as possible. The Agency anticipates the availability of these systems by the middle of the decade, contingent upon the availability of appropriated funding.

In order to maintain a U.S. presence on the ISS and to satisfy U.S. obligations to its non-Russian ISS partners, NASA intends to continue purchasing 6 Soyuz seats per year until demonstrated commercial crew transportation services and rescue services are available, provided that there is an exception to the INKSNA prohibition that allows the Agency to do so. As part of this strategy, the Agency plans to pursue a period of overlap between crew transportation and rescue services provided by Russian and U.S. commercial vehicles to ensure no gap in services. Once demonstrated U.S. commercial transportation services become available, NASA plans to purchase 8 commercial crew seats per year (4 seats twice a year) in order to maximize ISS utilization.

10. Under the authorization, NASA is supposed to have a core operational capability for its human exploration program by 2016. Would it make more sense to redirect the commercial crew money to help meet this deadline, which would advance exploration goals while also providing access to the Space Station? How would the expected costs of servicing the Station with the SLS and the MPCV compare to the expected costs of the commercial providers?

Answer: The NASA Authorization Act of 2010 set a 2016 goal for operational capability of the SLS and MPCV. Given the priorities set forth by the President's FY 2012 budget request, our SLS and MPCV planning teams are working to develop programs that will get as close to 2016 as possible for an initial operational capability of the SLS and MPCV. However, as outlined in earlier responses, much work remains in the coming months before we can establish a projected operational schedule. Our development efforts will be dependent on a realistic budget profile and sufficiently stable funding over the long term, coupled with a successful effort on the part of NASA and our eventual industry team to reduce costs and to establish stable, tightly-managed requirements for the SLS and MPCV programs.

The President's FY 2012 budget request established a balanced set of priorities across the Agency, and in particular, within the human spaceflight arena, i.e., to maintain an appropriate balance between developing affordable commercial crew services capability for near-term International Space Station servicing needs and developing long-term beyond-low Earth orbit (LEO) exploration capabilities. Therefore, NASA would not support efforts to redirect FY 2012 funding from commercial crew efforts toward SLS and MPCV.

As required by the NASA Authorization Act of 2010, the SLS and MPCV vehicles will be capable of providing crew and cargo transportation to the ISS as backup to our current international partners and future commercial crew transportation providers. Although the design and acquisition approaches have yet to be finalized, it is safe to assume that such a beyond-LEO system will be far more costly to produce and operate than a system which is designed strictly for LEO and ISS transportation needs. NASA has conducted assessments of the system requirements for LEO/ISS missions versus beyond-LEO missions, and these assessments show that the systems are much more complex and challenging for beyond-LEO. Therefore, the expected costs of servicing the ISS with the SLS and MPCV will likely far exceed those costs of acquiring services through commercial crew transportation providers. NASA believes, therefore, that the appropriate approach to human spaceflight is to maintain an appropriate balance between developing affordable commercial crew services capability for near-term ISS servicing needs and developing long-term beyond-LEO exploration capabilities.

Commercial Cargo

11. Much of the flexibility in the commercial cargo development schedule has been eroded over the past 2 years, and there is a reasonable likelihood that additional unanticipated difficulties will arise as new milestones are completed. What are your contingency plans for a delay in the commercial resupply capability? How is this risk reflected in your budget?

Answer: Based on funds appropriated as part of the FY 2011 Full-Year Continuing Appropriations Act (P.L. 112-10), NASA intends to fly STS-135 aboard Atlantis on June 28, 2011. This mission would carry the Raffaello multipurpose logistics module to deliver supplies, logistics and spare parts to the International Space Station (ISS), as well as a system to investigate the potential for robotically refueling existing spacecraft, and return a failed ammonia pump module for analysis. The mission would offset the risks of potential schedule delays in the operational availability of Commercial Resupply Services (CRS) capabilities; this would enable the ISS Program to absorb a delay in the availability of CRS vehicles of about a year without impacting Station operations and research until approximately January 2013.

James Webb Space Telescope

12. When do you expect to have a new budget and schedule baseline for the James Webb Space Telescope (JWST)?

Answer: Currently, we are developing a new JWST cost and schedule baseline. This requires a detailed analysis of all the work that remains to be done including all hardware components as well as a revised integration and test program. This plan will undergo independent review within the agency and by an outside team of experts to insure adequate levels of both cost and schedule reserves in the appropriate years. The revised schedule and lifecycle cost will be reflected in the 2013 Budget request.

13. How did you arrive at the $375 million requested in the FY 2012 budget for JWST? Without a completed budget and schedule, what plan will you use to guide the project?

Answer: The FY 2011 President's budget request for FY 2012 was $374M. In light of the Independent Comprehensive Review Panel's (ICRP) findings and recommendations NASA recognized the need to rebaseline the program and established the level funded $375M figure as one that will allow progress to continue on JWST hardware development.

JWST Program is using a recent, highly detailed and thoroughly reviewed estimate (from the Northrop Grumman Aerospace Systems proposal) as a starting point to develop the new baseline. The new baseline will reflect a high-confidence cost and schedule that supports the earliest launch date possible given the budget and schedule constraints. Decisions on funding the new baseline will be made in the context of FY 2013 budget formulation.

14. There is an expectation that the JWST budget will need to be significantly increased in the outyears and that the funding will need to be extended over more years than was anticipated. When it comes to JWST's ever-increasing budget requirements, how much is too much? When does JWST get so big that it crowds out all other opportunities for useful astrophysics investments or unacceptably limits flexibility within the Science Mission Directorate generally?

Answer: NASA is developing a new cost and schedule baseline and decisions on funding the new baseline will be made in the context of FY 2013 budget formulation.

JWST began in response to a 1995 study about the future of space astronomy after the Hubble Space Telescope era. The scientific case for a large infrared-optimized telescope has only strengthened since this early study as recent data about the distant universe have reached Hubble's limit, and the rich new field of exoplanets will benefit enormously and most quickly with the addition of JWST to the arsenal of astronomy tools.

In the Astrophysics Decadal Survey in 2001, JWST was ranked as the top large space mission for the Astrophysics Division. In the Astrophysics Decadal Survey in 2010, JWST capabilities and operations are the foundation of much of the science goals planned for in the survey.

JWST will bring significant value to the United States and the world through scientific discoveries that support NASA's strategic goals to: (1) expand scientific understanding; (2) create innovative new space technologies; and, (3) share NASA with the public, educators and students.

The investments in JWST are an essential part of the comprehensive strategic portfolio of projects for the Science Mission Directorate and NASA as a whole. Once we have a new baseline cost estimate for completing JWST, NASA will be in a position to emplace a plan for JWST in a balanced portfolio of science missions. Decisions on funding the new baseline vs. funding other missions will be made in the context of FY 2013 budget formulation.

15. The Independent Comprehensive Review Panel (ICRP) pointed out a host of management problems that contributed to JWST's difficulties beyond miscalculations in the project budget and schedule. How do we know whether these management problems also exist in any other large NASA projects? Has NASA undertaken any kind of systematic effort to apply the findings of the JWST ICRP to other projects?

Answer: As described in the answers to Questions 20-21, NASA has updated its policy guidance to assure that projects are confirmed with solid baselines. To assess performance after confirmation, NASA has recently taken steps to improve the way in which performance against plans for projects in implementation is assessed on a monthly basis, for example, by tracking risk retirement and assessing schedule and milestone drift. In addition, Mission Directorates are also taking steps to assess project performance through independent assessment at both the performing center and within the mission directorate.

The Science Mission Directorate is building up its internal capabilities to monitor program and project performance through the acquisition of independent cost and schedule analysis expertise. This expertise will increase the depth of performance assessment in monthly reviews of key programs and projects in addition to JWST. As the next large project in development, the Magnetospheric MultiScale (MMS) mission is receiving additional oversight based on lessons learned from the JWST experience. In particular, MMS project monthly reporting specifically includes the mission's threats and the Goddard Space Flight Center is conducting a revised Monthly Status Review to allow for greater discussion of project status and issues.

Launch Vehicle Availability

16. NASA currently has no replacement medium class vehicle lined up to replace the Delta II, despite having medium class science missions moving toward launch readiness dates. When do you expect to have the first new medium class launch vehicle certified? What if the certification process takes longer or costs more than anticipated? Has your budget made allowances for these possibilities?

Answer: The potential "new" medium-class launch vehicles proposed by various commercial vendors to fill the void left by the exit of the Delta II include the SpaceX Falcon 9, the Orbital Science Corp. (OSC) Taurus II and the Lockheed/ATK Athena IIc vehicles. Falcon 9 and the Athena IIc are currently available as part of the NASA Launch Services-II (NLS-II) contract. OSC has not yet made the Taurus II available on the NLS-II contract. (NLS-II is the contract that will be used for acquiring commercial launch services for the Agency's science missions.) In addition, neither Taurus II nor Athena IIc has yet had a first flight. Given those facts, the Falcon 9 is the most likely candidate to be the first new medium-class launch vehicle to go

through the NASA certification process for launch of medium and high value scientific payloads. Based on past experience and on initial work with SpaceX on the Falcon 9 as part of the International Space Station Commercial Resupply Services effort, we estimate that the Falcon 9 certification process will take approximately 24 months to complete. Since a launch service is typically awarded at least 30 months in advance of a launch date, there should be sufficient time to complete the Falcon certification. Based on NASA's experience with the certification of other launch vehicles (e.g., Atlas V, Pegasus, Taurus XL), it is expected that the review and assessment of any new launch vehicle will identify components and/or systems that will need to undergo additional testing in order to bring the risk level of a new launch system in line with a risk tolerance that is acceptable for the flight of multi-hundred million dollar scientific payloads. NASA will need to address the estimated cost of the potential additional testing required for certification in future budget submissions.

In the event that NASA determines that certification of a new medium-class launch vehicle would take longer, or cost more than anticipated, other options for providing launch services to NASA's medium-sized science missions include: (a.) utilizing Evolved Expendable Launch Vehicles (EELVs), like the Atlas V); (b.) resizing science missions so that they may be flown on multiple small-class launch vehicles; or, (c.) using the Department of Defense (DOD) "excess ballistic missile" based option known as the Minotaur family of launch vehicles. Unfortunately, (a) using an EELV or (b) resizing science missions would increase costs beyond what has been included in the NASA budget. Cost specifics would be mission-dependent. In the case of (c) using a Minotaur variant, Section 201 of the Commercial Space Act (CSA) of 1998 requires the Government to "acquire space transportation services from United States commercial providers whenever such services are required in the course of its activities." This section also provides for seven exceptions to this general requirement, including an exemption when the NASA Administrator makes a determination that "cost effective space transportation services that meet specific mission requirements would not be reasonably available from U.S. commercial providers when required." In cases where NASA makes such a determination, the Agency has considered the use of the Minotaur family variants for small- to medium-class missions, consistent with law and policy. This exception process holds even though the DoD uses a commercial vendor (currently OSC) to prepare and launch Minotaur vehicles for such purposes.

17. What is NASA's plan for those science missions that need to decide on a launch vehicle during the period between Delta II's retirement and the certification of a new vehicle? How is any associated risk reflected in the budget request?

Answer: Certification is not a prerequisite for NASA to select a launch vehicle for one of its missions. For those missions requiring a medium-class launch vehicle, NASA will select the appropriate vehicle on a case-by-case basis, using technical capability, cost, schedule and programmatic risk as selection criteria, including an assessment regarding whether the launch vehicle can be certified prior to launch. NASA has budgeted for a medium-class launch vehicle for every medium-class mission. Therefore, if certification of a vehicle is delayed, NASA may be limited to purchasing existing but more expensive launch vehicles. A substantial increase in launch vehicle cost could result in mission delays, or (less likely) cancelation of a mission.

18. NASA has several vehicles that are under consideration for certification. How do those anticipated vehicle costs compare to what you've been paying for Delta II flights? How do they compare to what you would pay to launch medium class payloads on other available vehicles like an Atlas V?

Answer: NASA anticipates paying approximately zero to 20 percent more for newly developed medium-class launch vehicles than traditionally paid for NASA's Delta II missions. It should be noted that the basis of this comparison excludes the price of the last contracted Delta II, which was significantly higher due to the increased infrastructure costs after USAF completion of Delta II operations. The comparison is also based on the *negotiated* prices for past Delta IIs against cost estimates based on the lowest *not-to-exceed* prices on the current NLS II contract.

The launch of a medium-class payload on an intermediate-class launch vehicle, like an Atlas V, would be approximately twice the cost of what NASA expects to pay for future medium-class launch vehicles.

19. NASA's needs for a medium class launch capability were insufficient to sustain Delta II production once DOD withdrew as a Delta II customer. Do you believe that your launch needs going forward will provide enough business to sustain a follow-on medium class provider?

Answer: Encouraging a robust domestic space launch industry, particularly given the retirement of the Delta II medium-class launch vehicle, is important to NASA. By utilizing medium-class vehicles to provide the ISS with cargo resupply services and by enabling new medium-class providers to bid on launch services for its science missions, the Agency intends to create a consistent demand that will serve to stabilize this segment of the market.

Cost Estimation and Project Management

20. Under NASA's new cost estimation policy, projects need to be budgeted at a 70 percent joint confidence level unless an exemption is provided to allow the project to proceed at a lower level. In what circumstances would you make an exception to allow a project to move forward with less than 70 percent confidence in its budget and schedule? How would you manage the increased risk?

Answer: After conducting portfolio analyses, NASA concluded that setting the expected joint confidence levels (JCL) at 70 percent joint confidence would provide an acceptable risk posture for the Agency. By setting the policy at a 70 percent joint confidence level, NASA assumes that the majority of projects can be completed at or below the estimated cost and schedule commitments (some returning funds to the portfolio) and that the remaining projects will exceed their joint confidence level commitments. If all projects in a portfolio are budgeted at a 70 percent JCL, then the portfolio's confidence level is closer to 95 percent.

Exemptions are provided for to allow the Agency to evaluate the risk profiles of specific sectors of the portfolio and to determine whether the risk of accepting a lower joint confidence level for a specific project is warranted. If the relevant section of the portfolio has a significant number of

low-risk projects, then it may be appropriate to allow the approval of a new project at a lower confidence level. To manage the potential for increased risk, the approved contents of that portfolio should be monitored for any change in the risk of each of the projects which might endanger the health of the overall portfolio.

21. Poor management decisions can prevent a project from sticking to a budget and schedule that were otherwise achievable, and, unfortunately, GAO has documented several such management problems at NASA. For example, NASA managers routinely allow projects to proceed into implementation when their technical readiness level is still low or when design requirements haven't been locked down. Why doesn't NASA have a policy in place to prevent these practices?

Answer: NASA program and project management policy is documented in NPD 7120.5D, which is in the process of being updated. In anticipation of the release of the new version of this document, NASA has recently taken steps to strengthen the monitoring of technical readiness through both regular oversight activities and as a planned component of assessing a project's readiness to proceed at key decision point milestones documented in NPD 7120.5D.

While it is important to have readiness metrics, taken individually, no single measure tells the entire story. It is necessary to evaluate multiple metrics and the likelihood of working off any deficiencies in a timely manner when considering whether a project is ready to proceed. The revised processes should help Agency management make more informed decisions about project readiness to proceed.

22. Congress has attempted to instill some accountability in NASA by requiring the submission of budget baselines and notifications of deviations from those baselines for large projects once they reach the development stage. Some NASA projects, however, will spend billions of dollars without ever reaching the threshold that triggers baseline reporting requirements. What does NASA do to ensure budget accountability for those pre-development projects? What additional steps are necessary?

Answer: Projects and programs of a significant size can indeed make substantial investments prior to establishing a baseline for NASA and Congressional approval. These investments are required to mature technologies, to understand and undertake efforts to mitigate or manage risks, and to refine the requirements to ensure better baselines and cost estimates. Cost and schedule ranges are provided for projects and programs at the Key Decision Point B to enable both external and internal reviewers to evaluate the impact of including the new effort. NASA exercises internal oversight and monitoring on all project and program expenditures. While the project is conducting technical and cost trade studies and the baselines are under development, NASA's primary accountability is to keep our leadership and stakeholders informed about any changes in identified cost and schedule ranges. NASA already reports on any project in formulation that issues any development contracts over $50M.

23. Do you believe that Congress's habit of providing relief for over-budget projects provides a disincentive for strict attention to budget control? What would be the impact of requiring a project's cost overruns to be offset within the project or within a program or theme?

Answer: NASA already works first to offset cost growth within a program or theme, asking for Congressional assistance only where absolutely necessary. When a program or theme has to re-balance to accommodate project cost growth, planned work has to be deferred or eliminated. Deferral of planned work can lead to outcomes such as a break in data continuity of certain measurements or delays in meeting customer priorities, and it often results in cost growth for the projects that must contribute to covering the cost growth of another project in the portfolio. This strategy provides some incentives for programs or themes to keep each of their component projects under control. The permissions for going outside program or theme bounds to meet exceptional technical or programmatic challenges are currently at the proper levels.

Contracting Problems

24. Because NASA does so much cutting edge research and development work where requirements are not always clear, you are highly reliant on cost reimbursement contracts. This type of contract vehicle, however, is the riskiest to the government and the most costly and difficult to administer. Is it feasible for NASA to do more of its work using firmer pricing models?

Answer: Much of NASA's complicated R&D requirements for state-of-the-art technologies are not Firm Fixed Price. Although the Government ordinarily prefers fixed-price arrangements, this preference applies in R&D contracting only to the extent that goals, objectives, specifications, and cost estimates are sufficient to permit such a preference. Use of fixed-price type contracts under these circumstances would also invariably result in contractors proposing significantly higher prices to compensate for the high risk. In order to mitigate the Government's risk under cost reimbursement-type contracts, NASA utilizes incentive arrangements, such as award fee incentives, performance fee incentives, cost incentives, and schedule incentives with our cost contracts. We do recognize the risk. NASA issued Agency Procurement Tenets in August 2008. One of the tenets is "Reducing Cost and Cost Risk for Procurements," which states, in part, that cost risk for each requirement must be properly allocated between NASA and industry. As a program matures, the risk shifts and contract types should also shift toward firm-fixed price contracts.

Consistent with the U.S. National Space Policy and NASA's Procurement Tenets, NASA pursued a commercial contracting model for the ISS Commercial Resupply Services (CRS) contracts. These competitive, firm fixed-price (FFP), multiple award, indefinite delivery/indefinite quantity (ID/IQ) contracts will provide commercial cargo resupply services to and from the International Space Station. Orders placed under these contracts currently total $3.5B. These contracts represent a significant step forward in our efforts to move away from high-risk, non-competitive, cost-reimbursement contracts.

President Obama issued a Memorandum on Government Contracting on March 4, 2009, which was followed by an OMB implementation memo, "Improving Government Acquisition," dated

July 29, 2009. OMB required that agencies subject to the Chief Financial Officer's Act to take action and submit a plan to OMB. One of the actions was to reduce by 10 percent the share of dollars obligated in FY 2010 under new contract actions that are awarded with high-risk contracting authorities (one of which is cost-reimbursement contracting). NASA embraced the memo, and is carrying the mandate internally through FY 2011. NASA met OMB's goal in FY 2010, and is projecting to exceed the goal in FY 2011. Examples from NASA's plan to OMB include:

NASA recently awarded its new Enterprise Application Service Technologies (EAST) contract for support services necessary to operate the NASA Enterprise Applications Competency Center (NEACC). The NEACC oversees the operation, maintenance, and enhancement of key Business and Mission-Supporting platforms, applications and infrastructure used across the Agency. The EAST is a FFP contract (previous contract was a Cost Plus Award Fee type contract) with a maximum potential value of $321,207,228.

Laboratory Services procurement is a follow-on requirement that will provide support to NASA's Stennis Space Center and various programs for over twenty five other Federal and State organizations located at the Center. Due to the operational maturity of these services, the acquisition strategy is shifting from a Cost Plus Incentive Fee (CPIF) type arrangement to a FFP type contract. This acquisition strategy change is expected to provide for increased competition and reduce SSC's overall cost and performance risk.

The transition of these service contracts to FFP type represents a significant acceptance on the part of the NASA acquisition community that, once programs are sufficiently mature, efforts should be made to shift away from higher-risk, cost-reimbursement contract types to FFP arrangements. These examples demonstrate that NASA is working diligently to avoid use of high risk noncompetitive and cost reimbursement contracts where appropriate. NASA is continually challenging programs and projects to re-assess acquisition strategies, particularly regarding the use of high risk contracts.

25. The NASA Inspector General has identified a number of issues with the way that NASA contracts are structured and believes that they do not appropriately incentivize good contract performance. For example, some contractors received all or most of their contract award fees even if the project they worked on was behind schedule, over budget or did not produce requested results. What steps do you believe NASA could take to better incentivize good contract performance, including adherence to schedule and cost targets?

Answer: NASA has been proactive in implementing award fee contracting policies consistent with the OMB Office of Federal Procurement Policy (OFPP) memorandum dated December 4, 2007, entitled, "Appropriate Use of Incentive Contracts," and the requirements set forth in the FY 2009 National Defense Authorization Act (NDAA), Section 867, entitled, "Linking of Award and Incentive Fees to Acquisition Outcomes." In compliance with the OMB/OFPP memorandum on the use of incentive contracts as well as Section 867 of the 2009 NDAA, NASA's procurement policies require that award fee incentive arrangements contain clear, unambiguous, and measurable evaluation criteria that are linked to the cost, schedule, and technical performance requirements of the contract. The linking of award fee evaluation

criterion to acquisition outcomes ensures that the contractor has a distinct incentive to control costs and produce a high quality item in a timely fashion. In order to reinforce this policy, NASA has been conducting training sessions in award fee practices at the various NASA Centers over the past two years. In addition, NASA reviews award fee ratings on selected programs/projects relative to the contractor's current performance level. This ensures that underperforming contractors on those programs/projects will receive early attention. In accordance with recently issued Federal Acquisition Regulation (FAR) guidance, NASA has implemented a process that routinely collects award fee data (e.g. award fee ratings and amounts for applicable contractual actions) as well as a system for measuring the effectiveness of award fee contracts. This process will ensure that we are incentivizing good contract performance in the areas of cost, schedule, and technical performance.

Facilities and Infrastructure

26. In 2010, the Aerospace Safety Advisory Panel noted that NASA does not have an agency-wide mechanism for tracking health- and safety-related infrastructure issues. Is this still the case? If so, how are you ensuring that these issues are being prioritized and addressed?

Answer: Requirements for identifying and mitigating safety issues in NASA facilities can be found in NASA NPR 8715.1, NASA Occupational Safety and Health Programs (OSHA). This regulation establishes the requirements for NASA's compliance with occupational safety and health programs required by Section 19 of the Occupational Safety and Health Act as well as Executive Order 12196, Occupational Safety and Health Programs for Federal Employees, and the implementing regulations found in 29 C.F.R. Part 1960. The requirements in the NPR are applicable to all NASA sites internationally and apply to all NASA employees, equipment, property, systems, and facilities.

NASA Centers and Component Facilities, including Jet Propulsion Laboratory (JPL), establish a formal schedule of inspections for all operations/facilities. All active areas and operations of each installation are inspected at least annually. More frequent inspections are conducted where there is an increased risk of accident, injury, or illness due to the nature of the workplace. Any facility, structure, operation, vehicle, or equipment that is in an inactive status is inspected at least annually. Prior to reactivation, the facility, structure, vehicle, operation, or equipment receives a thorough inspection to identify potential hazards. In addition, unannounced inspections and unannounced follow-up inspections are conducted to ensure the identification and abatement of hazardous conditions. Finally, special inspections may be conducted at the request of safety and health committees, employees, or their representatives, or upon notice of an unsafe or unhealthy condition. Unsafe conditions may also be reported by employees.

In response to reports of suspected unsafe or unhealthful conditions, Centers' safety and/or health officials conduct inspections. Based on the safety inspections of the facilities, the safety deficiencies that are identified must be corrected within 30 days, as required by OSHA. If the safety deficiencies cannot be corrected within 30 days, the NASA Center must develop an abatement plan along with a corrective action schedule to remediate the safety deficiencies. A frequent status update to the abatement plan by the NASA Center is required until the safety deficiencies have been corrected and closed. The identified safety deficiencies at the NASA

Center may require facilities maintenance and/or repair tasks to correct the deficiencies or Construction of Facilities (CoF) Projects as part of the abatement plan.

NASA prioritizes its CoF Program utilizing a Risk Assessment Matrix. This risk assessment uses definitions that are consistent with the NASA safety and health RAC system. In addition, projects that mitigate a specific documented RAC are assigned additional priority points to ensure that safety issues are addressed and mitigated.

NASA's current maintenance backlog or requirement for repair projects alone is $2.55B. NASA's current estimate for CoF Institutional funding for FY 2011 is $280.75M.

27. The budget request seeks to amend NASA's Enhanced Use Lease (EUL) authorities to allow NASA to accept in-kind contributions in addition to cash from lease holders. What is your rationale for requesting this additional authority? What kinds of in-kind contributions are you envisioning under the enhanced use lease program?

Answer: In-kind consideration for energy and utility projects will enable projects such as large-scale renewable energy production. By allowing NASA to receive in-kind consideration, such as a portion of the produced energy or additional facilities, the additional EUL authority would create conditions attractive to industry and supportive to NASA pursuing compliance with statutory and Executive Orders relating to energy and greenhouse gas requirements.

As an example success story, under NASA's EUL demonstration authority that permitted in-kind consideration, a NASA Center implemented a large-scale renewable energy production project. In June 2008, Kennedy Space Center (KSC) entered into an EUL agreement with Florida Power & Light (FPL), to construct, operate, and maintain solar power facilities on KSC. KSC leased land to FPL so they could create a 10 MW PV system for FPL's electricity generation purposes. As in-kind consideration for use of the land, FPL provided KSC a separate, nearly 1 MW PV system valued at $6.4 million for NASA ownership on the NASA side of the electric utility service meter. This innovative partnership helped the Federal government and FPL electricity consumers achieve the environmental benefits of using electricity generated from renewable sources, and also helped NASA reduce energy costs. Annually, the KSC 1 MW facility will produce an estimated 1,803 MWh, nearly three quarters of one percent of KSC annual electricity consumption, saving NASA $186,903. The FPL 10 MW facility will produce an estimated 16,000 MWh, enough to power 1,100 homes in Florida.

28. When will NASA's first integrated agency master plan for facilities management be completed? Without an integrated plan, how did you choose which construction, renovation, demolition and environmental compliance projects to include in the budget request?

Answer: NASA began building its first integrated Agency master plan in 2008, when it set forth an Agency Facilities Strategy of renewal and consolidation:
"NASA will renew and modernize its facilities to sustain its capabilities, and to accommodate those capabilities in the most efficient facilities set practical."

In 2009, the strategy was broadly vetted with mission and organizational leadership throughout the Agency. In 2010, each Center was asked to update its local facilities master plan to reflect the Agency Facilities Strategy. The resulting Center plans are already in use integrating capital facilities investment plans for construction of facilities recapitalization projects. NASA is working to appropriately document the integrated result of this planning process; the Agency Master Plan is scheduled for release by the end of FY 2011.

NASA uses a risk management approach to make prudent institutional investments in construction and environmental projects. Additionally, broader strategic alignment to ensure best value is realized in capital investment projects resulting from the Master plan.

Workforce Transition Issues

29. Now that NASA has been working on implementing the authorization for a few months, what is your expectation of the extent to which the Shuttle and Constellation legacy workforces will be able to transition into the newly authorized exploration program? Has the passage of the authorization improved your ability to make workforce planning decisions?

Answer: The enactment of the NASA Authorization Act of 2010 (P.L. 111-267) has provided valuable direction to the Agency and improved its ability to make workforce planning decisions. With this guidance, NASA has continued its efforts to map out the transition of its human spaceflight workforce from the Space Shuttle and Constellation programs to the Multi-Purpose Crew Vehicle and Space Launch System. This effort will be reflected in the Agency's next update to its *Workforce Transition Strategy* report, currently planned to be provided to Congress in the late spring/early summer of 2011. These reports provide details on NASA's initiatives to assist with workforce transition. The first three editions of this report are posted online at:

http://www.nasa.gov/transition/

During the FY 2011 Continuing Resolutions, NASA has continued to implement the Constellation Program and associated projects while we also work on the SLS and MPCV programs in parallel. NASA has continued to explore ways to capitalize on current investments and workforce, as appropriate. In parallel, NASA has taken steps to concentrate current spending on aspects of the Constellation Program that are expected to have the greatest applicability to the new SLS and MPCV programs. Currently, NASA has procurement teams who are mapping SLS and MPCV requirements (those outlined in the NASA Authorization Act of 2010 and those we are currently developing) against the Ares and Orion contracts (and other Agency contracts) to determine if the new requirements fit the scope of the existing contracts. For the SLS, we are reviewing each element of Ares (First Stage, Upper Stage, Upper Stage J-2X engine and avionics) to determine whether the new SLS requirements are within scope of the current contract. For the MPCV, our review of the Orion contract indicates that the MPCV is within scope of the Orion contract. The final acquisition plans for both vehicles are expected in the late spring/summer timeframe.

30. As you continue evaluating design alternatives for the launch system, some existing Constellation-era contracts could be terminated or significantly modified as you move forward. What are you doing to minimize workforce disruptions under these contracts while you are making these final determinations? How does your budget request support the transition of both the Constellation and Shuttle workforces?

Answer: Please see our response to Question 4 with regard to alternatives being considered, and please see our response to Question 29 with regard to workforce impacts, including civil servants and contractors.

NASA also has ongoing activities to facilitate transition of both key NASA civil service employees and contractor employees to other programs. The enactment of the NASA Authorization Act of 2010 (P.L. 111-267) has provided valuable direction to the Agency and improved its ability to make workforce planning decisions. With this guidance, NASA has continued its efforts to map out the transition of its human spaceflight workforce from the Space Shuttle and Constellation programs to the Multi-Purpose Crew Vehicle and the Space Launch System. This effort will be reflected in the Agency's next update to its Workforce Transition Strategy report, to be provided to Congress in the late spring/early summer of 2011. These reports provide details on NASA's initiatives to assist with workforce transition. The first three editions of this report are posted online at:

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31. It was generally believed that the end of Shuttle would result in a long term contraction of the aerospace industrial base as departing workers retired or were forced to change industries. Is that something you are concerned about? Have you been collecting and maintaining data on your workforce or on our industrial base capabilities that would validate those concerns?

Answer: As emphasized in the President's National Space Policy issued in June 2010, the Administration recognizes that a healthy space industrial base is critical to the success of NASA's missions, as well as to the security and economic competitiveness of the Nation. NASA is particularly concerned about any deleterious impacts that may occur due to the retirement of the Space Shuttle. NASA has been preparing for Shuttle retirement since 2004, and has taken a number of actions to address these impacts.

To determine the nature and magnitude of any impact, NASA partnered with the Department of Commerce (DoC) to release a survey request to NASA's human spaceflight industrial base in June 2010. Surveyed companies included not only Space Shuttle Program suppliers but also International Space Station and Constellation Program suppliers. The survey focuses on the financial health, skills and capabilities of the supply base and its workforce, potential gaps in the ability of the supply base to support future programs, and potential impact to other Agency programs. Survey results are currently being reviewed and a final report is scheduled to be prepared by Spring 2011.

NASA is also an active member of the Space Industrial Base Council (SIBC), which is a senior-level interagency group focused on the health of the U.S. space industrial base. The primary

Agency interface for the SIBC is the NASA Associate Administrator. The Associate Administrator is supported in this role by several organizations from across the Agency. NASA has also supported various studies and task forces on particular industrial base topics, such as the Department of Defense-led task force on the Solid Rocket Motor industrial base.

NASA also has ongoing activities to facilitate transition of both key NASA civil service employees and contractor employees to other programs. The enactment of the NASA Authorization Act of 2010 (P.L. 111-267) has provided valuable direction to the Agency and improved its ability to make workforce planning decisions. With this guidance, NASA has continued its efforts to map out the transition of its human spaceflight workforce from the Space Shuttle and Constellation programs to the Multi-Purpose Crew Vehicle and Space Launch System. This effort will be reflected in the Agency's next update to its *Workforce Transition Strategy* report, to be provided to Congress in the late spring/early summer of 2011. These reports provide details on NASA's initiatives to assist with workforce transition. The first three editions of this report are posted online at:

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NASA has also established the Space Shuttle Transition Liaison Office (SSTLO) in response to the NASA Authorization Act of 2008 (P.L. 110-422). The SSTLO coordinates assistance to local communities affected by the termination of the Space Shuttle Program by offering nonfinancial, technical assistance and identifying services from other Federal, State, and local agencies to assist in mitigating these impacts. This assistance includes sharing of information and potential partnership opportunities with Federal agencies to provide assistance to vendors that have supported the Space Shuttle Program and are being impacted by the retirement of the Program. The organizations include the Manufacturing Extension Partnership with the National Institute of Standards and Technology (NIST), the Economic Development Administration in the Department of Commerce, and the Office of Economic Adjustment in the Department of Defense.

Space Technology

32. The budget request for Space Technology is more than $200 million over the authorized level and more than $700 million over the 2010 enacted level. While the goals of the program are laudable, it is relatively new and NASA's technology roadmaps are still under external review. Would it make more sense to increase space technology funds gradually as the program institutionalizes itself rather than making such a dramatic increase in a relatively young program?

Answer: The FY 2012 budget request for Space Technology provides a modest increase above the level projected in the NASA Authorization Act of 2010, consistent with the Administration's priority on Federal investments in research, technology and innovation across the Nation. These investments are critical for the Agency's future, our Nation's future in space, and our Nation's technological leadership position in the world. Expanding this program is not only required to enable NASA's future missions in Science and Exploration, but doing so builds our Nation's economic competitiveness and creates high-tech jobs. As noted by the National Research

Council in numerous reports, NASA needs to make maturing transformative, high-payoff technologies a high priority if we are to see reductions in the cost and risk of the Agency's future missions. While the request is above the authorized level for FY 2012, NASA believes this amount is critical. This is a top Agency priority.

Within the FY 2012 request, NASA has integrated management responsibility of two technology development programs included in the NASA Authorization Act under the Office of the Chief Technologist. In FY 2012, Space Technology is proposed at approximately five percent of the Administration's $18.7B request for NASA. As defined in the FY 2012 request, Space Technology consists of three major components, two of which are well established, having existed at NASA for more than 5 years. These three components, as listed in Table 1, are: (1) the Small Business Innovative Research (SBIR)/Small Business Technology Transfer (STTR) program and related technology transfer and commercialization activities (FY 2012 request: $284 million) funded in FY 2010 and earlier through NASA's Innovative Partnership Program; (2) a majority of the Exploration Technology Development and Demonstration activities (FY 2012 request: $310 million) funded in FY 2011 and earlier in the Exploration Systems Mission Directorate (ESMD); and, (3) the Crosscutting Space Technology Development activities initially proposed as part of the President's FY 2011 request (FY 2012 request: $430 million). All components of Space Technology have been carefully formulated over the past year, and have deep roots in technology development approaches NASA has successfully pursued in previous years.

	FY 2010		FY 2011		FY 2012		
TRACE OF FY12 SPACE TECHNOLOGY CONTENT① ($ in millions and in full cost view)	Enacted	Actual	2010 Auth Act	2010 Auth Act (Trace of FY 2012 Activities)	2010 Auth Act	2010 Auth Act (Trace of FY 2012 Activities)	PBR
TOTAL	**327.2**	**275.2**	**600.0**	**512.0**	**923.3**	**796.0**	**1024.2**
Innovative Partnerships Program②	175.2	123.8 ⑤	350.0	175.2	486.0	175.2	284.0
[redacted]	**0.0**	**0.0**		174.8		310.8	430.2
Exploration Technology Development③	152.0	151.4	250.0	162.0	437.3	310.0	310.0
	82.6④	**87.2④**		**88.0④**		**127.3④**	**127.3④**

NOTES:

① Space Technology content as defined in President's FY 2012 request (inclusive of the SBIR/STTR program and related innovation, technology transfer and commercialization activities funded in FY 2010 through NASA's Innovative Partnership Program (IPP), a majority of the Exploration Technology Development and Demonstration (ETDD) activities funded in FY 2010 in the Exploration Systems Mission Directorate (ESMD), and the Crosscutting Space Technology Development activities initially proposed as part of the President's FY 2011 budget request).

② IPP merged into Space Technology in FY 2011. IPP FY 2010 Enacted levels are shown in FY 2011 and FY 2012 Auth Act split.

③ Sum of FY 2010 ETDP and planned FY 2011 ETDD efforts that are planned to move to Space Technology in FY 2012.

④ Advanced Exploration Systems content requested within ESMD in FY 2012 is not included in Space Technology total. ISS Research ($46.8M) not included in this total. Only includes Technology Infusion Projects.

⑤ $123.8M funding reflects FY 2010 SBIR/STTR transfer of $51.7M to Science Mission Directorate (SMD) which is planned for payback to SBIR/STTR in FY 2011 upon enactment of FY 2011 appropriations.

Table 1: FY 2012 Space Technology content integrates the long-standing efforts of NASA's Innovative Partnership Program, Exploration Technology Development Program, and the Crosscutting Space Technology Activities first proposed in NASA's FY 2011 budget request.

Relative to FY 2010 enacted levels, an increase of $109 million is requested for the SBIR/STTR and related innovation, technology transfer and commercialization activities formerly associated with the NASA Innovative Partnership Program. Small businesses have generated 64 percent of

net new jobs over the past 15 years. A significant fraction of this increase is targeted for the small business community, directly fueling the number of high-tech jobs that small businesses create in America. Additional funds are also planned to expand NASA's efforts in transferring and commercializing NASA-developed technologies into the private sector

Relative to FY 2010 enacted levels; an increase of $158 million is planned for Exploration Technology Development activities formerly budgeted within ESMD. This increase is consistent with the Authorization Act. This component of Space Technology funds activities largely at the NASA Centers that are critically focused on NASA's beyond low-Earth orbit Exploration priorities. In order to meet the exploration goals established in the NASA Authorization Act of 2010, NASA needs to develop the mission-specific capabilities required for its future Exploration missions. Exploration Technology Development investments will benefit future adaptations of the Multi Purpose Crew Vehicle and the Space Launch System and form the basis for the in-space transportation systems required for deep space exploration.

Relative to the NASA Authorization Act of 2010, an increase of $120 million is requested for NASA's Crosscutting Space Technology Development activities. Focused on broadly-applicable, high-payoff technology that industry cannot tackle today, NASA's Crosscutting Space Technology Development activities mature the technology required for NASA's future missions in Science and Exploration while proving the capabilities and lowering the cost of other government agency and commercial space activities. As evidenced by more than 1,400 Requests for Information responses, more than 300 external participants at the July 2010 Industry Day Forum, and a relatively large number of letters and opinion editorials, there is a large community of innovators throughout the Nation interested in working with NASA on Crosscutting Space Technology Development activities. Consistent with the NASA Authorization Act of 2010, these efforts are guided by a strategic set of technology roadmaps, available today in draft form and presently under review by the National Research Council (NRC). The NRC's final report from external review of the draft NASA Space Technology Roadmaps is scheduled for release in January 2012 (with a preliminary report scheduled for September 2011) in time to guide the FY 2012 Space Technology competition-based acquisition process.

33. The budget proposal transfers significant amounts of exploration technology development funding out of the Exploration Systems Mission Directorate and into the new Space Technology program. How will you ensure that exploration-specific technology priorities are met when the funding for these projects is mixed in to a larger, broader development budget?

Answer: In FY 2012, NASA is proposing to move a majority of the Exploration Technology Development and Demonstration activities funded in FY 2011 and earlier in the Exploration Systems Mission Directorate (ESMD) to Space Technology. These transferred activities are funded at a total of $310M. For traceability and management control, a specific budget element named "Exploration Technology Development" is established within Space Technology. Through this distinct budget element, NASA plans to manage the budget for these mission-specific Exploration technology activities apart from the broader technology development budget of Crosscutting Space Technology Development. The Exploration Technology Development and Crosscutting Space Technology Development activities are distinguished by their customer focus, balance between competed versus guided projects, and cost-share requirements.

The Exploration Technology Development activities, moved from ESMD, are critically focused on NASA's beyond low-Earth orbit mission-specific Exploration priorities. These priorities have been set by ESMD through the Human Exploration Framework Team (HEFT) and related planning activities. In FY 2012 and future years, ESMD will continue to provide prioritized requirements and remain the primary customer for all transferred Exploration Technology Development activities. NASA's Office of the Chief Technologist will manage the Exploration Technology Development activities based on these priorities. This transfer allows ESMD to focus on exploration vehicle development, but maintain control of the overall strategy, architecture and technology requirements for future beyond low-Earth orbit human exploration plans. The Office of the Chief Technologist will focus on performing the critical technology development and mission infusion activities. In FY 2012, to capitalize on expertise and progress of ongoing activities at the NASA Centers while still allowing for modest augmentation and gap filling, the activities within the Exploration Technology Development program will be largely guided to the NASA Centers based upon their core technical competencies.

34. The budget requests no funding in 2012 for robotic precursor missions; instead, robotic precursors are relegated to missions of opportunity within the Science Mission Directorate. Robotic precursor missions have long lead times and are necessary for scouting and validating possible destinations for manned missions to near-Earth asteroids and deep space locations. How does a delay in getting the robotic precursors started affect our long-term readiness for these missions outside of low Earth orbit?

Answer: In these tight budgetary times, priorities had to be made and, in Exploration, these priorities focus on the development of the SLS, the MPCV and Commercial Crew Transportation to low-Earth orbit, in alignment with the elements of the NASA Authorization Act of 2010. However, opportunities are anticipated for NASA's Exploration Systems Mission Directorate (ESMD) to achieve robotic precursor measurements by leveraging future missions in NASA's Science Mission Directorate and missions of our international partners, as well as potentially very low-cost, stand alone missions using innovative approaches. Such collaborations are in the best interest of the taxpayer as they leverage an already significant investment in robotic missions to advance exploration needs at relatively low cost. Plans for this more focused robotic precursor effort are still in the early stages, as are plans for the deep space vehicle missions that would take humans to destinations such as near-Earth asteroids, so it is not possible to assess the specific time impact of the shift in funding at this time. ESMD will prioritize needed measurements and work expeditiously with our partners to ensure that robotic precursor needs are met so they do not cause delay in enabling human missions beyond low-Earth orbit.

Recent Launch Failures

35. Did the Mishap Investigation Board for the Orbiting Carbon Observatory (OCO) identify the root causes of the OCO launch failure? If so, how did the problem recur during the launch of Glory this week? If not, how could NASA assert that the risk associated with Glory's launch vehicle had been retired?

Answer: The Mishap Investigation Board (MIB) for the Orbiting Carbon Observatory (OCO) did not identify the root cause for why the payload fairing (PLF) did not separate from the OCO launch vehicle; however, extensive analysis was conducted and mitigation steps were taken to address the most probable suspected causes of the OCO launch failure. Although it appears that the PLF once again did not separate from the Taurus XL during the launch of the Glory mission, the investigation into this launch failure is in its early stages, and thus there is no information yet available to support a conclusion as to root cause for this launch failure.

36. Where does the development and launch of a replacement Glory mission fit into NASA's Earth Science priorities? What options does NASA have to replace the data sets that Glory would have provided if NASA decides not to develop a replacement satellite?

Answer: NASA currently has no plans to refly a near-identical Glory mission. Owing to its use of the spacecraft bus from the cancelled Vegetation Canopy Lidar mission, which was designed and built more than a decade ago, it would neither be possible nor efficient to build a "carbon-copy" Glory-2 mission today. NASA is, however, continuing to pursue the development and flight of the 14 missions identified in the FY 2012 budget request for flight between now and 2020 as well as the competitively selected Venture-class instrument and small satellite missions.

The Glory mission was designed to allow scientists to better understand how the Sun and tiny atmospheric particles called aerosols affect Earth's climate. The Glory satellite carried two instruments – the Total Irradiance Monitor (TIM) and the Aerosol Polarimetry Sensor (APS). TIM was intended to precisely measure the amount of solar energy that enters the Earth's atmosphere, while APS was designed to identify different aerosol types and their scattering properties.

The on-orbit ACRIMSat and SORCE missions continue to provide measurements of total solar irradiance. A next-generation solar irradiance instrument, the Total Solar Irradiance Sensor (TSIS), is in the implementation phase, as a collaboration between NOAA and NASA. NASA is developing this instrument on a reimbursable basis for NOAA and instrument delivery is scheduled for late 2012. NOAA is currently examining options for flight of TSIS.

No precise measurements of aerosol composition and scattering properties are presently being made from space. Limited aerosol distribution measurements are currently being made by the MODIS instruments on Terra and Aqua, the OMI instrument on Aura, the MISR instrument on Terra, and the CALIOP instrument on CALIPSO. The VIIRS instruments on NPP (to launch this Fall) and planned for JPSS (first launch in 2016) will have some capacity for measuring global aerosol distributions. The PACE mission in the FY 2012 budget request, for launch in 2020, will carry an aerosol polarimetry instrument, potentially as an international collaboration with CNES.

NASA is assessing whether it would still be scientifically valuable to fly a copy of the APS instrument in the next 3-4 years and what mission options are possible to fly such an instrument. NASA is currently conducting two studies to address possible options for, and the cost/schedule of, rapid development and flight of a copy of the aerosol polarimetry instrument. The first study focuses on the scientific justification for flying such an APS in the context of the current Earth

Science program. The second study focuses on the technical/cost/schedule feasibility and implementation of the smallest, lowest-cost mission approach that would meet the science objectives, which could be either a free flyer or an instrument on some other satellite. No decision has been made at this time on whether or not we will propose a rapid development of a replacement APS instrument.

37. How does NASA's experience with Glory impact the budget or launch readiness of OCO-2 and GEMS, which are both slated to use the same launch vehicle that failed on the Glory mission?

Answer: NASA's Launch Service Program in the Space Operations Mission Directorate and Science Mission Directorate are evaluating options for launching OCO-2. OCO-2 is in development and the satellite is on-track for a February 2013 launch readiness date. OCO-2 was expected to launch on the next Taurus XL. NASA will reassess the OCO-2 schedule and launch vehicle plan based on the results of the mishap investigation of that launch vehicle failure.

With regard to GEMS, no launch service acquisition effort has been initiated. It is therefore premature to comment on the impact that the Taurus XL launch failure might have on GEMS.

Planetary Science

38. The new planetary science decadal survey recommends: the continuation of all current missions in operation or development; a 5 percent increase in research and analysis funding; a technology development program funded at 6-8 percent of the total planetary science budget; a continuation of funds for the Discovery program at an inflation-adjusted level; and funding for the selection of New Frontiers 4 and 5. If all of these activities are funded in 2012 at the recommended levels, how much would remain for the development of the large flagship missions?

Answer: The new planetary decadal survey was released after the submittal of the 2012 President's Budget, and our current outyear budget projections are notional. We will consider the funds available for a flagship mission as part of the FY 2013 budget.

39. The decadal survey recommends that NASA undertake a descoping process for both the Europa mission and the first stage of a Mars Sample Return mission. How long will NASA need to complete these descoping processes, and how much will it cost to perform the analysis?

Answer: Early planning is currently underway. We expect that the descoping process will be completed in time to inform the President's FY 2013 budget request. The costs of studies to evaluate descoping options will be $2-4M in FY 2012.

40. Many of the planetary science program's long term plans are dependent on the availability of Plutonium 238. What is the latest that Plutonium 238 production can be restarted without impacting the mission readiness of any planetary science project?

Answer: NASA has already made, and is making mission limiting decisions based upon Pu-238 availability. In order to conserve this limited resource, the New Frontiers 3 AO was limited to proposals not using Radioisotope Power Systems (RPS), even though many of the missions in the candidate set identified by the National Academy of Sciences for the New Frontiers program required it. Solar Probe has also been descoped from using RPS as a cost-saving measure. Future Discovery, New Frontiers, and flagship class missions will all be allocated a power constraint based upon the need to manage the Pu-238 supply, though greater science could result from more available power. The amount of power available to a spacecraft and its science instruments is a fundamental design consideration and must be resolved early in the mission planning process in order to avoid costly changes and to ensure the scientific return of these proposed missions. Significant progress toward initiating Pu-238 production will be required to retire the risk of plutonium unavailability, and allow mission planners to commit to an RPS-based power source requiring newly produced Pu-238.
The Administration requested the restart of plutonium-238 (Pu-238) production in FY 2011. The Department of Energy (DOE) has examined current national needs for Pu-238 and received significant input from NASA regarding our specific mission needs. Both agencies agree that an adequate national supply of Pu-238 can be maintained if an average production rate of 1.5 kilograms per year is in place by 2015, and DOE is successful in finalizing the purchase of 10 kg of Russian Pu-238.

Using existing facilities with some modifications, DOE expects to produce up to two kilograms of Pu-238 per year and to accommodate an average annual production rate of 1.5 kilograms on a sustained basis, meeting NASA's needs. If activities necessary for the restart of domestic production were started immediately (which would have required that both the $15M requested in the FY 2011 NASA budget request, and the $15M requested in the FY 2011 Department of Energy budget request, were appropriated during the third quarter of FY 2011), it would take approximately 6-8 years to have enough plutonium-238 on hand to support NASA's missions currently under study.

41. What is NASA doing to develop technology that will replace or reduce our dependence on Plutonium 238? When might this type of capability be ready for use?

Answer: For nearly 50 years, Radioisotope Thermoelectric Generators (RTGs) have provided safe, reliable electric power for NASA missions where solar power is not feasible. Although RTGs have performed with exceptional reliability over very long mission durations, they are limited by the low conversion efficiency of thermoelectric materials, with only 4-7 percent of the heat given off being converted into power. Because Plutonium-238 (Pu-238) is an extremely limited resource, for which the United States currently has no authorized production capacity, DOE and NASA are pursuing higher-efficiency systems, such as the Advanced Stirling Radioisotope Generator (ASRG) that would reduce the amount of Pu-238 required for a given electric power output. Each ASRG is projected to produce 120-130 Watts of power using less than 1 kg of Pu-238 fuel; this is about 25 percent of the Pu-238 that would be required for a comparable RTG.

Although Stirling engines have been in use since the early 1800s, they have never been used to generate electricity for spacecraft. Before the ASRG can be considered as an alternative to

RTGs for NASA missions, a flight-like system must be built and demonstrated, and its reliability must be well understood. These are the primary near-term goals of the joint NASA-DOE project to develop the ASRG for use in space. The next step toward the use of an ASRG on a mission is qualification. This phase involves building, fueling and testing an ASRG that is of the same design and rigorous quality requirements as one that would be used for flight. After qualification, a flight generator could be available for NASA mission use as early as 2015.

NASA is working to infuse this technology into the Discovery program as a means to encourage an early test flight of ASRGs. In the most recent Discovery Announcement of Opportunity (AO), NASA offered to provide two fueled and fully qualified ASRGs at no cost to the proposer as an incentive to infuse this technology into their proposal. Some of the proposers opted to include ASRGs as part of their proposal; a selection decision is expected later this year.

GAO Report on Government Duplication

42. Last week, GAO released a report on duplication across selected categories of government spending. The report identified 82 discrete government programs focused on improving teacher quality, including activities at NASA, NSF, Department of Education and elsewhere. Do you believe that NASA's teacher quality programs are duplicative of similar programs at other agencies? If not, how are you coordinating your programs to ensure that there is no unnecessary overlap?

Answer: On Monday, March 1, the GAO released a report entitled, "Opportunities to Reduce Potential Duplication in Government Programs, Save Tax Dollars, and Enhance Revenue." The chapter on teachers/STEM education references NASA.

The NASA Office of Education has read the section of the GAO report entitled, "Teacher Quality: Proliferation of Programs Complicates Federal Efforts to Invest Dollars Effectively". It cites 10 agencies with programs related to teacher quality, NASA being one of them. The agency agrees that it does support this initiative'; however, because NASA's education programs are built upon the science and engineering that we do for space and Earth-based missions and programs, our education efforts do not duplicate those of other agencies.

At NASA, sharing information is a mandate within our founding legislation. The Space Act of 1958 instructs us to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof". Through the excitement of missions and activities, we help stimulate student interest and achievement in science, technology, engineering and mathematics (STEM) fields. NASA is in a unique position to inspire students with our programs.

We periodically reassess our programs and approaches to ensure that our resources are focused and used effectively. In 2010, NASA instituted an Education Design Team to perform an assessment of the agency's education in the context of current trends in education. The Team has completed its task, and its recommendations to implement new sustainable and innovative STEM education programs are reflected in the FY 2012 education budget request. This proposed FY

2012 baseline will also serve as the program and budget structure for future NASA education funding requests.

NASA is a member of the OSTP National Science and Technology Council's Committee on STEM Education. This is an executive-level STEM forum that allows all agencies involved in STEM Education outreach to network, coordinate and leverage opportunities.

We also work with the Department of Education and other federal R&D agencies on specific education events/initiatives. A perfect example is taking place this week in Washington, DC: The Global Climate Change Education Principle Investigators' Meeting is bringing together approximately 200 investigators from NASA, NOAA and NSF for discussion and networking. Collaborative events such as these actually reduce duplication and foster discussion, identify lessons learned and best practices and lead to increased efficiency in education across a number of agencies.

Also, in 2009 a GAO report found that NASA higher education programs do not duplicate those of other federal agencies: http://www.gao.gov/htext/d1087r.html <http://www.gao.gov/htext/d1087r.html>

Quote from report: "We focused on three areas within --Science, Aeronautics Research, and Education--for review and excluded other activities such as space operations and exploration missions that are unique to NASA. We judgmentally selected projects and activities from each of the three areas and compared them against similar activities in other organizations. We found no apparent duplication among the selected projects or activities. Although we did not look at all programs within NASA, policies, procedures and mechanisms are in place that facilitate the avoidance of duplication by engaging in collaboration and coordination between NASA and other federal agencies. For example, NASA coordinates its work with other agencies by participating in formal groups such as the NSTC and various interagency working groups."

The Hon. Chaka Fattah
House Appropriations Subcommittee on
Commerce, Justice, Science and Related Agencies

Questions for the Record
Hearing on the FY 2012 Budget Request
for the National Aeronautics and Space Administration

1. The space shuttle program is winding down, and while work will continue on the space station through 2020, it will be a long time before NASA has the ability to transport astronauts into deep space. Until then, what is NASA's vision for how it will continue to capture the public's imagination and build the public's support for the space program during a period of tight budgets?

Answer: NASA is at an exciting point in its history, as the Agency prepares to retire the remarkable Space Shuttle fleet and the International Space Station (ISS) completes its transition from construction to full operations. As NASA embarks on the development of new systems for transporting astronauts into space and beyond low-Earth Orbit (LEO), the Agency will continue to capture the public's imagination and inspire people around the world; among other activities, NASA will:

- Conduct numerous experiments on ISS. Some of these will improve our understanding of how to keep astronauts alive and productive on long-duration spaceflights, while others will develop new technologies. Non-NASA research will be conducted on ISS as part of the National Laboratory effort; many of these experiments may have terrestrial applications in areas such as medicine and biotechnology (for further details, please see response to Question #5).
- Engage students in developing and participating in research aboard the ISS. Recently, students in the 5th and 6th grades have had experiments performed on the ISS by astronauts. The overall goal is to involve the public in ISS operations and research.

- Develop, launch and operate Earth Science missions designed to help scientists better understand Earth as a system, including interactions among the oceans, atmosphere, and land. NASA maintains climate change modeling capabilities to enhance forecasts of regional and other effects. There are currently 14 Earth-observing spacecraft in operation and 7 more in development.

- Develop, launch and operate Planetary Science missions to expand knowledge of the varied bodies in our solar system, including planets, their moons, asteroids and comets. The Mars Science Laboratory, scheduled for launch in 2011, will be the most capable planetary rover ever fielded. There are

currently 10 Planetary Science missions in operation, 7 more in development, and selection of 2 new missions planned this year.

- Develop, launch and operate Astrophysics missions, including the James Webb Space Telescope, which will be up to 100 times more powerful than the highly successful Hubble Space Telescope. NASA's astrophysical observatories are helping scientists rewrite textbooks about the nature of the cosmos. There are currently 13 Astrophysics missions in operation and 5 more in development.

- Develop, launch and operate Heliophysics missions to improve researchers' understanding of our local star, the Sun, as well as the impact of solar weather on Earth. The Solar Probe Plus will explore the Sun's corona itself. There are currently 17 Heliophysics missions in operation and 6 more in development.

- Encourage the development of commercial ventures in LEO through the ISS National Laboratory and commercially provided cargo and crew transportation to and from the Space Station. The Agency hopes this will lead to the growth of an orbital space economy.

- Develop long-range technologies to enable human exploration, and demonstrate critical in-space capabilities such as cryogenic propellant storage and solar electric propulsion.

- Develop and refine key technologies, systems, and concepts of operations for human space exploration via testing and demonstrations in terrestrial analogs for the extreme environments of space. This includes the underwater NASA Extreme Environment Mission Operations (NEEMO) facility off the coast of Florida and analog sites that include Black Point Lava Flow in Arizona and Pavilion Lake in British Columbia. These analogs are also used to refine science and exploration operations as well as leverage astronaut and scientist training opportunities in a very realistic environment.

- Conduct cutting-edge aeronautics research with an increased focus on enhancing aviation safety and airspace efficiency, and reducing environmental impacts.

In addition to the many experiments, missions, and technology development efforts above, NASA will inspire the next generation through its focus on Science, Technology, Engineering, and Math (STEM) education. NASA is uniquely positioned to inspire students to be future scientists, engineers, explorers, and educators. The FY 2012 budget request provides NASA with the resources necessary to continue a rich tradition in STEM education through support for the Nation's students and educators, the leveraging of cutting- edge education technologies, and partnerships with industry. For example, NASA will enable student launch initiatives, hands-on payload development, and engineering opportunities for NASA

missions. Through partnerships with NASA Centers, universities, and industry, students will gain research experiences and hands-on engineering experience on a variety of real-world platforms that may include high-altitude balloons, sounding rockets, aircraft, space satellites, and the ISS.

2. Last fall, Congress passed the NASA Authorization Act of 2010, directing NASA to develop a space launch system and crew vehicle for missions to near-Earth orbit and regions of space beyond low-Earth orbit utilizing existing contracts, investments, workforce, industrial base, and capabilities from the Space Shuttle, Orion, and Ares 1 projects to the extent practicable. If NASA did not have this specific requirement to utilize its existing elements and instead had complete flexibility to decide on the engineering of the systems for enabling exploration beyond low-earth orbit, how would NASA choose to go forward? Would NASA's plans differ from the requirements of the NASA Authorization Act? Does NASA envision that there would be significant similarities in approach? Are there any requirements of the Authorization Act that NASA believes could add cost or delay to NASA's deep space efforts?

Answer: The NASA Authorization Act of 2010 is the law, and therefore it would not be appropriate for NASA to hypothesize about what it could do if portions of the law did not exist.

With passage of the Authorization Act and the 2011 Consolidated Appropriations Act (P.L. 112-10), NASA has a clear direction for our human spaceflight programs, and we are aggressively moving forward with our next-generation human spaceflight system development efforts. While NASA has not yet finalized its development plans for the SLS and MPCV, NASA is working expeditiously to ensure we have a credible and integrated plan with which to move forward. We understand and appreciate the direction provided by the NASA Authorization Act of 2010, and we are honoring those requirements as we implement the Act. It is important to note that the President's FY 2012 budget request also reflects all of the major elements of the Authorization Act.

To date, the Agency has selected a Reference Vehicle Design for both the SLS and MPCV, giving us a baseline from which to start developing schedule, budget and requirements, as well as acquisition plans. NASA will evaluate the Reference Vehicle Designs and other alternatives this spring through in-house analyses and maturation of concepts and will incorporate results of industry studies that the Agency solicited earlier this fiscal year. In particular, one of the greatest challenges for NASA will be to reduce the development and operating costs (both fixed and recurring) for human spaceflight missions to sustain a long-term U.S. human spaceflight program. We must plan and implement an exploration enterprise with costs that are credible and affordable for the long term under constrained budget environments. As such, our development efforts also will be dependent on a realistic budget profile and sufficiently stable funding over the long term, coupled with a successful effort on the part of NASA and our eventual industry team to reduce costs and to establish stable, tightly-managed requirements.

NASA is exploring ways to transition the design and development efforts of the Constellation Program so that NASA will be able to capitalize on current investments and workforce, as appropriate. While some may consider Constellation's investment to date to be wasted and sunk costs, much of what Constellation has accomplished is indeed transferrable to the SLS and MPCV programs, not just in terms of hardware, validated requirements and infrastructure elements, but also in terms of less tangible items such as knowledge and experience gained by our team with the Constellation Systems being developed. Therefore, as we work to close out the Constellation Program, we are also taking care to capture and build upon Program accomplishments, especially those technologies that have a high likelihood of feeding forward into the SLS and MPCV programs.

Over the last year, due to provisions of the FY 2010 Consolidated Appropriations Act (P.L, 111-117), NASA has been prohibited from terminating any Constellation contracts. As such, NASA has continued to implement the Constellation Program and associated projects, while at the same time prioritizing Constellation funding on work that was most related to the SLS and MPCV. With the passage of the FY 2011 Consolidated Appropriations Act (P.L. 112-10), NASA now has the authority to terminate unnecessary Constellation work that is not required for the new SLS and MPCV Programs. As such, NASA is currently, NASA is finalizing its Constellation Transition Plan, which will provide the framework for moving ahead on the SLS and MPCV.

3. To what extent might the additional funding requested for Space Technology activities help accelerate the date by which NASA will be able to travel beyond low-earth orbit? To what extent will the Space Launch System and Multi-purpose Crew Vehicle development activities directly benefit from these additional technological development efforts?

Answer: The Space Launch System (SLS) with the Multi-Purpose Crew Vehicle (MPCV) are critical capabilities required for a manned mission beyond low Earth orbit. However, they are not the only capabilities required for deep space exploration. Within the FY 2012 budget request for Space Technology, under the Exploration Technology Development program, funds are identified for initiation of two exploration-specific technology demonstration missions: Cryogenic Propellant Storage and Transfer (CPST), and Solar Electric Propulsion (SEP). These demonstrations missions are intended to mature critical in-space propulsion technologies identified by recent Human Explorations Frameworks Team (HEFT) analysis and numerous past studies as necessary to reduce the cost and risk of deep space (beyond low-Earth orbit) human exploration.

The FY 2012 budget request for Space Technology also proposes investment across a spectrum of exploration-specific technologies required for deep-space human exploration including: deep-space communications and navigation, entry systems, space power generation and storage, composite cryogenic propellant tanks, human-robotic systems, next generation life support, radiation protection, in-situ resource utilization, autonomous systems, and human exploration telerobotics.

In addition, through the Crosscutting Space Technology component of the FY 2012 budget request for Space Technology, NASA will mature the broadly applicable

technologies required for its future missions in Science and Exploration. Crosscutting advances in lightweight materials, power systems, communications, and propulsion technology will reduce the cost and risk of numerous NASA missions, including deep space human exploration. As noted by the National Research Council in numerous reports, NASA needs to make maturing visionary, far-reaching concepts and technologies a high priority if we are to see advanced concepts infused into its future systems.

NASA's Space Technology investments will benefit future adaptations of the SLS and MPCV. one example, composite cryogenic propellant tanks, being developed through Space Technology, will significantly increase the launch capability of future incarnations of the SLS while simultaneously reducing its cost and manufacturing complexity. This technology development is also applicable to future human exploration lander systems. Similarly, planned Space Technology investments in human exploration telerobotics, deep-space communications and navigation, space power generation and storage, next-generation life support, radiation protection, and autonomous operations will all contribute to the operational capability of the MPCV. In order to realize a deep-space human exploration capability, in addition to the SLS and MPCV, NASA will need new capabilities and systems that are reliant upon the suite of technologies planned within the Space Technology Program.

4. What metrics does NASA have for measuring the success of NASA's education efforts? To what extent do we know how much NASA's efforts in this regard are inspiring young people to pursue careers in math, science, and engineering? Why does the budget request once again seek to cut funding for these efforts?

Answer:

Education Metrics

- In FY 2009, 6,743 higher education students self-reported as being part of an underserved and underrepresented race or ethnicity. This represents 40.6 percent of the total number of higher education students served, an increase from 28 percent in FY 2008.
- Of higher education students served, 43 percent self reported being women, an increase from 41 percent in FY 2008. These figures are well above national averages for participation of minority students according to the National Science Foundation's report, Women, Minorities, and Persons with Disabilities in Science and Engineering, released in April 2010.
- NASA higher education projects are actively working to increase the participation of underrepresented and underserved students. Future efforts include plans to work more closely with community colleges and institutions that tend to serve large numbers of underserved students. The Space Grant Program, which works with affiliates in all 50 states, the District of Columbia, and Puerto Rico, has actively encouraged state consortia to better engage minority-serving institutions

in their networks. The consortia are accountable for improving the participation of underserved students in their programs, determined as a percentage of their audience base.

- The strategy has been successful, as participation of racially and ethnically underserved and underrepresented students in the Space Grant Program has increased from 15 percent in FY 2007, to 21percent in FY 2008, and to 29 percent in FY 2009.
- 93 percent of educators responding to NASA surveys report using NASA resources in their classroom instruction after participating in long duration NASA training programs in 2010.
- 86 percent of educators responding to NASA surveys report using NASA resources in their classroom instruction after obtaining NASA content-based education resources or participating in short-duration NASA education activities in 2010.
- In FY 2010, 553,589 elementary and secondary students participated in NASA instructional and enrichment activities.
- In FY 2010, over 400 museums, science centers and planetariums participated as active members of the NASA Museum Alliance.

The President's FY 2012 budget request for NASA Education reflects a $7.4M decrease from the previous request, sufficient to fund the highest priority activities. NASA's Office of Education will focus its funds on existing commitments and grant renewals, continuation of scholarships, internships and fellowships, and activities that directly serve educators, students, and the general public. The decrease will be managed by reducing the number of new grant awards and seeking operational efficiencies (e.g., increased use of education technologies, reduction in printing /warehousing/shipping costs, reducing travel, coordinating solicitations).

5. With regard to the extension of the mission of the space station until 2020—this will obviously require billions more federal dollars to cover the additional years of operating costs, but can NASA explain the kinds of benefits that the U.S. can expect to realize from the work of the station continuing for several more years, such that it will be a good return on the public's additional investment?

Answer: The ISS has transitioned from the construction era to that of operations and research, with a 6-person permanent crew, 3 major science labs, an operational lifetime through at least 2020, and a growing complement of cargo vehicles, including the European Automated Transfer Vehicle (ATV) and the Japanese H-II Transfer Vehicle (HTV).

The Station is the largest crewed spacecraft ever assembled, representing a unique research capability aboard which the United States and its partner nations can conduct a wide variety of research in biology, chemistry, physics and engineering fields which will help us better understand how to keep astronauts healthy and productive on long-duration space missions.

In addition to conducting research in support of future human missions into deep space, astronauts aboard the ISS will carry out experiments anticipated to have terrestrial applications:

- ISS research has shown that bacteria can become more virulent in microgravity (i.e., more aggressive in causing disease). In several cases, scientists have successfully identified the genes responsible for this increased virulence and are now developing vaccine candidates. AstroGenetix, Inc. has funded its own follow-on studies on ISS and is now preparing to submit Investigational New Drug applications to the Food and Drug Administration for the treatment of both *salmonella*-induced food poisoning and methicillin-resistant *Staph aureus* (MRSA).

- Microcapsules are tiny micro-balloons used in cancer treatment to deliver anti-cancer drugs directly to a tumor site. Microcapsules with improved cancer treatment properties developed on the ISS were reproduced on Earth and were successful in targeting delivery of anti-cancer drugs to successfully shrink tumors in ground tests. A device to produce similar capsules on Earth has now been patented, and clinical trials of the drug delivery method are planned at M.D. Anderson Cancer Center and the Mayo Clinic.

- A Japanese scientist crystallized the HQL-79 protein (human prostaglandin D2 synthase inhibitor protein) on the ISS, producing an improved structure that identified the location of critical hydrogen bonds that were not previously known. This allowed drug design for a candidate treatment to inhibit the progression of Duchenne muscular dystrophy. Continuing work is examining other proteins and viruses.

- Numerous plant growth experiments have investigated both the effects of microgravity, as well as the capability for growing regenerable food supplies for crew. Technology developed for a greenhouse flown on the ISS is now widely used on Earth, killing 98 percent of airborne pathogens (including Anthrax) for food preservation, doctors' offices, homes, and businesses.

Research into areas such as biotechnology, bioengineering, medicine, and therapeutic treatment will be enabled by the National Laboratory function of the Station. NASA has 5 Memoranda of Understanding (MOUs) with other U.S. government agencies, and 9 agreements with non-government organizations to conduct research aboard the ISS. NASA intends to continue to expand the community of National Laboratory users of the ISS. In support of this effort, on February 14, 2011, NASA released a Cooperative Agreement Notice (CAN) for an independent non-profit organization to manage the multidisciplinary research carried out by NASA's National Laboratory partners. The Agency anticipates making a selection in late spring with final award by mid-summer. The non-profit organization will serve the following important functions to facilitate research: (1) act as a single entry point for non-NASA users to interface efficiently with the ISS; (2) assist researchers in developing experiments, meeting

safety and integration rules, and acting as an ombudsman on behalf of researchers; (3) perform outreach to researchers and disseminate the results of ISS research activities; and, (4) provide easily accessed communication materials with details about laboratory facilities, available research hardware, resource constraints, and more.

ISS can also play a key role in the demonstrations and engineering research associated with exploration. Propellant storage and transfer, life support systems, and inflatable technology can all benefit by using the unique research capabilities of ISS. Several ISS analog test missions will also be conducted with both space and ground assets in order to develop and refine key technologies, systems, capabilities, and concepts of operations for challenging beyond LEO space exploration missions.

In addition to supporting a variety of research and development efforts, the ISS will serve as an incubator for growth of the low-Earth orbit space economy. NASA is counting on its Commercial Resupply Services (CRS) suppliers to carry cargo to maintain the Station. It is hoped that these capabilities, initially developed to serve Station, may find other customers as well, and encourage the development of further space capabilities and applications:

As a tool for expanding knowledge of the world around us; advancing technology; serving as an impetus for the continued development and evolution of the commercial space sector; demonstrating the feasibility of a complex, long-term, international effort; and, perhaps most importantly, inspiring the next generation to pursue careers in science, technology, engineering, and mathematics, the ISS is without equal.

6. How extensive is the backlog of maintenance projects at NASA facilities, and how does the fiscal year 2012 budget request address this issue? What other steps is NASA taking to address this problem, and does NASA expect to see its deferred maintenance backlog decrease in the short term?

Answer: NASA assesses its facilities and reports an estimate of Deferred Maintenance (DM) annually, as required by FASAB, OMB, E.O. 13327, and GSA (Federal Real Property Reporting Requirements). This estimate of Deferred Maintenance (DM) is the total of essential, but unfunded, facilities maintenance work necessary to bring facilities and collateral equipment to the required acceptable facilities maintenance standards. The estimate represents the total work that should be accomplished, but that cannot be achieved, within available resources.

The annual DM estimate reported for NASA in FY 2010 was $2.553B. This includes $506M for inactive facilities. The DM increased by $84.9M from FY 2008-2009 and by a smaller amount, $6.16M from FY 2009-2010. This slowing of the deferred maintenance growth is primarily the result of NASA's demolition program and the current low inflation rate. The FY 2012 budget request for NASA Center Management and Operations (CMO) continues to address the ongoing maintenance and repair work, which typically includes the Preventative Maintenance Program and maintenance and repair work within the CMO budget. The majority of the proposed

FY 2012 Construction of Facilities (CoF) Program includes projects that address repair requirements (deferred maintenance) that cannot be funded within the CMO budget, such as repair of electrical distribution systems, repair and replacement of water and waste systems, and fire distribution systems. NASA's renovation and replacement of obsolete facilities will reduce or eliminate deferred maintenance in several critical NASA facilities. NASA also plans to continue with the demolition program, which eliminates un-needed facilities and is the most cost-effective way to reduce the overall DM.

NASA does not expect to see its deferred maintenance backlog decrease significantly in the short term, but does have a long-term strategy to renew and modernize its facilities and sustain its core capabilities over the long term. This strategy will allow NASA to reduce its maintenance backlog and reduce its overall footprint over the long term.

7. According to NASA's Real Property Asset Management Plan, approximately 10 to 50 percent of NASA's warehouses and 30 to 60 percent of its laboratories are underutilized. NASA has recently put out a Request for Information to identify interest from industry for some facilities at the Kennedy Space Center that may become available for commercial use following the end of the Shuttle Program. What additional steps does NASA plan to take to make more cost-effective use of its many facilities?

Answer: The percentages of NASA warehouses and laboratories cited as underutilized in the question are misinterpretations. These percentages are the definitions established by the Federal Real Property Council for defining "under-utilization rates" for warehouse and laboratory spaces.

The NASA Kennedy Space Center (KSC) is particularly affected by changes to NASA's mission; KSC is working on its facilities master plan this year. Having identified major assets that NASA may no longer need, KSC has issued a Request for Information (RFI) to explore whether these facilities could have value to private sector partners before a disposition is planned. One means of entering into real estate partnerships is Enhanced Use Leasing, and this authority is available to all NASA Centers.

In addition to changes in the quantity of facilities needed, NASA's evolving mission requirements and the very high share (>80%) of its facilities assets that are beyond their design lifespan result in a facilities set composed of assets that are, in many cases, a poor fit with NASA's future. In response, NASA has chosen and is further developing and implementing an Agency Facilities Strategy: "NASA will renew and modernize its facilities to sustain its capabilities, and to accommodate those capabilities in the most efficient facilities set practical."

To best implement the Agency Facilities Strategy and to make more cost-effective use of its many facilities, NASA has developed its strategy in consultation with

Agency and Center leadership, and via enhanced local facilities master planning. Having reworked its local plans, NASA is now weaving these local plans into a coherent, integrated Agency Master Plan which will be broadly available by the end of FY 2011. Together with the financial resources to carry them out, the Agency is responding to its facilities challenges in an integrated, responsible fashion.

Commerce, Justice and Science Subcommittee Hearing
Department of Commerce Appropriations
Questions for the Record
Robert B. Aderholt (AL)

The Honorable Charles Bolden
Administrator
National Aeronautics and Space Administration

1. I am happy know that the NASA has announced the program office for the Space Launch System (SLS) at Marshall Space Flight Center. Since Marshall is home to the program office, will the managers and personnel selected by Director Lightfoot be responsible for the systems engineering and also for determining the requirements for the heavy lift vehicle?

Answer: NASA has full confidence in the long-standing history of the Marshall Space Flight Center and its experience with propulsion development. As such, the Agency recently assigned the lead for SLS efforts to Marshall and is in the process of standing up the SLS Program Office at the Center. The office will report to the Exploration Systems Mission Directorate (ESMD) and be responsible for managing the development and integration of the launch vehicle in response to requirements set forth by the Agency. In addition, it will support ESMD's cross-program integration between MPCV, SLS, and 21st Century Launch Complex to deliver a beyond-LEO human exploration capability. The majority of personnel supporting SLS in program management, system engineering, and mission safety will be resident at Marshall, but expertise will be drawn from multiple NASA centers.

2. Will Marshall also be responsible for the work known as sustaining engineering for the heavy lift vehicle?

Answer: The sustaining engineering phase of a program is later in the Program's life cycle and is performed during the operational phase of the launch vehicle. There will be some level of sustaining engineering effort as part of the SLS after development is complete. The specifics have not yet been defined.

3. The FY 2012 request includes $1.8B for the heavy lift vehicle. Some within the aerospace industry say that this is a very tight budget, and that it will need to be efficiently utilized if the heavy lift vehicle is to be successfully developed. Will the MSFC heavy lift office have the responsibility for identifying the agency's people and infrastructure that will need to be supported out of the $1.8B and the authority to decline to support agency personnel and infrastructure that they believe is not needed for the successful execution of the heavy lift vehicle project, including FY 2012?

Answer: Cost-effective development is a key component of NASA's plans for developing a beyond LEO capability. All programs have been asked to identify the most affordable use of government workforce and infrastructure to meet their requirements. This information will integrated into the Agency's overall strategy for institutional services and the results detailed in the update to the NASA's January 2011 Congressional report about MPCV and SLS.

4. When will NASA actually start building the heavy lift vehicle? And when can we expect the heavy lift vehicle to attain its Initial Operating Capability?

Answer: With passage of the NASA Authorization Act of 2010 and the FY 2011 Full-Year Continuing Appropriations Act (P.L. 112-10), NASA has a clear direction for our human spaceflight programs, and we are aggressively moving forward with our next-generation human spaceflight system development efforts. While NASA has not yet finalized its development plans for the SLS and Multi-Purpose Crew Vehicle (MPCV), NASA is working expeditiously to ensure we have a credible and integrated plan with which to move forward. We understand and appreciate the direction provided by the NASA Authorization Act of 2010, and we are honoring those requirements as we implement the Act.

In moving forward with our SLS and MPCV planning efforts, NASA will ensure that we have efficient contracting and management approaches so as to ensure affordability in the near term and over the long run. We will also build an evolvable and interoperable human spaceflight transportation system that will serve us for decades to come as we explore multiple compelling mission destinations. In a constrained budget environment, we know how important it is to look for ways to make our programs and projects more efficient, so finding and incorporating these efficiencies is a primary goal for us. Therefore, NASA has embraced the challenge to deliver human spaceflight systems for lower cost, and the opportunity to become more efficient, innovative and agile in our programs. For example, we are revising the management of our requirements, contracts, and projects, and, as stated above, incorporating approaches to ensure affordability in the near term and over the long run. This includes the use of focused insight/oversight, specifying, where appropriate, to industry what we need instead of how to build it, designing for cost-effective operations, increasing the use of common components and parts, and smartly consolidating infrastructure.

Much work remains to be accomplished over the next few months, such as in-depth planning to synchronize the schedules and budgets for SLS, MPCV and Ground Operations efforts such that their developments are coordinated in order for each to deliver its capability in a planned timeframe. Since an integrated schedule for the SLS and MPCV vehicles is an essential product of our planning efforts, NASA required additional time to gain reliable information from on-going system trade studies, obtain a better understanding of budget requirements and constraints, and develop acquisition strategies that can put development on an affordable and sustainable path. Therefore, by summer, NASA expects to have completed several key analytical steps – information that will be contained in our follow-on report to Congress:

- The basic framework for a capability-driven architecture and concept of operations that provides the strategic context for exploration of multiple destinations, a plan that applies the principles of affordability, sustainability, commonality, and interoperability, and a framework for expanded partnerships with the international, interagency, industry, and academic communities;
- Analysis of the current Ares and Shuttle contracts for their applicability to the future development program;
- Analysis of the cost and benefits of the Reference Vehicle Designs for the SLS and MPCV and alternate vehicle designs; and,
- Analysis of potential initial acquisition approaches (in the case when contract changes or new procurements are indicated, NASA will follow applicable procurement regulations, including the March 4, 2009, Presidential Memorandum on Government Contracting).

Until this work is completed and appropriations are made available, NASA cannot realistically offer a prediction on an Initial Operational Capability for the SLS and MPCV. However, we are working to get as close to 2016 as we can – the goal set by the NASA Authorization Act of 2010.

5. My understanding is that the mass level which must be reached, to launch an Orion-based multi-person-crew vehicle beyond low-earth-orbit, is 40 metric tons minimum and that that equates to a launch vehicle of no less than 130 metric tons. Is that correct?

Answer: The numbers cited in the incoming question are hard to verify, as requirements such as this beyond minimum and maximum capabilities of the MPCV and SLS are mission contingent. For example, the mass of an MPCV for a beyond-LEO mission will vary depending on crew size and their required support elements.

With regard to the SLS, the NASA Authorization Act of 2010 directs NASA to develop a SLS that is capable of accessing cis-lunar space and the regions of space beyond low-Earth orbit (LEO). The Act also states that the SLS must be capable of lifting the MPCV, and that the SLS must be able to initially lift 70-100 mT to LEO, while ultimately being evolvable to 130 mT or more. For the initial capability, the Authorization Act set a goal of achieving operational capability for the core elements no later than 2016. (Note: The Authorization Act specified vehicle performance in terms of "tons" but NASA develops capability in terms of "metric tons." Therefore, lift capability references are referred to in this answer in terms of metric tons.)

NASA's SLS development effort is focusing initially on the 70 to 100 mT lift capability, so as to get as close to 2016 as possible in terms of initial operational readiness. We also are seeking ways to capitalize on synergies between the lower-range and upper-range lift capabilities, thereby allowing us to develop some of the upper-range capabilities at the same time as we are focusing on the 70 to 100 mT capability. Doing so is actually a fairly natural, evolvable progression in terms of developing these capabilities. However, before making any final decisions, we must first understand how our approaches to heavy-lift will fit within the budget profile, how they will fit into a future exploration architecture, and how they might benefit other agencies to maximize the investment for the taxpayer. It is very helpful that appropriations for SLS and MPCV development efforts in FY 2011 have been finalized as part of the FY 2011 Full-Year Continuing Appropriations Act (P.L. 112-10). Gaining increased clarity regarding future budget profiles will also be an important factor in helping NASA to finalize plans for the SLS and the MPCV.

6. In your testimony, you also propose outsourcing non-NASA and non-governmental uses of the International Space Station (ISS) to a Non-Governmental Organization (NPO). Will taxpayer dollars still be used? What is your vision for the management of NASA's utilization of the ISS? Do you foresee outsourcing this function?

Answer: Non-NASA research into areas such as biotechnology, bioengineering, medicine, and therapeutic treatment will be enabled by the National Laboratory function of the Station. NASA has 5 Memoranda of Understanding (MOUs) with other U.S. government agencies, and 9 agreements with non-government organizations to conduct research aboard the ISS. NASA will pay for the transportation and ISS infrastructure costs (i.e., use of power, thermal control systems, communications, etc.) associated with National Laboratory research, and provide some grant funding for experiments conducted by research institutions. However, experiments sponsored by private firms will be funded by the National Laboratory partners – not by NASA.

On February 14, 2011, NASA released a Cooperative Agreement Notice (CAN) for an independent non-profit organization to manage the multidisciplinary research carried out by NASA's National Laboratory partners. This organization will: (1) act as a single entry point for non-NASA users to interface efficiently with the ISS; (2) assist researchers in developing experiments, meeting safety and integration rules, and acting as an ombudsman on behalf of

researchers; (3) perform outreach to researchers and disseminate the results of ISS research activities; and, (4) provide easily accessed communication materials with details about laboratory facilities, available research hardware, resource constraints, and more. The Agency anticipates making a selection in late spring with final award by mid-summer.

Through the management partnership, research opportunities will be expanded to conduct more research in both life and physical sciences.

NASA research conducted aboard ISS will be dedicated to improving our understanding of how to keep astronauts healthy and productive on long-duration space missions. ISS will also play a key role in the demonstrations and engineering research associated with exploration. NASA will continue to manage these types of science and engineering research.

7. What was the number of employees, including contractors and detailees, at NASA Headquarters in January 2008? How many in January 2011? How many employees, including contractors and detailees, do you project at NASA Headquarters at the end of FY12?

Answer:

January 2008:

Number of employees (civil servants): 1,210

Number of contractors: 610 Work Year Equivalents (WYEs)*

Number of detailees: information not available

January 2011:

Number of employees (civil servants): 1,234

Number of contractors: 656 WYEs**

Number of detailees: 93

January 2012 Projections:

Number of employees (civil servants): 1,208

Number of contractors: Not able to make projections at this point in the budget cycle

Number of detailees: information not available***

* Total WYE usage in FY 2008 (see note below)
** Total WYE usage in FY 2010
*** The numbers of detailees to HQ cannot be projected for 2012 as these numbers fluctuate from year to year based on program need and development program opportunities

Note: Due to the way the contracts are structured, the Agency does not pay for a specific number of contractor employees, rather we pay for either amount of hours worked (regardless of how many individuals performed the work) or we pay for a finished product. It is very difficult to determine the exact number of contractor employees working for NASA at any point in time. Instead, the Agency tracks the number of Work Year Equivalents (WYEs) on an annual basis. The WYE calculation is similar to the calculation of full-time equivalent employees (FTEs).

8. Please update me on the status of the I3P program.

Answer: The status of NASA's IT Infrastructure Integration Program (I3P) for provisioning of end user services, enterprise applications, communications services, web services, and data center services is as follows:

- **End User Services:** NASA awarded the Agency Consolidated End User Services (ACES) contract for the provisioning of end user services to Hewlett-Packard Enterprise Services on December 27, 2010. The ACES contract will develop a long-term outsourcing arrangement with the commercial sector to provide and manage the vast majority of NASA's personal computing hardware, Agency standard software, mobile IT services, print services, peripherals and accessories, associated end-user services, and supporting infrastructure. Transition to the new contract has begun with all Centers implementing the new contract by March 2012. NASA will extend the existing end user services contract (Outsourcing Desktop Initiative for NASA, (ODIN)) to cover the time period until ACES services are available.

- **Enterprise Applications:** NASA awarded the Enterprise Applications Service Technologies (EAST) contract to SAIC on October 28, 2010. The primary purpose of the EAST contract is to provide the services necessary to operate the NASA Enterprise Applications Competency Center (NEACC). The NEACC provides services to operate, maintain, and enhance key Business and Mission-Supporting platforms, applications and infrastructure used across the Agency. Contract phase-in started on November 1, 2010, and the contract started on February 1, 2011. The EAST contract is in a stabilization period until July 31, 2011.

- **Communications Services:** The NASA Integrated Communications Services (NICS) contract will develop a long-term arrangement with the commercial sector to provide and manage the vast majority of NASA's IT communications infrastructure. NASA is in the final selection process for the NICS contract with award imminent. We plan to start phase-in shortly after award with contract start as early as June 1, 2011.

- **Web Services:** NASA plans to award the Web Enterprise Service Technologies (WEST) contract the week of May 23, 2011. We plan to start phase-in on June 6, 2011, with contract start on October 6, 2011. The WEST contract will continue the development of a long-term outsourcing arrangement with the commercial sector to provide and manage the vast majority of NASA's external Web sites and services, including search services and collaboration tools, along with a defined set of internal sites and services and extranet capabilities.

- **Data Center Services**: NASA has revised its data center strategy. OMB issued the Federal Data Center Consolidation Initiative in February, 2010, requiring agencies to inventory data centers and commit to reducing data centers through consolidation,

virtualization and adopting cloud computing solutions. OMB's data consolidation mandate and "Cloud First" policy was reinforced in December 2010 in their "25 Point Implementation Plan to Reform Federal Information Technology Management". Therefore, NASA has moved from a single consolidated data center (NEDC) approach to regional data centers (one or more key data centers at each NASA center). All NASA Centers will continue their plans to consolidate data centers and eliminate server rooms within the scope of their existing Center support contracts.

9. The Propulsion Research Laboratory (PRL) at Marshall Space Flight Center seems to be a unique resource within the agency, is this true? If so, please elaborate. What are NASA's plans for utilizing this state-of-the-art facility so that the taxpayer gets full benefit from the investment? Are these same capabilities being planned for construction anywhere else?

Answer: The Propulsion Research and Development Laboratory (PRDL) at Marshall Space Flight Center (MSFC) is a unique resource with a flexible design layout to explore a wide range of advanced in-space propulsion concepts. Opened in 2004, the 66,000 square foot facility has a variety of laboratory room sizes from small labs (approximately 24) to large high-bays (6) with overhead lifting cranes to deploy and stage large research equipment and protective shielding within experimental areas to support varied activities and customers. The facility is highly flexible with multifunction and reconfigurable environments, allowing the projects to share expensive research equipment, diagnostics, and professional technicians. This designed in flexibility can help meet the changing landscape of NASA's future propulsion portfolio as emerging technologies are identified, matured and transferred to industry.

Advanced in-space propulsion activities are defined in the technology roadmaps from the NASA Office of Chief Technologist and serve to further NASA's mission of space exploration. The MSFC PRDL was designed to accommodate the development of multiple in-space propulsion technologies, including the following critical areas:

- High power electromagnetic plasma thrusters using super heated electrically charged gases.
- Nuclear propulsion concepts using a variety of nuclear energy sources (e.g., fission, fusion, antimatter annihilation).
- Nuclear power for space application (electric propulsion and surface power) using simulated nuclear space reactors hardware configurations to evaluate thermal hydraulic response (reactor's temperature/power distribution) and interaction with power conversion and thermal management.
- Solar energy high-bay designed to capture up to 75 kilowatts of sunlight.
- Special test cells and labs for advanced chemical propulsion propellant synthesis, characterization and combustion

Over the past years NASA has partnered with the Department of Energy, industry, and universities on experimental activities in nuclear, electric and solar propulsion. These organizations continue to seek NASA partnerships and have shown continued interest in experiments at the PRDL to develop advanced in-space propulsion technologies. Ongoing partnerships in the areas of nuclear thermal propulsion and electric propulsion are utilizing the PRDL in support of NASA's Advanced In-Space Propulsion Project. One example involves the Department of Energy (e.g., Idaho National Engineering Laboratory) making use of the PRDL fuel fabrication and testing capabilities for nuclear propulsion and in-space power. Partnerships with industry (e.g., BUSEK, The Elwing Company) and universities (e.g., Princeton University, University of Alabama Huntsville) are utilizing PRDL for facility capability and expertise with an electric propulsion concept known as the Pulse Inductive Thruster, which can operate with a

broad range of propellants in support of future in-space missions. A number of new proposals have been submitted this year, and, if awarded, would expand the use of PRDL to many other outside partners.

In addition, areas within the PRDL have been configured to support design, integration and test of systems for future launch systems. The facility supports planning of block configurations and upgrades for the SLS vehicle. For rockets during their boost phase to orbit and other vehicles that operate outside the atmosphere (where aerodynamic control surfaces are ineffective) thrust vectoring is the primary means of attitude control.

The facility provides the unique ability to identify and resolve design and implementation issues through early integration of avionics and software with thrust vector control (TVC) components such as actuators and valves. By integrating hardware-in-the-loop, a real-time environment is created to "fly" simulated missions with avionics and TVC system elements. The capability exists within the PRDL and is configurable for a wide range of test scenarios, vehicle architectures, operating environments, and physical hardware size/geometry and system technologies (including R&D support for advanced in-space systems).

NASA is working to fully utilize this national asset. There are no current plans to construct any other NASA facility with the same range of research capabilities.

10. When will NASA provide the U.S. with human access to space (LEO) on a U.S. vehicle? Ares I would have been ready by 2015 or 2016 at the latest.

Answer: Please see NASA's response to Question 4 with regard to NASA's efforts to develop the SLS and MPCV.

However, it is also important to note that NASA's FY 2012 budget request includes $850 million to provide incentives for commercial providers to develop and operate safe, reliable, and affordable commercial systems to transport crew and cargo to and from the ISS and LEO, thereby freeing NASA to focus on SLS and MPCV development efforts. The Agency anticipates the availability of these commercial systems by the middle of the decade, contingent upon the availability of appropriated funding.

11. I believe space exploration is what the American people expect from NASA. Please explain the rationale for cutting robotic research funding, and how many years of delay this would add to, for example, a mission to explore the oceans of Europa.

Answer: The decision to reduce funding for planetary science in the FY 2012 request was driven purely by the necessity to reduce overall spending in light of the very difficult fiscal circumstances facing the Federal Government today. An initial comparison of the FY 2012 budget request with the new Planetary Science Decadal Survey released earlier this month indicates that NASA could still implement a robust set of medium (Discovery) and larger (New Frontiers) missions per the Survey's recommendations. This leaves about $1B total over the 5-year budget horizon of the FY 2012 budget to invest in a flagship class mission.

Implementing a flagship-scale mission beginning in this period will thus require doing so in partnership with the European Space Agency. The Survey identified a prioritized set of flagship missions accompanied by a detailed set of decision rules. A mission to Europa ranks second on

that list, but the Survey notes that "it should fly in the decade 2013-2022 only if changes to both the mission and the NASA planetary budget make it affordable without eliminating any other recommended missions." NASA will spend the next few months exploring how to implement the Decadal Survey's complex recommendations concerning flagship-class missions (including a potential mission to explore Europa), and our proposed path forward should be available in time for the release of the President's FY 2013 budget request in February 2012.

12. If I read the budget correctly, compared to the Authorization bill, NASA's budget has an $800 million DECREASE of the Space Launch System, $400 million decrease of the Multi-Purpose Crew Vehicle, and $350 million INCREASE for Commercial Crew. Why is there such a difference in funding levels between the FY 2012 budget request and the recent 2010 NASA Authorization Bill which the Administration advocated, and which the President agreed to? Which Center Directors were consulted about these changes? Please do not answer with the phrase "pre-decisional."

Answer: NASA's FY 2012 budget request steps up to the challenge of tough budget times. The top-line reduction and USA pension payment reduced NASA's program funding by -$1.3B from the authorized level of $19.5B. NASA has made every effort to address all elements of the NASA Authorization Act while also prioritizing the safety of the astronauts on the ISS. This is best accomplished by providing safe and effective transportation services to the ISS and the FY 2012 budget request seeks to ensure that Commercial Crew/Cargo programs are successful to do this by as early as 2016.

Requirements for a NASA-developed expendable launch vehicle, the Space Launch System, capable of transporting humans to low-Earth orbit and beyond are being formulated. The FY 2012 budget request reflects NASA's best estimate for providing sufficient resources to develop these core capabilities and hold the top level of Human Exploration Capabilities at a slightly higher level than FY 2011 in the Authorization Act. The cost and development schedule for this vehicle are unknown at this time and NASA plans to provide an update to the report we provided to Congress earlier this year that will further describe the vehicle capabilities.

13. Last December, the Federal Communications Commission granted conditional approval for a company to build a new ground-based system of up to 40,000 high-power transmission towers across the nation for next-generation wireless internet access. I understand that NASA has raised concerns about the potential for interference to the Global Positioning System (GPS) L1 band used for military, federal and all commercial applications if the FCC decision stands. Please tell me how this issue affects NASA, whether the FCC communicated with NASA as part of its approval process, and what NASA would view as the next acceptable step in this process.

Answer: The waiver that the Federal Communications Commission (FCC) granted on January 26, 2011 to LightSquared conditionally waived the FCC's prohibition against stand-alone terrestrial wireless in the Mobile-Satellite Service (MSS) band immediately below the Global Positioning System (GPS) L1 band. NASA, and other Federal agencies, voiced concerns to the National Telecommunications and Information Administration (NTIA) about potential interference to GPS reception from the proposed LightSquared terrestrial wireless network and advocated that NTIA oppose FCC granting the waiver until such time as proper technical analysis could be conducted and mitigation measures developed to protect GPS. While NTIA noted NASA's and other Federal agencies' concerns about potential interference to GPS, NTIA did not oppose granting of the waiver by the FCC.

The potential disruption of GPS reception due to interference from a terrestrial wireless network could affect a number of terrestrial and space-based NASA science missions. Affected terrestrial missions could include Earth science applications such as geodesy (e.g., earthquake monitoring and the measurement of changes on the Earth's surface) and environmental monitoring relying on GPS measurements at the ground sites of the Global Differential GPS System (GDGPS) and International GNSS Service (IGS). Space-based science missions potentially affected would include receivers used for GPS occultation measurements for atmospheric and ionospheric monitoring and characterization.

The FCC did coordinate the January 26, 2011 Order and Authorization granting LightSquared a conditional waiver of its rules against stand-alone terrestrial networks. However, on March 26, 2010, the FCC issued a Memorandum Opinion and Order and Declaratory Ruling (MO&O) regarding the acquisition of SkyTerra (now LightSquared) by Harbinger Capital Partners that contained several conditions. Of primary concern to GPS stakeholders was that FCC required Harbinger to build out a terrestrial wireless network covering approximately 90 percent of the U.S. population by December 31, 2015, which would increase the density of the terrestrial use of the band and the interference potential to GPS. The final draft of this MO&O, which contained the conditions requiring deployment of a terrestrial broadband network, was not coordinated with NASA as part of the NTIA-led Federal interagency coordination process.

The conditional grant of the waiver to LightSquared by FCC required the establishment of a Technical Working Group (TWG) to examine the GPS interference issues. LightSquared is required to submit a final report stemming from the work of the TWG to the FCC by June 15, 2011. Consistent with the Federal Advisory Committee Act, NASA is participating in the work of this industry group to ensure its GPS equities are appropriately considered and represented. In addition, NASA is conducting independent test and analysis of the susceptibility of its GPS receivers to interference from the LightSquared network as well as participating in Federal agency test and analysis efforts being jointly led by the Air Force and Federal Aviation Administration (FAA). All of the current test and analysis efforts are expected to be completed in the early June time frame and before the final report from LightSquared is due to the FCC.

14. What is your transformation plan for the Space Shuttle workforce at MSFC?

Answer: NASA has been preparing for Space Shuttle retirement since 2004, including conducting ongoing activities to facilitate transition of both key NASA civil service employees and contractor employees to other programs. The passage of the NASA Authorization Act of 2010 (P.L. 111-267) has provided valuable direction to the Agency and improved its ability to make workforce planning decisions. With this guidance, NASA has continued its efforts to map out the transition of its human spaceflight workforce from the Space Shuttle and Constellation programs. This effort will be reflected in the Agency's next update to its *Workforce Transition Strategy* report, to be provided to Congress in the late spring/early summer of 2011. The first three editions of this report may be viewed at the website below, under "Workforce Highlights – View Archives." These reports provide details on NASA's initiatives to assist with workforce transition.

http://www.nasa.gov/transition/

It should also be noted that Marshall Space Flight Center will lead NASA's efforts on a heavy-lift rocket that will carry humans beyond low-Earth orbit. The Center will house the program office for the Space Launch System and continue to support International Space Station operations.

Question for the Record
Rep. John Culberson
March 3, 2011 CJS Hearing with NASA Administrator Charles Bolden, Jr.

1. Please comment on how NASA's projected funding for the remainder of FY 2011, FY 2012, and FY 2013 will be used for transitioning the Orion, Ares, and Space Suit contracts to NASA's schedule for the first manned flight of the Multi-Purpose Crew Vehicle. Please provide a breakdown for each component: the Multi-Purpose Crew Vehicle and the Space Launch System.

Answer: The FY 2011 Consolidated Appropriations Act (P.L. 112-10) provided $1.8B for the Space Launch System (SLS) and $1.2B for the Multi-Purpose Crew Vehicle (MPCV). Similarly, the FY 2012 President's budget request includes $1.8B (with labor) for the SLS and $1.0B (with labor) for the MPCV. Budget numbers in the request beyond FY 2012 were considered notional and will almost certainly be adjusted in the FY 2013 budget process. Therefore, NASA cannot provide any greater detail on those at this time.

Given these challenging fiscal times, it is clear that NASA must reduce the development and operating costs (both fixed and recurring) for human spaceflight missions to sustain a long-term U.S. human spaceflight program. We must plan and implement an exploration enterprise with costs that are credible and affordable for the long-term under constrained budget environments. As such, our development efforts also will be dependent on a realistic budget profile and sufficiently stable funding over the long term, coupled with a successful effort on the part of NASA and our eventual industry team to reduce costs and to establish stable, tightly-managed requirements for the SLS and MPCV programs.

NASA is exploring ways to transition the design and development efforts of the Constellation Program so that NASA will be able to capitalize on current investments and workforce, as appropriate. In the meantime, NASA is taking steps to concentrate current spending on those aspects of the Constellation Program that will have the greatest applicability to the new SLS and MPCV programs. Currently, NASA has procurement teams who are mapping SLS and MPCV requirements (those outlined in the NASA Authorization Act of 2010 and those we are currently developing) against the Ares and Orion contracts (and other Agency contracts) to determine if the new requirements fit the scope of the existing contracts. For the SLS, we are reviewing each element of Ares (First Stage, Upper Stage, Upper Stage J-2X engine and avionics) to determine whether the new SLS requirements are within scope of the current contract. For the MPCV, our review of the Orion contract indicates that the MPCV is within scope of the Orion contract.

NASA has been engaged in detailed deliberations to define the next transportation system that will carry humans into deep space in accordance with the NASA Authorization act of 2010, the FY 2011 Full-Year Continuing Appropriations Act, and Administration policy. In January 2011, NASA submitted an interim report to Congress regarding the SLS and MPCV, and identified reference vehicle designs for both vehicles. On May 24, the Administrator decided to accept the Orion-based reference vehicle design as the MPCV. In the coming weeks, NASA will be making further decisions with regard to transportation architecture, and is currently refining the SLS concept and defining strategy alternatives based on detailed Government analysis and

completed input from industry through Broad Agency Announcement study contracts. Further details about NASA's analysis and decisions regarding SLS and MPCV and their path forward will be provided to Congress in a follow-on report in the late spring/summer timeframe. Following that report, NASA will finalize development plans and acquisition decisions through the normal Agency processes in the mid-to late-summer. The development of the SLS and MPCV and supporting capabilities must be planned by developing an integrated budget and schedule to understand how these programs collectively fit within budget profiles and to determine when preliminary flight dates are possible. In this timeframe, costs and schedule will be preliminary, based on pre-formulation information for these new programs.

Over the last year, due to provisions of the FY 2010 Consolidated Appropriations Act (P.L, 111-117) – restrictions that have since been rescinded in the FY 2011 Consolidated Appropriations Act , NASA has been prohibited from terminating any Constellation contracts. As such, NASA has continued to implement the Constellation Program and associated projects, while at the same time prioritizing Constellation funding on work that was most related to the SLS and MPCV.

For example:

- **Ares** has worked closely with SLS planning team to focus our development efforts on technologies and processes that could be utilized in the eventual SLS configuration. This includes vehicle avionics, J-2X Engine testing, First Stage Engine testing (Development Motor-3), and installation of Upper Stage tooling applicable to large diameter tanks. At the same time, we deferred activities that were highly vehicle configuration-dependent, including a ground vibration test article and design of Upper Stage component hardware such as the reaction control system.

- **Orion** has focused our development efforts on crew safety, targeting an orbital test flight mid-decade to validate 10 of the top 13 analyzed crew safety risks in the real flight environment -- risks primarily in the regimes of entry, descent, and landing. At the same time, we deferred efforts in areas posing relatively small risk to crew safety, such as life support, communications, crew support systems and the launch abort system (LAS). NASA has deferred further work on the LAS for the near-term since it is ahead of other Orion systems in its design and testing.

- **EVA** has coordinated with Orion to focus our development efforts on suit architecture trades in light of the new beyond-LEO mission timetable, and including modified Advanced Crew Escape System (Shuttle launch and entry suit) in launch and entry suit trade study. At the same time, we have deferred efforts on beyond-LEO suit design and commonality with the launch and entry suit.

- **Ground Operations** has coordinated with the SLS team and focused our Ground Operations work on items that would mostly likely be needed by heavy-lift launches – works such as launch pad construction, launch control center construction and crawler overhauls (the crawler is the vehicle that transports a launch vehicle stack from an integration building to the launch site.) At the same time, we deferred Vehicle Assembly

Building modifications at KSC until we know the dimensions of our new heavy-lift vehicle.

- **Mission Operations** has coordinated with Orion to focus our efforts on activities required for general human spaceflight mission support, with efforts concentrated on Mission Control Center and Training Systems. At the same time, we have deferred efforts on highly configuration-dependent activities, such as a high-fidelity Orion mockup or docking adapter trainer.

2. Radioisotope power systems (RPS) are the only viable source of electrical power for spacecraft operating where low levels of Sunlight make solar power unfeasible.

   The Planetary Science Decadal Survey released on March 7, 2011 recommends the Jupiter Europa Orbiter (JEO) as the second highest priority large mission. JEO requires five Radioisotope Thermoelectric Generators (RTGs) powered by plutonium-238 (^{238}Pu) which exceeds our current supply.

   Alternatively, JEO could use Advanced Stirling Radioisotope Generators (ASRGs). However, the Decadal Survey states, "Unless additional plutonium-238 is acquired, there will be only three ASRGs available for the subsequent decade, so there will not be a Europa mission, a Titan Saturn System Mission, a mission to Neptune, or long-lived mission to the surface of Venus in future decades. There are no technical alternatives to plutonium-238, and the longer the restart of production is delayed, the more it will cost."

   If production of plutonium-238 were restarted immediately, how long would it take to produce enough plutonium to power a spacecraft sent on a mission to the Europa?

   In order to launch a spacecraft on a mission to the Jovian system by the end of 2022, by approximately what date would production of plutoniuim-238 need to begin?

   In this regard, what can Congress do to ensure these missions are flown?

Answer: The Administration requested funding for the restart of plutonium-238 (Pu-238) production in FY 2011, and has again requested funding in the FY 2012 budget request. The Department of Energy (DOE) has examined current national needs for Pu-238 and received significant input from NASA regarding our specific mission needs. Both agencies agree that an adequate national supply of Pu-238 can be maintained if an average production rate of 1.5 kilograms per year is in place by 2015, and DOE is successful in finalizing the purchase of 10 kg of Russian Pu-238.

Using existing facilities with some modifications, DOE expects to produce up to two kilograms of Pu-238 per year and to accommodate an average annual production rate of 1.5 kilograms on a sustained basis. If activities necessary for the restart of domestic production were started immediately (which would have required that both the $15M requested in the FY 2011 NASA budget request and the $15M requested in the FY 2011 Department of Energy budget request

were appropriated during the third quarter of FY 2011), it would have taken approximately 6-8 years to have enough plutonium-238 on hand to support NASA's missions currently under study.

The Planetary Decadal also requested that NASA study the option of using ASRGs for the Europa Mission in order to conserve as much Pu-238 as possible for use in other programs such as Discovery and New Frontiers. NASA will undertake such a study in FY 2012. The amount of power available to a spacecraft and its science instruments is a fundamental design consideration and must be resolved early in the mission planning process in order to avoid costly changes and to ensure the scientific return of these proposed missions. Significant progress toward initiating Pu-238 production will be required to retire the risk of plutonium availability, and allow mission planners to commit to an RPS-based power source requiring newly produced Pu-238.

Completing the design and initiating facility modifications for the irradiated target processing line, notionally in FY 2013, would likely provide sufficient confidence to NASA that production will occur and additional Pu-238 availability will result. The earliest missions supported by this notional timeline would launch in the 2020 timeframe or beyond, assuming a FY 2012 start of capability development for domestic production and uninterrupted production at an average rate of 1.5 kg per year in 2015.

In order to launch a spacecraft on a mission to the Jovian system by the end of 2022, the conceptual design activities related to restarting domestic production of Pu-238 would have to begin within the next few months. However, it is important to note that based on budget realities and the need to fund other, higher priority activities, NASA is not likely to develop and launch a mission to Europa by 2022.

THURSDAY, MARCH 10, 2011.

NATIONAL SCIENCE FOUNDATION

WITNESS

DR. SUBRA SURESH, DIRECTOR, NATIONAL SCIENCE FOUNDATION

OPENING REMARKS OF VICE CHAIRMAN BONNER AND RANKING MEMBER FATTAH

Mr. BONNER. Good morning. Chairman Wolf is testifying at another hearing and we expect him here in just a few minutes. In the meantime, he asked us to go ahead and get started.

I had the pleasure of introducing myself to the witness earlier. My name is Jo Bonner. I am from Mobile, Alabama, and I am pleased to serve as vice chairman of the Subcommittee.

I would like to welcome everyone to the hearing today on the fiscal year 2012 budget request of the National Science Foundation. Our witness is Dr. Subra Suresh, the Director of NSF.

Sir, thank you so much for being here with us today.

Dr. Suresh, you are sitting before a subcommittee which I hope you know is very supportive of your agency and its mission to advance the country's scientific research and educational enterprises.

Our national struggles in these areas have been well documented, most notably in the 2007 report entitled "Rising Above the Gathering Storm."

Unfortunately, in spite of the increased visibility of the problem, it appears we have made very little lasting progress in reversing some of the trends that were outlined in that report. In fact, an update of "Gathering Storm" issued just last year concluded that our situation has only gotten worse.

We have an enormous challenge ahead of us. We are facing unrelenting competition from other countries that are highly motivated to overtake our position as the global leader in this global economy. And we have to face that competition while we are still dealing with a very slowly recovering economy, one we hope continues to recover, but I think by all accounts is the worst recession since the Great Depression.

It is clear to Members on both sides of the aisle that NSF will play a key role in meeting that challenge and helping to push the United States back to the forefront of technical innovation.

Your ability to play that role obviously depends on the size of the budget at your disposal, and that is what we are here to discuss today.

The NSF budget request for the fiscal year 2012 is $7.8 billion. It represents, as you know, a 13 percent increase over your last enacted appropriation. That is a significant new investment, particularly given the constraints on the larger federal budget.

Just as a quick aside, I came to Capitol Hill in 1985 as a young staffer for my predecessor in Congress. At that time, the deficit was $1.8 trillion. Now it is over $14 trillion.

And as we all know, just the other day, it was reported that the deficit for February was $223 billion. So our Nation truly is struggling with serious financial challenges in front of us.

But as I said earlier, the NSF is so important to our mission as a Nation.

Within your total request, you have a number of significant new program proposals as well as some suggestions for where NSF can or should scale back its involvement.

I know I will have some questions for you, as will the Ranking Member and others who will be coming. There are several committee hearings taking place at this time, so please do not take offense at Members coming and going throughout the morning.

In a moment, Dr. Suresh, we will have you give a summary of your written testimony and then we will proceed with the questions.

But before we do that, I would like to turn to my friend, the gentleman from Pennsylvania and our Ranking Member, Mr. Fattah, for any opening remarks he would like to make.

Mr. FATTAH. Thank you very much.

And I want to thank the chairman. And it is a pleasure to see him in the chair even though this is not his formal role on this committee, but our chairman will be here momentarily. I was watching him testify before a hearing in the Homeland Security Committee.

But let me welcome you. It is good to see you again.

I agree with the chairman that the national debt is a very important priority. In fact, next week, I am going to be offering legislation to address the national debt in the most forceful way that would have been suggested to this point.

So I do not minimize it, but I do not see the glass as half empty. I see it as mostly full. That is to say, we are the wealthiest country in the world. We have well over $900 trillion in transactions, money moving around in our economy every single year.

The notion that we cannot afford to pay our bills I think is a faulty one. Whether we cut one and a half percent of the budget this year or something a little less than that, which is the debate between the $41 billion and the $61 billion between the two parties, is not going to address our debt. It is not going to address our deficit. It is really a distraction. We spend a lot of time being distracted here in Washington.

I want to focus on the question of the country's future. I think we have this kind of sense that we are a declining power, we are broke, we cannot afford to do the things that we need to do to prosper as a Nation, that is to educate our children or to invest in science and innovation. I do not believe that about our country.

Now, I spent the weekend with some of my Republican colleagues. We went out to visit a couple of our national labs. I was at Sandia. I was at one of the other nuclear weapons laboratories, at Los Alamos. I saw how exceptional our Nation truly is. I mean, I saw in the work of these scientists what is really being done.

And when you look through the great work of the National Science Foundation, whether it is the over 1,200 scientists you have at the South Pole or all of the other investments and building blocks, as you call them, in our country's future, I think that we should be inspired as a Nation.

Now, I think that is a paltry sum, that is this $7.8 billion, even though it is a 12 percent increase, 13 percent increase.

When you look at a country like Singapore with less than 5 million people, 4.8 million people investing $5 billion in their National Research Foundation, making a commitment as a nation that takes three percent of their gross domestic product and have it in scientific research, it should suggest to a Nation like our own that we risk being pushed aside on this kind of innovation highway if we are not careful.

First of all, we cannot be a superpower on the cheap. We cannot fight two wars, not pay for it, add it to the debt, give away tax breaks to people and not account for it in any way, and grow the domestic side of the budget all at the same time, which is what we have done over the last ten years and then be intellectually surprised that we have a debt or a deficit. I mean, it is just that the two do not add up.

But at the same time, we cannot afford not to make the investments in science for our national security, for our economy. And I think that the Congress, whoever is in the majority, and the other team is in the majority at the moment, we owe it to our country to make these investments because as we compete with much larger countries like China or India, the only way a country of 300 million people is going to be able to position itself is through the same decision that Singapore made.

It is a very rational decision that if you are going to have a smaller population, then, you have to innovate more. You have to educate more. You have to do these things.

And so I am looking forward to your testimony and I hope that as we go through this that we will not try to apply an unscientific approach to protecting our country's security economically and in other ways, that in some notion that we can somehow dumb down our population, do less research, less investment, and somehow still stay ahead.

Thank you very much.

Mr. BONNER. Thank you, Mr. Fattah.

Dr. Suresh, your written statement will be made a part of the record and now you may proceed with the summary of your remarks.

DIRECTOR SURESH'S INTRODUCTION TO THE FY 2012 REQUEST

Mr. SURESH. Thank you.

Chairman Bonner, Ranking Member Fattah, soon to come Members of the committee, it is my privilege to be here with you today to discuss the National Science Foundation's fiscal year 2012 budget request.

My name is Subra Suresh and I am director of the National Science Foundation.

I came to the United States as a young engineering student because it was the world's beacon of excellence in science and edu-

cation. The mission of NSF is to sustain that excellence as we continue to lead the way for the important discoveries and cutting-edge technologies that will help keep our Nation globally competitive, prosperous, and secure.

The fiscal year 2012 budget request for NSF, as the chairman said in his statement, is $7.8 billion, an increase of 13 percent or $895 million over the fiscal year 2010 enacted level.

NSF's request is consistent with the President's Plan for Science and Innovation and with the America COMPETES Reauthorization Act of 2010.

America's economic prosperity and global competitiveness depend on innovation that comes from new knowledge, new technologies, and a highly-skilled and inclusive workforce. NSF has an unparalleled track record in supporting the best ideas and the most talented people for over 60 years.

The fiscal year 2012 budget builds on these past accomplishments and provides a direction for future success. NSF will strengthen support for basic research in education, the building blocks of future innovation while strengthening our disciplinary excellence.

A new NSF-wide investment of $117 million will accelerate the progress of science and engineering through the deployment of comprehensive cyberinfrastructure. Cyberinfrastructure Framework for 21st Century Science and Engineering will explore ways to handle the vast quantities of data generated by today's cutting-edge observational and computational tools, broaden access to cyberinfrastructure, and support community research networks.

Research at the Interface of the Biological, Mathematical, and Physical Sciences, a new $76 million investment, will explore nature's ability to network, communicate, and adapt and apply this understanding to engineer new technologies.

This program aims to discover new bio-inspired materials and sensors and support the advanced manufacturing of bio-inspired devices.

Today's most challenging research problems often bring together insights from across computer science, mathematics, and the physical life and social sciences. INSPIRE, new to the NSF portfolio, is a $12 million investment to encourage investigators to undertake the interdisciplinary research that is the hallmark of much of contemporary science and engineering.

Because NSF supports research across all disciplines, we are positioned to catalyze the new fields and new research paradigms that emerge from this cross-fertilization.

Many NSF activities provide incentives for investigators to undertake use-inspired research that translates basic discoveries into applications for the benefit of society and the economy.

A $15 million investment in Enhancing Access to the Radio Spectrum will pursue innovative ways to use the radio spectrum more efficiently, enabling more applications and services used by individuals and businesses to occupy the limited amount of available spectrum.

Over the next five years, NSF will receive $1 billion from the Wireless Innovation Fund or WIN established with receipts from spectrum auctions.

NSF's support of advanced economics research led to the FCC's current system of spectrum auctions that have netted over $45 billion for the Federal Government since 1994.

The Wireless Innovation Fund is expected to provide $150 million to NSF in fiscal year 2012 for research on cyber-physical systems such as smart sensors for buildings, roads, and bridges. Many fields are on the threshold of discoveries that can establish U.S. leadership in next generation technologies.

In the 1960s and 1970s, NSF's support of mathematical and process innovations led directly to rapid prototyping and revolutionized how products are designed and manufactured. The budget includes $190 million for a new advanced manufacturing initiative to pursue innovations in sensor- and model-based smart manufacturing and nanomanufacturing.

Another investment of $30 million in the new interagency national robotics initiative will focus on robots that will work cooperatively with people in areas such as manufacturing, space and undersea exploration, healthcare, surveillance and security, and education and training.

NSF will continue to play a lead role in the multi-agency National Nanotechnology Initiative with an investment of $456 million, $117 million of which will explore signature initiatives in nanoelectronics, solar energy collection and conversion, and sustainable nanomanufacturing.

NSF's support for nanotechnology research is already producing returns. Over the past decade, NSF nanotechnology centers and networks created 175 startups and developed collaborations with over 1,200 companies.

U.S. leadership in science and engineering requires the most knowledgeable and skilled science, technology, engineering, and mathematics or STEM workers in the world. Three new programs in STEM education, each funded at $20 million, will improve teacher preparation, strengthen undergraduate STEM education, and broaden participation of under-represented groups in the science and engineering workforce.

People and their ideas form the core of a robust science and engineering enterprise, but leading-edge tools are also needed to advance the frontiers and train students for the workplace.

The budget sustains investments in major recruitment and facilities projects that are already underway.

To conclude, One NSF characterizes my vision for NSF as a model agency. NSF will work seamlessly across organizational and disciplinary boundaries to create new knowledge, stimulate discovery, address complex societal problems, and promote national prosperity.

Robust NSF investments in fundamental science and engineering have paid enormous dividends, improving the lives and livelihoods of generations of Americans. The Fiscal Year 2012 NSF Budget Request will carry this success into the future.

Mr. Chairman and Members of the subcommittee, this concludes my testimony. I thank you for your leadership. I will be pleased to answer any questions you may have.

[The information follows:]

Dr. Subra Suresh
Director, National Science Foundation

Before the
Committee on Appropriations
Subcommittee on Commerce, Justice, Science and Related Agencies
United States House of Representatives

On
The President's Fiscal Year 2012 Budget Request
for the National Science Foundation
March 10, 2011

Chairman Wolf, Ranking Member Fattah, and Members of the Subcommittee, it is my privilege to be here with you today to discuss the National Science Foundation's fiscal year (FY) 2012 Budget Request. My name is Subra Suresh and I am Director of the National Science Foundation (NSF).

I hope to make a clear and compelling case for the critieal value of NSF support for science and engineering research and education at a time when America faces many pressing needs and tight budget constraints. I came to the United States as a young engineering student because it was the world's beacon of excellence in science and engineering research and education. I stayed for the same reason. The mission of NSF is to sustain that excellence as we continue to lead the way for the important discoveries and cutting-edge technologies that will help keep our Nation globally competitive, prosperous, and secure.

The President's request for NSF for FY 2012 is $7.8 billion, an increase of 13 percent, or $894 million, over the FY 2010 Enacted level. *The President's Plan for Science and Innovation* calls for doubling the federal investment in key basic research agencies. NSF's request is consistent with this plan, with the Administration's Innovation Strategy, and with the America COMPETES Reauthorization Act of 2010. The increase will support 2,000 more research awards across the nation.

In FY 2012, NSF will strengthen support for basic research and education in all fields of science and engineering, and promote collaborations that reflect the increasingly interdisciplinary nature of modern science and engineering, while strengthening our disciplinary excellence. We will capitalize on many promising areas of investigation where new discoveries can help establish U.S. leadership in next generation technologies, and we will invest in transformational work, new fields, and novel theoretical paradigms to fuel the innovations of the future. Innovative programs to bolster world-class science, technology, engineering, and mathematics education (STEM), from coast to coast, and from north to south, are central to the success of all these activities.

NSF: Where Discoveries Begin

Sustained federal support for research and education has fueled innovation and provided benefits to the American public for decades, and NSF has played a significant role in this success. For over 60 years, NSF has been a catalyst for the development of new ideas in science and engineering and supported the people who generate them.

In 1952, Caltech professor Max Delbruck used one of NSF's first grants to invent molecular biology techniques that enabled one of his students, James Watson, to determine the molecular structure of DNA. Since then, an entire biotechnology industry has bloomed and prospered, with profits reaching $3.7 billion last year.

In the 1960s and '70s, NSF provided seminal funding for fundamental mathematical and process innovations for manufacturing that industry considered too risky to fund. These led directly to rapid prototyping—and revolutionized how products are designed and manufactured.

In the 1980s, NSF supported the very first computer science departments in U.S. universities, bringing computer science into the mainstream of research, and providing a training ground for the first and subsequent generations of computer scientists and entrepreneurs. Today, NSF provides 82 percent of total federal support for research in computer science conducted in the nation's universities and colleges. Jobs related to computer and information technologies are among the most rapidly growing in the nation according to Bureau of Labor Statistics projections.

In the 1990s, NSF supported pioneering research in the emerging field of nanotechnology. Between 2001 and 2010, NSF-supported centers and networks created 175 start-ups and developed collaborations with over 1,200 companies.

Investments in basic research often yield unexpected benefits as well. NSF's support of game theory, abstract auction theory, and experimental economics provided the Federal Communications Commission (FCC) with its current system for apportioning the airwaves. Since 1994, FCC "spectrum auctions" have netted over $45 billion in revenue for the federal government and more than $200 billion in worldwide revenue.

The NSF FY 2012 Budget Request builds on these past accomplishments and provides a direction for future success. To fuel the innovations of the future, NSF continues to support fundamental research and education in all fields of science and engineering to maintain a global edge in the competition for new ideas and the most talented people. The core science and engineering disciplines form the "building blocks" for future innovations, and provide the new ideas and approaches needed to advance the interdisciplinary research that is a hallmark of contemporary science and engineering. In all these activities, we keep a steady focus on the frontier, where discoveries begin.

The NSF FY 2012 Budget Request

The Administration's *A Strategy for American Innovation* makes clear the larger rationale for investments in science and engineering research and education. This is to put knowledge to work—to create the industries and jobs of the future, and to improve the quality of life and enhance the security and prosperity of every citizen. NSF investments support each of the three pillars of this strategy: *Invest in the Building Blocks of American Innovation, Promote Market-Based Innovation,* and *Catalyze Breakthroughs for National Priorities.*

Invest in the Building Blocks of American Innovation.

A robust U.S. science and engineering research enterprise is necessary to maintain a global edge in the competition for new ideas. In FY 2012, NSF will continue to support the most promising research programs and launch several new initiatives.

Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) will support new activities to encourage investigators to undertake the interdisciplinary research that is a hallmark of much contemporary science and engineering. This effort will be in concert with disciplinary excellence. INSPIRE will catalyze interdisciplinary research by seamlessly integrating a suite of new activities with existing efforts and other NSF investments. The goal is to foster and support the transformative research that interdisciplinary research so often produces. INSPIRE is a new $12 million initiative in FY 2012, and will involve participation from all Directorates.

Science and Engineering Beyond Moore's Law (SEMBL) explores next generation computing, including quantum computing, that addresses the limits of current technology. Those limits may be reached in as few as 10 to 20 years. In FY 2012, NSF will invest $96 million to continue this multidisciplinary program.

Research at the Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS) is a $76 million investment to investigate biological systems that provide architectural and operational blue prints which can guide engineering of adaptive technologies. BioMaPS will integrate research in the biological, engineering, mathematical, and physical sciences to better understand and replicate nature's ability to network, communicate, and adapt. The research will accelerate the generation of bio-based materials and sensors, and the advanced manufacturing of bio-inspired devices and platforms.

Global leadership also requires the most knowledgeable and skilled STEM workers in the world. NSF's approach is to develop the nation's talent pool by integrating research and education. This longstanding NSF practice facilitates the direct transfer of new knowledge to the private sector. It happens every time graduate students with experience working at the frontiers of discovery enter the work force. A strong suit in U.S. competitiveness, this is one of NSF's greatest contributions to the nation's innovation system. NSF will support three new initiatives to strengthen STEM education throughout the nation, and continue support for highly effective efforts to develop the nation's talent and workforce.

Teacher Learning for the Future (TLF), funded at $20 million, is a new teacher-training research program that will fund innovative efforts that design, develop, implement and test new teacher-training programs in cooperation with the Department of Education.

Widening Implementation and Demonstration of Evidence-based Reforms (WIDER), a new $20 million program to support research on how to achieve widespread sustainable implementation of improved undergraduate instructional practices and student outcomes at major universities.

Transforming Broadening Participation through STEM (TBPS), a third new program, will expand support for activities to broaden participation of underrepresented groups through partnerships that match research centers with other institutions committed to broadening participation. The FY 2012 investment in TBPS is $20 million.

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. In FY 2012, NSF will invest $222 million to support approximately 606 CAREER awards, an increase of 60 awards.

The Graduate Research Fellowship program (GRF), funded at $198 million in FY 2012, supports the development of graduate students in order to cultivate the next generation of STEM workers. In FY 2012, NSF will award 2,000 new fellowships, sustaining the doubling of new fellowship awards achieved in FY 2010. In addition, the cost of education allowance will be increased from $10,500 to $12,000, the first increase in this level since 1998. The Budget Request also includes initial funding for a stipend increase to $32,000 that will be fully implemented in FY 2013.

Community college funding continues to be a priority for NSF in FY 2012. NSF engages community colleges through several programs, including Advanced Technological Education (ATE), Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (TUES), the Louis Stokes Alliances for Minority Participation (LSAMP), and the Tribal Colleges and Universities Program (TCUP). The total investment in community college programs is $100 million.

Promote Competitive Markets that Spur Productive Entrepreneurship.

Advances in technology, economic growth, and a prosperous society depend on the translation of fundamental discoveries into new processes, practices, and commercial products that are widely used. Many NSF activities provide incentives for scientists, engineers, and educators to undertake use-inspired research that transforms basic discoveries into applications for the benefit of society and the economy.

The Advanced Manufacturing initiative will pursue advances in sensor and model-based smart manufacturing; cyber-physical systems such as advanced robotics; smart buildings and bridges; and nano-manufacturing. This initiative holds tremendous potential for significant short-term and long-term economic impact by developing the foundation for entirely new classes and families of products that were previously unattainable. The NSF request for FY 2012 includes $190 million for these activities.

The Wireless Innovation (WIN) Fund, a component of the Administration's new Wireless Innovation and Infrastructure Initiative (WI3), will provide $1 billion to NSF over the next five years. WI3 proposes to reallocate a total of 500 megahertz of federal agency and commercial spectrum bands over the next ten years to increase the Nation's access to wireless broadband. NSF will support research on experimental wireless technology testbeds, more flexible and efficient use of the radio spectrum, and cyber-physical systems such as wireless sensor networks for smart buildings, roads, and bridges. A portion of the receipts generated through electromagnetic spectrum auctions will provide funding for WIN. NSF's FY 2012 investments will be coordinated with a number of other agencies, including the Defense Advanced Research Projects Agency and the National Institute of Standards and Technology.

Enhancing Access to the Radio Spectrum (EARS), in addition to the related research funded through the WIN, will support research into new and innovative ways to use the radio spectrum more efficiently so that more applications and services used by individuals and businesses can occupy the limited amount of available spectrum. NSF proposes an investment of $15 million in FY 2012.

Engineering Research Centers (ERCs) and **Industry/University Cooperative Research Centers (I/UCRC)** direct much of their basic research to problems with potential economic impact. By working closely with industry, these programs create enabling technologies for national needs, such as managing the electrical power system, improving manufacturing and biological processing, and supporting new healthcare information and telecommunications technologies. They also prepare students for innovation leadership in a globally competitive marketplace. The FY 2012 NSF investment is $96 million.

The Small Business Innovation Research (SBIR) and **Small Business Technology Transfer (STTR)** programs, funded at $147 million in FY 2012, build partnerships between the academic and industry sectors. They bolster the innovation economy by funding translational research at U.S. small businesses on topics that span the breadth of NSF scientific and engineering research and reflect national and societal priorities.

Catalyze Breakthroughs for National Priorities.
In FY 2012, NSF will focus on key national priority areas, where the expertise of physical, biological, and social scientists and engineers can help advance U.S. goals through frontier research. NSF-catalyzed research includes investments in clean energy and the advancing fields of bio- and nanotechnology, areas that are poised for innovative breakthroughs.

Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) is a new portfolio that builds on NSF's long history of providing leadership for cyberinfrastructure and computational science for the U.S. academic science and engineering community. The $117 million CIF21 will advance data-enabled science through the development of novel approaches to collect, manage, and curate the vast quantities of data generated by modern observational and computational tools. The program will also expand access to cyberinfrastructure to promote collaboration, and support improved community research networks to connect people, facilities, computers, and other tools.

The Science, Engineering, and Education for Sustainability (SEES) portfolio, funded at $998 million in FY 2012, draws together NSF programs that spark innovations for tomorrow's clean energy solutions. SEES will promote a cross-disciplinary approach to sustainability science to explore the environment-energy-economy nexus in order to inform energy and environmental policies and improve our capabilities for rapid response to extreme events, such as power grid disruption, floods, or extreme weather.

Clean Energy investments, a significant component of SEES, will lead to future clean energy and energy efficiency technologies. Investments totaling $576 million are found throughout the NSF portfolio, in core research programs and in activities such as BioMaPS and SEES.

The National Nanotechnology Signature Initiatives are promising research themes that have the potential to generate applications with widespread economic benefit, as well as address national and homeland security challenges. In FY 2012, NSF will invest $117 million in three research areas: Nanotechnology for Solar Energy Collection and Conversion, Sustainable Nanomanufacturing—Creating the Industries of the Future, and Nanoelectronics for 2020 and Beyond. NSF also supports advanced manufacturing research through these investments.

The National Robotics Initiative (NRI), a new interagency initiative for FY 2012, partners NSF with the National Aeronautics and Space Administration, National Institutes of Health, and the U.S. Department of Agriculture. NRI will marshal broad science and engineering support to provide U.S. leadership in the development of next generation robotics. The focus is on robots that work beside, or cooperatively, with people in areas such as manufacturing, space and undersea exploration, healthcare and rehabilitation, military and homeland surveillance and security, education and training, and safe driving. Collaboration and coordination strengthens the research effort and also ensures that agency programs do not overlap. NSF will invest $30 million in NRI in FY 2012.

Interagency Initiatives

NSF participates in a number of interagency programs that aim to coordinate research and development activities in areas of critical national importance.

National Nanotechnology Initiative (NNI), involving 25 departments and agencies across the federal government, focuses on realizing the tremendous potential of nanotechnology. Investments in nanotechnology have led to the discovery and development of entirely new classes of materials. NSF will increase support for NNI research by 10.6 percent to a total of $456 million. This investment includes the National Nanotechnology Signature Initiatives.

The Networking and Information Technology Research and Development (NITRD) explores new frontiers in computer, information, and networking science, and coordinates these efforts among multiple agencies. NSF will increase its investment in these activities by 15.3 percent to $1.258 billion in FY 2012. The focus of NSF support includes human-computer interaction and information management, high-end computing infrastructure and applications, large scale networking, and cybersecurity and information assurance. Other initiatives in the NSF budget will explore new techniques in education and workforce training to exploit cutting edge networking and information technologies.

Homeland Security Activities across NSF will increase by 9.2 percent to about $426 million. The focus is on two general areas: protecting critical infrastructure and key assets and defending against catastrophic threats. Approximately 73 percent of this investment supports research in cybersecurity, emergency planning and response, and risk management, modeling, and simulation of resilient infrastructure.

Major Research Equipment and Facilities Construction

People and their ideas form the core of a robust science and engineering enterprise. But leading-edge tools are also needed in many cases to advance the frontiers and train students for the workplace. NSF provides the assets that will be central to success in the emerging "New Era of Observation," without precedent in terms of the sheer scale, scope, reach, resolution and volume of what we are able to observe. This new era has been enabled by the "Era of Data and Information" where we are now entering an emerging paradigm of data-enabled science.

NSF provides sophisticated tools to a broad population of scientists, engineers, students, and educators. All of the projects in the Major Research Equipment and Facilities Construction account undergo major cost and schedule reviews, as required by NSF guidelines. The following projects receive continued support.

- The **Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO)** is a planned upgrade of the existing Laser Interferometer Gravitational-Wave Observatory (LIGO). AdvLIGO will be ten times more sensitive, powerful enough to approach the ground-based limit of gravitational-wave detection. The FY 2012 investment is $21 million.

- The **Advanced Technology Solar Telescope (ATST)** will enable study of the Sun's magnetic fields, which is crucial to our understanding of the types of solar variability and activity that can affect communications and navigational satellites in space and power grids here on earth, and may influence climate. The FY 2012 investment is $10 million.

- The **Atacama Large Millimeter Array (ALMA)** is the world's most sensitive, highest resolution, millimeter wavelength telescope. ALMA will provide a testing ground for theories of planet formation, star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. The FY 2012 investment is $3 million.

- The **National Ecological Observatory Network (NEON)** will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated

research platform for regional to continental scale ecological research. The FY 2012 investment is $88 million.

- The **Ocean Observatories Initiatives (OOI)** will provide continuous, interactive access to the ocean through a network of sensors designed to collect physical, chemical, geological, and biological data. OOI will produce never-before-seen views of the ocean's depths. The FY 2012 investment is $103 million.

Terminations/Reductions

NSF continually assesses its portfolio to ensure that investments align with agency priorities and focus on the frontiers of innovative science and engineering research. NSF proposes six programs for termination or reduction in FY 2012.

- **Deep Underground Science and Engineering Laboratory (DUSEL):** NSF eliminates funding for DUSEL. Termination is based on National Science Board reviews that concluded the cost and scope of DUSEL were inconsistent with the agency's traditional strengths and its role in advancing research and education across many fields and disciplines. NSF will continue to solicit proposals for future particle physics research. No funding is required in FY 2012 for DUSEL.

- **Graduate STEM Fellows in K-12 Education:** NSF eliminates the agency-wide Graduate STEM Fellows in K-12 Education (GK-12) program. While the program has been effective in meeting its overall goals, recent evaluation findings indicate that the effects of this program's fellowship experience in improving research skills is mixed, and program design limits the ability of participants to gain in-depth experience in K-12 teaching. NSF plans to build on experiences gained during the ten years of GK-12 funding to widen the breadth of graduate traineeship experiences through other programs.

- **National STEM Distributed Learning Program (NSDL):** NSF eliminates funding for the NSDL program (formerly the National STEM Digital Library). While NSDL has been successful in meeting its original goals, an October 2010 preliminary evaluation by the RAND Corporation, Steps Toward a Formative Evaluation of NSDL: Phase 2, noted the challenges of sustaining the collection in the face of changing technology, and raised concerns about the currency of the collections, peer review of collections, collaboration across pathways, and lack of standardization. NSF plans to build from the substantial NSDL experience to address key areas in cyberlearning through other programs and activities, such as Cyberlearning Transforming Education (CTE). No funding is required in FY 2012 for NSDL.

- **Research Initiation Grants to Broaden Participation in Biology:** NSF eliminates funding for the Research Initiation Grants to Broaden Participation in Biology program (RIG) because it did not achieve the goal of broadening participation in biology. The number of proposals from underrepresented groups did not increase. RIG concludes in FY 2011.

- **Science of Learning Centers (SLC):** NSF proposes to reduce funding for the SLC program, which currently supports six large-scale, long-term centers that conduct science of learning research. The on-going center review process and reviews from an external May 2010 Advisory Committee both recommended that NSF phase the program down as

funding for individual centers concludes and shift resources wherever possible to enhance support for the science of learning using non-center mechanisms. NSF expects there may be additional reductions to this program in future years as funding for individual centers comes to a close.

- **Synchrotron Radiation Center (SRC):** NSF eliminates funding for the Synchrotron Radiation Center facility at the University of Wisconsin. The SRC is 30 years old, and more powerful and capable facilities have come on-line since 1980.

Model Organization

The National Science Foundation aims to perform as a model organization in carrying forward its mission. Only 6 percent of the NSF annual budget is spent on management and administration. The FY 2012 request includes $494 million, an increase of $64 million, for activities to strengthen NSF's ability to manage its operations effectively and efficiently. These funds will support:

- Staff will include 40 additional full-time equivalents for a total of 1,365 FTE;
- IT investments of $86 million will include NSF financial system modernization (iTRAK), Research.gov expansion, and improvements to the operational IT system's reliability and security;
- Headquarters lease expiration funding is $45 million to plan and prepare for a new headquarters lease; and
- Acquisition, part of the government-wide effort to strengthen the acquisition workforce and improve capabilities in the pre-solicitation phase of major acquisitions, receives $2 million.

NSF is committed to promoting strong, independent evaluation to inform its policy decisions, program management, and performance, and to sharing publicly available findings online.

OneNSF

The concept "OneNSF" characterizes NSF efforts to perform as a model agency. The National Science Foundation will work seamlessly across organizational and disciplinary boundaries to create new knowledge, stimulate discovery and address complex societal problems and promote national prosperity.

Within this overarching context, the process of setting NSF priorities involves many considerations and results in our best view of how to advance the nation's science, engineering, and education enterprise. Internally, NSF holds a series of retreats and planning meetings where directions are developed based on an understanding of new research frontiers, emerging fields, and opportunities to advance research and educational goals. NSF also considers opportunities to coordinate and collaborate with other agencies. Staff from all Directorates and Offices participate in these activities.

The NSF system of competitive merit review helps to bring the best ideas forward from every corner of the nation. NSF continues to accept and review unsolicited proposals, a practice that ensures that unanticipated and novel ideas of great promise are heard.

Conclusion

President Obama has spoken of this generation's new "Sputnik moment," a reference to the challenge of meeting the nation's economic and societal needs in the current climate of global competition for new ideas and talent. NSF's strategic investment in research and education will help the nation meet the challenges of our times and move beyond them.

Mr. Chairman and members of the Subcommittee, I hope my testimony explains NSF's transformative role in building our nation's future prosperity and continued leadership at the frontiers of discovery, innovation and learning. Robust NSF investments in fundamental science and engineering have paid enormous dividends, improving the lives and livelihoods of generations of Americans. The FY 2012 NSF Budget Request supports leading edge programs and activities that will continue this success in the future.

This concludes my testimony. I thank you for your leadership. I will be pleased to answer any questions the Members may have.

Mr. BONNER. Thank you very much for that testimony.

We have been joined by our colleague, Mr. Aderholt from Alabama, who also has the pleasure of chairing the Homeland Security Subcommittee. And I think he indicated that he actually has to go out and prepare for a hearing that is coming up, but he may have some questions to submit for the record, as will other Members.

Let's go into a few questions. And I think the first one probably should be the fact that we are operating under a Continuing Resolution at the present time. We are on a short-term two-week extension. We will see where that goes in terms of whether we will have to do another one. Hopefully, though, Democrats, Republicans, Congress, the White House will be able to come to an agreement in the next few weeks so that we can have some certainty to finish fiscal year 2011.

IMPACT OF CONTINUING RESOLUTION

How is the CR impacting the work of the NSF at the present time?

Mr. SURESH. I think we are continuing with plans to honor commitments. We are spending wisely and carefully. We are very mindful of the need for continued workforce development. But it is constraining our ability, so there are two aspects to this.

One is the real impact of it, but equally importantly and perhaps more importantly the psychological impact of it on students, faculty, and researchers in the country.

And I would say that we wish we did not have a Continuing Resolution. We are working very hard to assure the community that we are doing everything possible within our constraints to make sure that their activities will continue to be supported by NSF while we are looking to the future at the very cutting edge in both research work and instrumentation for the community.

Mr. BONNER. You know, it is interesting. I think Mr. Fattah would agree. I do not know any Member of Congress that likes the CR either. It is one of the hands that sometimes we are dealt.

There may be some additional questions about the balance of fiscal year 2011.

INCREASED FUNDING FOR GRADUATE RESEARCH FELLOWSHIP PROGRAM

Let me shift, however, to the fact that your budget request proposes an increase in funding for the Graduate Research Fellowship Program and within that program, an increase in the educational allowance and stipend levels.

My sister is the provost at the University of Alabama so I know how important this work is as it relates to graduate students throughout the country, at great universities like Penn State and Alabama and Brown and others.

Higher allowances and stipends will certainly make the awards more useful to the individual recipients, but increasing the per award cost will reduce the total number of awards that can be made.

Why in your view is this increase in the value of each award worth the loss of additional fellowship opportunities?

Mr. SURESH. Thank you for that question.

I think the Graduate Research Fellowships are an important part of what NSF does. Since 1962, NSF has supported 46,000 graduate research fellows. I have had the honor and privilege of supervising more than ten students in two different institutions who have received NSF graduate fellowships.

We have maintained a commitment to keep the increase that was introduced in 2010 for Graduate Research Fellowships. So in the fiscal year 2012 budget, we will have 2,000 graduate research fellows. But at the same time, the cost of education allowance has not kept up with the increasing cost of education over the past many years. So in the fiscal year 2012 budget, we will be increasing it from $10,500 to $12,000.

Also, the cost of living has gone up quite a bit and graduate students already live in many places under substandard conditions. So we want to make sure that in the not-too-distant future, we also increase the stipend for graduate students so that we can address that as well.

Because all three are important, I think if we do not support the students adequately, then their ability to go into graduate education is going to be reduced. At the same time, to improve the workforce, we have to support enough numbers and increasing numbers of graduate students.

If you look at our budget, we have made some very difficult choices. It is not that we are asking for increases. There are also six programs that are going to be terminated. There are some programs that are being reduced which will impact graduate students. And I think this is a mechanism that we are trying to find.

The other mechanism we are looking at, and it is also in the America COMPETES Reauthorization Act, is that the graduate research funds will be supported through a combination of funds allocated to EHR and also to the Research and Related Activities category of the budget.

PROGRAM TERMINATIONS

Mr. BONNER. I am going to have some additional questions, and I would like to yield to Mr. Fattah, but could you tell us about the six programs that you are proposing to eliminate?

Mr. SURESH. Sure. So of the six programs, the major program that will be eliminated will be DUSEL, Deep Underground Science and Engineering Lab. The National Science Board, which is the oversight body for the National Science Foundation, in its meeting in December unanimously and very clearly articulated that the model that was proposed for stewardship of DUSEL was inconsistent with the mission of NSF and was not acceptable.

In light of that, the Administration has proposed to terminate the fiscal year 2012 budget for DUSEL. So that will be one of the programs.

The other program is the Graduate STEM Fellows in K through 12 Education or GK–12. GK–12 is a program that was initiated in 1999. This program has had a rich and successful history. We have had some very good outcomes out of this, but NSF always funds good things, learns from the experience, gets community feedback, and funds for a long period of time.

But we have to move to new directions as well. So as a result of this, we will incorporate the best practices of GK–12 into other programs as we move forward. We will honor existing commitments for GK–12 in 2012, but there is no new funding for GK–12.

The third program is called National STEM Distributed Learning program or NSDL and, again, with increasing emphasis on cyberlearning and other activities across NSF in different portfolios, including in EHR and some of the new programs that will come into existence, it was decided that we take the best practices of this and terminate this program for fiscal year 2012.

The fourth program is Research Initiation Grants to Broaden Participation in Biology. Broadening participation is at the core of NSF. It is in every activity that we do. And since joining NSF, I have made a very firm commitment to broadening participation in everything we do.

So one of the things we decided to do was to take in this program and fold it into other activities. And one of the new programs that will be initiated in EHR will address aspects of this program as well.

The next one is the Science of Learning Centers. These have provided useful input. Now, we have had extensive reviews of the successes of these programs and some will continue and terminate over time. And those that have served their useful purpose, we take the input and then we will wind them down over the coming years.

And the last one is a Synchrotron Radiation Center at the University of Wisconsin. This is a 30-year-old center and just refurbishing it will not keep us at the forefront of this field. So, therefore, it was decided to terminate it.

Mr. BONNER. Thank you very much.

Mr. Fattah.

Mr. FATTAH. Let me work from the general for a minute here and we will get to some specifics.

INTERNATIONAL COMPETITIVENESS IN SCIENTIFIC DISCOVERY

The National Science Foundation has invested in the research of a couple hundred thousand scientists and a whole range of areas that statutorily you have been instructed to do basic research in. And this is the only entity of the Federal Government that has this singular responsibility in terms of basic scientific research.

You are involved with the National Academies both here and in other countries, Germany and the like. I wonder if you could share with the subcommittee your perspective on this kind of international race in terms of science.

Let me give you a for instance. The computer was obviously developed here, and I would have the chairman note, at the University of Pennsylvania in my district. But today if we are looking for the fastest supercomputers, they would not be in the United States of America. They would be in China.

And so when you go to talk about simulations, we do not have the world's fastest or the greatest computers anymore. And you could go over all kinds of areas where we see competition successfully challenging America on this front.

So I was wondering if you could, given your perspective, give us a sense about what you think it means to our Nation if we allow others to move substantially ahead of us in these areas of scientific discovery.

Mr. SURESH. Thank you, Mr. Fattah.

As you mentioned, I have been fortunate and very privileged to have had the opportunity for a number of international experiences. I received my first degree in engineering from Indian Institute of Technology and came to the United States.

I am quite active in a number of academies, the German National Academy of Sciences, the National Academy of Engineering in the U.S., and the Engineering and Science Academies in India, and the Science Academy in Spain.

And you mentioned in your opening remarks about the investments that the government of Singapore makes. The Singapore government created the National Research Foundation on January 1, 2006. In fact, I know the existence of that particular entity since the day it was founded. And I had interacted quite a bit with that foundation through my activities as dean of engineering at MIT.

And one of the things that is happening now as we face the biggest budget constraint since the Great Depression and the biggest financial crisis since the Great Depression, we are also facing unprecedented competition from the international arena, from countries large and small.

I met with a number of colleagues from China who tell me that over an already increasing base for research funding over the last two decades or so, over the next five to six years, there is discussion that China will increase its research funding including basic research funding by 50 percent from already a high level.

Singapore, as you indicated, a tiny country of 4.6 million people, invests billions and billions of U.S. dollars into research. And I have seen the infrastructure go up in front of my eyes over the last two decades or so.

And the concern that I have both from personal experience and these observations is that unlike the time in 1977 when I came to the U.S., at that time, there was no question in my mind where I wanted to go. There was only one place to go and that was here.

And to some extent, some would argue this is still the same. But there are growing indications that this may not be the same ten years from now if we are not careful. Let me give you a few data points.

Germany, Japan, South Korea spend more money on research as a fraction of GDP, non-defense research spending compared to the U.S. and they also passed us in 2000. For ten years, we have been lagging behind those three countries and they have become major forces in science and engineering discovery and translation.

Smaller Scandinavian countries have also surpassed us like Finland, for example, and other Scandinavian countries. Singapore is on a path to significantly increase research funding. So that is one problem.

The second problem is that we have—let me give you one piece of anecdotal information. This is not yet a trend, but this is the most compelling data that I have seen. In my graduating class in engineering, all branches of engineering from an elite national in-

stitution in India, there were 250 of us in 1977. More than 200 of us had an opportunity to come to the U.S. to pursue graduate education. All 200 of us came and all 200 of us stayed here. Pretty much all of us became American citizens and we joined academia, industry startups, created jobs.

Fast forward 32 years. The most recent year for which we have data which is 2009, the same campus, still 250 people, only 16 percent of those students chose to come here. Eighty percent could have if they tried.

And one of the remarkable things about the American scientific enterprise as a Nation is that this has been the unquestioned destination for many, many decades, for more than half a century or even longer. And if we lose that, I think we are going to have a problem.

Mr. FATTAH. The chairman in his opening statement referred to this report that kind of benchmarked what we needed to do to stem the tide. We have not done much of that.

And your sister is a provost. And to talk about graduate school, we look at the students who pursue degrees in the hard science. Less than a third of them are American students and it is decreasing and decreasing whether at the great University of Pennsylvania or at the University of Auburn. And this is a real challenge.

Mr. BONNER. University of Alabama.

Mr. FATTAH. Alabama.

Mr. BONNER. Auburn is that other university.

Mr. FATTAH. So this is a great concern because if we are not growing our own or if others are not coming and staying, it just positions our country in a very bad way.

When I went out to visit these labs, I was struck by the fact that way back in the 1940s and for every year since, our country has made a very significant investment in research. And the labs I was visiting had to do with our nuclear weapons. And obviously some of the issues were classified.

But what was fascinating about this was that, in one discussion about a much smaller country and what they were doing in this regard, I asked how they could afford to do this. The response of the person giving the briefing was that, and quoting the briefer, their position was they would eat grass if necessary in order to pursue this research.

Now, this was in a much more defense-related posture, but the point here is that the question becomes what is our resolve as a Nation to make sure that we position ourselves at the very front, to win and win consistently. And if we want to do that, we cannot afford to abandon our investments in this regard.

Now, a 12 percent increase in this budget, given the financial climate, I guess we can say, is a step forward. But when a football team from the University of Alabama and Penn State line up, it is compared to what. It is not just what are you doing compared to what you did last year. It is what you are doing compared to the other teams that you are lining up against.

So we are competing economically with countries that seem to have decided that winning is important. And the question becomes, since we have historically been winning, whether or not we have

decided that we no longer want to win and that what we would rather do is to do something less than our best.

And I just think that rather than just the details of the budget, that what is important—because we have heard the Patent Office in this room say that for the first time in the year 2000, the same year that you mentioned, we crossed over a rubicon in which the majority of the patents being sought in our country are sought by people who are not Americans or not American entities, right?

So, you know, so goes research, so goes to innovation, so goes intellectual property, and we know what follows from there because then it is taking those products, to the market, manufacturing them, and they are going to go other places.

So we have to really think about how we are going to go forward and even in our rush to cut, we need to think that we do not want to create a situation where, unlike those who made these investments in the 1940s and the 1950s and the 1960s, that somehow we want to be the generation of leaders who decided to diminish America's place in the world.

And I think that where the rubber meets the road is at this point of innovation. It has nothing to do with party or partisanship. If four percent of our population are scientists and engineers, we need to make sure that they have the very best opportunities to succeed here.

Mr. BONNER. So that I do not get in trouble with my home State, we also have a great university in Auburn. We are the only State that I know of that has won back to back national championships and has back to back Heisman Trophy winners. And we are proud of that.

But Mr. Fattah raises a good point. In this Nation, we have spent a lot of time, probably an inordinate amount of time focusing on the achievements on the gridiron or the football field and do not put near the emphasis that we should as a Nation on the achievements of our scientists and our biologists and our engineers. And that is something that I think we can all agree is one of the reasons that we are in the position that we are in today.

POTENTIAL DUPLICATION BETWEEN GOVERNMENT PROGRAMS

Last week, the GAO issued a report identifying areas of potential duplication between government programs. You just previously identified six programs that you are proposing to eliminate.

One of the report's major findings is that the government has 82 distinct programs whose purpose is to improve the quality of American teachers. Those programs are divided among ten different federal agencies, including both NASA and NSF.

Do you believe that your teacher quality programs are duplicative of those offered by other agencies. Then a follow-up question to that is, what kind of government-wide coordination takes place to ensure that these programs are effectively and efficiently aligned?

Mr. SURESH. Thank you for that question.

Mr. BONNER. The real chairman is here now.

Mr. SURESH. Thank you for the question, Mr. Bonner.

The GAO report is something that I have looked at. In response to your point, NSF's goal in the education arena whether it is K

through 12 or undergraduate, postgraduate, and higher education is that we develop models and practices through scientific research, test them out, validate them, and they are taken up by other agencies for large-scale implementation.

And as you saw in the six programs that we terminated, we continually look at things that are effective, that are not effective, so we work very closely with the Department of Education.

There are three new programs that I mentioned in my opening remarks that have been articulated for the fiscal year 2012 budget request. And those are intended to look at what we have done well, how to take them and then how to expand them.

One of the new programs is WIDER and this is essentially geared at large-scale implementation for undergraduate education. And as part of that, we look at all the existing things including things that could potentially be duplicate activities and remove them or try to eliminate them.

I have charged the head of our EHR, Dr. Ferrini-Mundy, who is sitting behind me, with looking at how EHR can work with all the directors within NSF to bring education to everything that we do, not just in one particular unit, but across NSF. Conversely how do we take the best practices in education across all the different activities and then bring them back to EHR.

So we are very aware of this and we are looking at this. And, you know, one of the unique things about what NSF does is across the spectrum of fields and from a scientific perspective creating models rather than large-scale implementation.

Mr. BONNER. It may just be pennies on the dollar, but whatever you can save in eliminating duplicative programs can be invested in other areas of the important work that you are doing.

One of the things, just as an aside, going back to Mr. Fattah's comments, I have advocated for years with NASA is that they need to do a better job of letting the American taxpayer know where their work is making a difference in our everyday lives.

COMMUNICATING RESULTS OF NSF INVESTMENTS

You know, when we passed the stimulus bill, some of us voted for it, some of us voted against, but all of a sudden, you see these road signs all across the country with the emblem that this is a project of the stimulus bill.

I do not know whether NSF is able to brand itself on the work that you are doing. I know the good work you are doing is paying dividends not just in this country but around the world.

But I really think that might be something that if the American taxpayer is in the grocery store and they are picking up a bottle of detergent or whatever and they see your work helped lead to the discovery of that ingredient, it just might bring a better understanding of your important work. And that way, we would not be arguing over whether NSF should have a 13 percent increase or whether it should be a 25 percent increase. The fact is people could have a better grasp of the impact you are making on their daily lives. Just a thought.

Mr. SURESH. You are right on, Mr. Bonner. In fact, these very comments resonate very well with the first retreat that I held since arriving at NSF. How can we make the work that NSF does be

available or at least accessible so people can understand what NSF does, not just the scientists and engineers, but a much broader population.

So let me mention a few of the specific things that I have started in the last few months. First and foremost is improving all channels of communication. So I have actually set up a task force that within NSF will look at how we communicate the outcomes of what we do to The Hill, to K through 12, to middle school students, and so forth. This is very important and it is increasingly important.

The second thing is to update the technology that we use to do that. And it is not conventional technology anymore. There are a variety of media, especially that are appealing to younger people increasingly so. How do we tap into that?

The third one is not only gathering data but making the data accessible to a broader cross-section of people, both public information but also scientific information.

So we have a variety of programs that are underway. STAR Metrics is a program that we are working on right now in collaboration with some other agencies as well like NIH. And this is something that during the course of this year I hope will be a very strong medium through which the impact of NSF's work is broadly recognized.

Mr. BONNER. Thank you, Mr. Chairman.

Mr. FATTAH. If the gentleman would yield for just one second because the chairman is going to jump in here.

I totally agree with you. I mean, I think one of the problems is when we look at NASA, we look at National Science Foundation. Even though there are literally tens of thousands of very important discoveries that have contributed to our country and to the world, the public has no concept that this was through these investments or through these entities.

We know when we go after a great football coach or a player, we are all rooting for our team no matter what the price. Sign the guy, sign him because we want to win. And that is the same kind of attitude we have to bring in this area of innovation, that we want to win. We want to know what it costs to win and then we want to pay the cost because we really do not want to pay the cost to come in second to some of these other nations in our world.

Thank you.

Mr. BONNER. If I might, this will be my last question and then I am going to go to another hearing. I really have enjoyed being with you and I appreciate the chairman allowing me to be in his chair for a few minutes.

Yesterday the prime minister of Australia was here and twice, at the beginning of her speech and at the end of it, she cited as a young girl, and I could relate, as we are approximately the same age, how all the way down under, she was able to look to the United States and the world leadership we were providing by putting a man on the moon. And then when she closed with that, basically it was a challenge for America to always continue to lead.

And, you know, sometimes it is refreshing to hear from outside the role that we play and that we should continue to play.

Thank you, Chairman Wolf.

Mr. WOLF [presiding]. Thank you, Mr. Bonner. I want to thank you for chairing the hearing. I was at another hearing testifying, so I appreciate it very much.

And I agree with what both Mr. Bonner and Mr. Fattah said.

K–12 STEM EDUCATION REPORT

This is a question based on my disappointment in NSF and in Dr. Bement. Back in 2009, I asked the NSF to pull together a team of experts to identify the best practices in K–12 STEM education and make recommendations on how these practices could be replicated across the country. Despite all the time, two years that has gone by since then, that team of experts has yet to meet. And the earliest we can get the recommendations would be early summer. We have actually lost a couple of young kids from pursuing STEM subject because of the failure of NSF to respond.

When is the NSF going to fulfill this directive, and what is the justification for this unnecessarily long delay? We did the same thing on prison reform. Mr. Mollohan to his credit, and I want to make sure he always gets the credit, had the very best hearing on prisons and prison reform.

We asked the Pew Foundation and the Council of State Governments to do an in-depth review, bringing the best minds. They finished their report. They published it. They have gone out to all the governors and you all have not even responded. Two years have gone by.

So when you say that you are really that excited about education, I do not see the results. So what is the justification for this unnecessarily long delay, and when are you going to fulfill the directive? Why the delay first?

Mr. SURESH. Thank you for the question, Mr. Chairman. But I also want to thank you for your interest in STEM and your leadership in this area.

Let me respond to that. As you know, I arrived at NSF on October 18th last year, about four months ago. As soon as I found out about the need for this report, I had charged the head of our EHR unit, Dr. Ferrini-Mundy, who is here, to give me an update on this, but also to look into how quickly we can have this report submitted.

There are three parallel activities that are going on——

Mr. WOLF. Why did it take so long to do it, two years?

Mr. SURESH. I think that there are three reasons for this. One is to identify the best practices in STEM education. There was an NRC Committee that was set up with experts from around the country. And they are submitting written material ahead of a meeting that is going to be held in May of this year, on May 11th and 12th.

And, in fact, I very much hope that you will be available to kick off that meeting. There was an invitation that was sent to your office about two weeks ago or so. And we very much hope that that event will take place. And that event will be a culmination of all the background work that has gone on. So that was one factor.

The second factor is that NSF has also charged the Urban Institute to look at two states where we can take the best practices and use them in the report with enough careful scientific data. This is

a very important topic and NSF is extremely grateful to you for the leadership you have shown in this. This has galvanized us actually to do a scientific study that typically the way NSF does and to give you a report that is complete and comprehensive and that addresses the issue.

The third reason for this, NSF has also engaged the COSMOS Corporation to look into the best practices of the American Science Program and to incorporate the findings with respect to STEM education into the report. And they are also charged to get that.

So I asked the head of EHR to give me an interim report on where things stand with specific deadlines. That report was given to me about a little more than a week ago and that report has been forwarded to your office as well.

And the symposium will take place in May and the preliminary report will be done in June of this year. And the final report will be submitted by mid July of this year.

Mr. WOLF. Well, just the thought of two years is so long, and I am really disappointed in the former director. He left town. How hard you work on the last day is as important as how hard you work on the first day, and on the last day, he did not finish this. He specifically sat there and promised that it would be done.

I am concerned that NSF's actions in response to this directive may be too narrow and will result primarily in a report to this committee. It is interesting and this committee will look at it. But what are you going to do to make policymakers, school officials, teachers, and other interested parties aware of the findings so that they can actually put it to use?

The purpose is to make sure the superintendent of schools in Fairfax County and the city of Philadelphia and Harrisburg and Richmond get this thing quickly. And as you know, school years begin, curriculum is set up.

How are you getting it out to the real people that matter, not to this committee? It really does not matter what you tell this committee. What are you going to tell the superintendents and the guidance counselors and the science teachers around the country, and how will you get it into their hands so that it can be implemented?

K–12 STEM EDUCATION COMMUNICATIONS STRATEGY

Mr. SURESH. So if I could quickly answer that question. One of the things I have also charged not only Dr. Ferrini-Mundy but our communications folks is a communications strategy for these kinds of very important reports. That also goes back to Mr. Bonner's earlier question which is very relevant to this particular issue.

I fully agree with your sentiment on making this available as broadly as possible and so we are looking into that strategy right now to get it to as wide an audience as possible.

Mr. FATTAH. If I could suggest to the chairman, we would love for your second favorite city, Philadelphia, to host a roll-out of the study for all the school superintendents from around the country and——

Mr. WOLF. You going to go?

Mr. FATTAH [continuing]. We could tie them in by web if they cannot travel. We could do it at the great Constitution Center and

NSF could roll this out in a very large media market that would get a lot of exposure. And the chairman and I could be there to help open up the discussion. So we will be glad to work with you.

Mr. WOLF. I would be open to do it. We could go down to Pat's Steaks and get a steak.

Mr. FATTAH. I am paying for the steak. All right? So I think we have a bipartisan agreement that we should roll this study out in Philadelphia.

Mr. WOLF. You want to do that? You want to work out something?

Mr. FATTAH. I want to work with NSF on that regard.

Mr. SURESH. Mr. Chairman, I also want to assure you we definitely want to do as the National Science Foundation better than the Department of Prisons, so we will do everything possible.

Mr. WOLF. Well, the prisons people turned it around. Pew Foundation and Council of State Governments did it very, very fast. It was quite a report. I was going to bring it today, but I did not want to embarrass you. It is very impressive.

MAINTAINING STUDENT INTEREST IN STEM

At what age do you think you lose a young person? First, second, third, fourth, fifth grade? Very few people go to college and major in business and then transfer into sciences or physics or chemistry.

When I go into the schools, I have my own perception. But what grade do you think you begin to lose somebody? If you lost them, I cannot say you never get them back, but it is very tough. Fifth grade, sixth grade, seventh grade, first grade? What is your answer?

Mr. SURESH. Well, it depends on a number of circumstances, but I would say it is very early. I think one can always energize them with the right mentoring at different stages, but the earlier we excite somebody about the importance and the impact of science and engineering, the better it is.

There are some constituencies where we lose certain segments of our scientific workforce at a much later stage. For example, in the case of women in science and engineering, 40 percent of the postgraduates in the country in science and engineering are women, but in the workforce, they are only 26 percent. We lose them in their early career stage after they have been trained, after they have made the initial impact for a variety of reasons.

But in terms of capturing the attention of young minds, the earlier, the better.

Mr. WOLF. There must be an age. There has got to be a point when the line crosses, and I am trying to get when that is.

Mr. SURESH. Well, I mean, obviously the earlier, the better, but I can only give some response. I have two daughters. Both are into science and engineering and one got interested in science at fourth grade. And fourth grade according to data is what studies suggest. But there are also, you know, differing circumstances. But if you are asking about based on scientific studies on average, it is about fourth grade.

Mr. WOLF. So whatever we do with limited resources, we have to put the emphasis on kindergarten, first grade, second grade,

third grade, fourth grade and fifth grade to keep these kids active and interested in science.

Well, that is what we are looking to find out and what schools have done——

Mr. SURESH. Right.

Mr. WOLF [continuing]. Not just in two states but around the country to bring that about.

NSF INTERNATIONAL OFFICES

NSF has permanent offices located in Beijing. Can you describe what this office does and why it is necessary?

Mr. SURESH. So, Mr. Chairman, before you came here, we had a lively conversation about international engagement and growing competition and so forth. NSF, as you know, has three overseas offices, one in Tokyo, one in Beijing, and one in Paris. We also have operations in Antarctica where we use Christchurch, New Zealand as a focal point if not an official office for our Antarctic program.

As we discussed earlier here, the U.S. has been the unquestioned destination for decades, for nearly a century for scientists and engineers to come from all over the world. And I am a living example of that population.

We have also been the generators of ideas, innovative ideas. We have been a very open society not just in science but as a society. And as a result, it has benefitted what we do enormously and it has benefitted the scientific enterprise around the world.

Now, as other countries grow, other countries invest a lot of money and it is very important that agencies like NSF not only find out what our competition is, not only try to understand how we ensure that we remain at the very cutting edge of it, but equally important, we make sure that we give our scientists and engineers and our students an opportunity to any technologies that may evolve over there.

So one of the purposes of the Beijing office would be to, A, find out what goes on in China in science and engineering education and research——

Mr. WOLF. And do they give you a weekly or a daily or monthly report?

Mr. SURESH. There is a monthly report that comes to our international office.

Mr. WOLF. How many people are in Beijing?

Mr. SURESH. I think it is an office with just one or two and they interface with the State Department.

Mr. WOLF. Are they located in the embassy?

Mr. SURESH. I do not think so. I will be visiting them later this year. I have not visited them.

CYBERSECURITY

Mr. WOLF. Let me ask you this. How many cyber attacks have there been against NSF?

Mr. SURESH. Recently there was one last fall, but, you know, we take the cyber attacks very, very seriously. And, in fact, in the 2012 budget request, we have $155 million for cybersecurity research which is a 20 percent increase over the 2010 enacted level. And this is something that is a major part of the emphasis for us.

Mr. WOLF. Last month, your Inspector General testified that a significant cybersecurity incident recently occurred at NSF and the computers involved had been wiped clean before investigators from the IG's office had an opportunity to examine them.

Have you made changes to your security breach procedures to ensure these circumstances do not repeat?

Mr. SURESH. Yes. We have increased firewalls. We have increased cybersecurity software and also made the system much more secure following that attack.

In addition to that, we have a fairly high-level committee that has been set up since that time at NSF looking into all of our practices and interfacing with the different parts of NSF.

Mr. WOLF. Following on that, portable IT devices like BlackBerries and laptops are common targets of foreign intelligence services in countries like China where NSF employees travel frequently on official business. I was concerned to hear that NSF has no formal policy on protection of IT devices during official travel.

Mr. SURESH. Actually, we now have. We have a policy.

Mr. WOLF. As of when? Monday, or as of when?

Mr. SURESH. No, no. As of about a month and a half ago.

Mr. WOLF. What is the policy with regard to BlackBerries and laptops taken to China?

Mr. SURESH. So initially they have to go through a check at NSF. It goes through our cybersecurity folks first to make sure that appropriate filters are put in for these devices.

Mr. WOLF. But they tell me that you can never really take a BlackBerry or a computer to China and have it clean.

Mr. SURESH. I am not familiar with that, but my understanding is that this is very much on the radar screen of our IT folks. And we have this committee that is looking into ensuring that there is no proprietary or sensitive information from NSF or any information from NSF that is compromised when people travel overseas anywhere including in China.

Mr. WOLF. Well, say by Monday, maybe you can have somebody come up to sit down with the staff to tell us specifically what you are doing about BlackBerries and laptops going to any single country, and how you clean them. Many of the security agencies are giving new ones to take over there and then they turn them back in when they get back.

Mr. SURESH. Okay.

Mr. WOLF. If they compromise your BlackBerry or laptop, they can come through to your computer. So if somebody can come up next week and sit down with the staff to let us know what you are doing and how quickly. Not just for travel to China, but——

Mr. SURESH. Okay.

Mr. WOLF [continuing]. To Syria, and to any country so we have some sense.

Mr. SURESH. I will be very happy to do that, have somebody meet with your staff and update them on——

NSF SPACE LEASE

Mr. WOLF. I am going to go to Mr. Serrano in a minute. But the lease for your current headquarters expires in 2013. GSA has already begun looking at replacement options.

Is remaining in your current facility still a possibility? What would need to be done to those buildings in order to make them consistent with GSA requirements and NSF's ongoing space needs?

And I can recall Senator Robb, Chuck Robb, moved NSF to Virginia. NSF fought it tooth and nail. They wanted to be downtown close to the White House. Now they seem to be happy. At least Mr. Bement said they were happy.

Many employees have moved there now. They live around there. And I do not want to see you guys pick up and head off to Timbuktu when people have bought homes and made an impact.

So what needs to be done to these buildings? Where are you going to go, and what are you doing with regard to office space?

Mr. SURESH. So, you know, this as a former renter, I know that there is never a good time for the lease to come up for renewal. And as you mentioned, our lease is coming up for renewal in 2013.

The process to address what happens in 2013 started in 2009 and in consultation with GSA. And based on these discussions over the past two years or so, nearly two years, GSA has determined that there is sufficient competition for a new site and also sufficient opportunities for infrastructure and access to critical infrastructure for NSF in the northern Virginia area. Of course, this is subject to Congressional approval and this is a discussion that they have been having.

With respect to your question——

Mr. WOLF. Just for the record, that is not my congressional district. I just want the record to——

Mr. SURESH. No. I——

Mr. WOLF. It is Congressman Jim Moran's district.

Mr. SURESH. Yes. So that is what GSA has determined over the last year or so. With respect to the existing building, the existing building could be one possibility. But NSF moved into the existing building in 1993. And NSF's operations have grown significantly since 1993, so there are critical infrastructure improvements from transformers to elevators to panel rooms to IT infrastructure to cybersecurity and so forth that need to be done in the existing building should NSF or should GSA and Congress decide that we stay in the current location. And that will require significant improvements to the current location. That is also one of the possibilities. We do not know how this will evolve over the next few months or so.

Mr. WOLF. The GSA prospectus for the project establishes location criteria for any potential future NSF headquarters. What are the criteria, and how does the application of those criteria limit the geographic area in which GSA can look?

Mr. SURESH. The criteria, you know, broadly would be a variety of them that include access to critical infrastructure, access to places like hotels and things like this because last year, we engaged something on the order of 290,000 referees in the communities. Not all of them came. About 19,000 people or so came into the NSF area. We also hold meetings.

And so the criteria are still evolving. They are not finalized, but broadly there are criteria. So I can tell you that the infrastructure that I mentioned, airports, Metrorail, interstate trains, easy to reach from different airports, that is one criterion.

Last year, as I mentioned, we had 20,000 merit review panelists who visited the NSF site or nearby hotels. So access to that is very important.

Specific criterion would be that hotel accommodations deliver a minimum of 1,500 room nights per week. And so——

Mr. WOLF. Okay.

Mr. SURESH. [continuing]. Hotel infrastructure has to be——

Mr. WOLF. Well, I would ask you to stay in touch with the committee and also Congressman Moran, Senator Mark Warner and Senator Webb on this issues.

You know, it is interesting. We had to offer an amendment to beat NSF back. They fought to stay on Constitution Avenue. There is no rail on Constitution Avenue. There are no restaurants on Constitution Avenue. There are no hotels or motels on Constitution Avenue. And you all fought to stay there.

So I want you to be faithful to the criteria and I would ask that you keep Mr. Moran informed. Because what I am afraid of is there is going to be somebody in the middle of the night try to move this agency somewhere, and your employees are going to be left high and dry. They have got mortgages on their house. They have investments that they have made. They have moved their families. Their kids are invested.

And, again, the record must show NSF is not in my congressional district and never will be in my congressional district.

But you start doing this, and you hurt people. So I am going to ask you to keep the committee informed and keep Mr. Moran and Mr. Warner and Mr. Webb also informed.

Mr. FATTAH. If the gentleman would yield.

Mr. WOLF. Excuse me.

Mr. FATTAH. It is definitely not in my congressional district. But let me just say that on behalf of this side of the team, I am fully in support of what the chairman is saying. I believe that the stability of the employee base is critically important.

And, Mr. Chairman, I think that NSF and GSA should figure out what the requirements are that they need. But I am not opposed to using the appropriations bill to help them focus in a way that will not have them wasting their energy looking for places to go other than in the general vicinity in which they are in.

Mr. WOLF. I appreciate Mr. Fattah's comment. That is what we went through the last time. Actually, Dr. Bement used to live in Maryland and moved over, if some may recall. I have talked to some of the employees. They said they have made these investments, and now they are hearing word that there may be this effort to move.

I have never tried to take any federal agency and put it in my congressional district. And this is not in my district.

Mr. FATTAH. I am willing to support language, prohibitions or other language that could be instructive in this matter.

Mr. WOLF. I appreciate that.

Mr. SURESH. If I could just add to your comments. One of the things I have done since joining NSF about nearly five months ago was to meet with each and every office and directorate at NSF in my first two months. And that has been extremely beneficial to me not only for the scientific work that NSF does or the education

work that NSF does, it also gave me an opportunity to feel the pulse of the staff.

And I am very much committed to making sure that the staff are very happy. And we would not want to do anything that significantly disrupts their lives and is a blow to their morale.

Mr. WOLF. Where do you live?

Mr. SURESH. I live in Washington. I recently moved here and—

Mr. WOLF. Buy or rent?

Mr. SURESH. Mine is a six-year appointment, so it was too long a time to rent. Even though it was too short a time probably to buy, I decided to buy it.

Mr. WOLF. Mr. Serrano.

ARECIBO OBSERVATORY

Mr. SERRANO. Thank you, Mr. Chairman. Thank you.

One of my subjects of interest, Doctor, is the Arecibo Observatory in Puerto Rico. Now, it serves the purpose that it does scientifically and otherwise. It is also very symbolic for the Federal Government and NSF and NASA to have chosen one of the territories for such an important project so long ago.

And so you can see that by my comments that we both pay attention to the significance of it in terms of what it accomplishes and what it has accomplished and why it is needed and also the importance of having it in a territory and how the people feel about that.

So for a while, it looked like it was going to close down. Now it seems like that is not the case. New reports came out about the near earth objects. I am always amazed by that comment. That is kind of a scary comment, you know. I think we have some near earth people in here, but objects are something of great interest to me.

So what is the status? I mean, is it going to close down? Is it going to stay open? Have you rediscovered an importance for the Arecibo Observatory?

Mr. SURESH. So the facility in Puerto Rico——

Mr. SERRANO. And for the record, Mr. Chairman, NSF is not in my district. But as a disclaimer, Puerto Rico is the territory where I was born, although I represent the Bronx, just for the record.

Mr. SURESH. Mr. Serrano——

Mr. FATTAH. Is there a record of your birth?

Mr. SERRANO. Well, I know for sure I cannot be President.

Mr. SURESH. Thank you, Mr. Serrano, for the question.

I will be happy to answer that just for the record and for full disclosure, I have to say until five months ago, I held a job for an institution whose official mascot is a beaver. And I had a beaver ring on my finger until recently.

The facility in Puerto Rico has multiple benefits. And, in fact, I am not an astronomer or astrophysicist, but the facility is the largest single antenna facility in the world. It not only serves in scientific discoveries in the astrophysics arena, it has also been beneficial for educational purposes.

The decision that was made in 2006 was based on the senior review that was done where it was felt that cost sharing should be done from sources outside of NSF because it is also of interest to NASA and it is also of interest to not only the Astronomy Division

of the Mathematical and Physical Sciences Directorate but also the Atmospheric and Geospace Division of the Geosciences Directorate at NSF.

And based on that, attempts were made and now we have an ongoing management competition underway with a new five-year cooperative agreement to be awarded in fiscal year 2012. That is the current status. And there are still attempts being made to ensure in response to the senior review that we will get matching support from other sources. The fiscal year 2012 budget request for the facility will be $8.7 million.

Mr. SERRANO. So based on that statement, one would say that an immediate plan to close it is not in the works and that, in fact, if things go well, we know the observatory will be around at least until 2017?

Mr. SURESH. Well, that is correct. I think it depends on the outcome of this management competition, but we are going through the process and a decision will be made in fiscal year 2012.

Mr. SERRANO. I also appreciate and thank you for being probably one of the first folks to come before this committee, I have been on this committee for many years and took a hiatus, forced by circumstances, and glad to be back, the first one to mention the educational value of the observatory. So since there are no secrets in politics or in public hearings, I am sure there are a lot of folks who will be happy at your comments. And I thank you for that.

Mr. SURESH. If I could just add one comment to that just to put some numbers to that, the Angel Ramos Foundation Visitors Center attracts roughly 100,000 visitors per year at the facility. And so there is also not only a research component and an education component, there is also a public outreach component to excite people about it.

Mr. SERRANO. It is also featured in a James Bond movie. Did they get paid for that? I mean, what happens? I have always wondered when they use a facility like that, do we get paid for it?

Mr. SURESH. I have to look into that. I am not——

Mr. SERRANO. Yeah. And do they get like a piece of the action every time it is shown on the James Bond marathon, you know?

BROADENING PARTICIPATION IN THE STEM WORKFORCE

Mr. SURESH. Maybe that will convince a lot of young people to go into science.

Mr. SERRANO. It does. It does.

And staying on the issue that Chairman Wolf had brought up, I had always heard also that fourth grade is the key. In fact, prior to my State Assembly days where I was chairman of the Education Committee, I worked for the local school district and there were many people who sadly stated that if a child was not into school in terms of feeling good about going to school every day by the fourth grade that it was a serious problem. And it seems like it is so early. But by the fourth grade, if that child was not feeling good about going to school and learning and being excited by teachers and parents and the community that that child could be lost as early as the fourth grade.

There has been a lot of talk throughout the years and a lot of efforts by your folks to invite more African Americans and Latinos

into the math and science fields. And I know you have done a lot of work with that.

What is the ongoing issue there, and is there an interest first by government to invite those folks into the field and, secondly, is there a response from the communities?

Mr. SURESH. So there are a number of programs that NSF has under the broad category of broadening participation. And one of the critical things that we are going to face as a country will be the workforce issue for the future. We address one aspect of it.

And as I see it, there are three critical components to that workforce issue. The first component is going to be the representation of women in the future science and engineering workforce of this country. So that is about 50 percent of the population. They represent 40 percent in terms of early career scientists and engineers, but then from that point until a few years later, their representation in the workforce drops to about 26 percent. 2006 is the most recent year for which we have the data. Until we fix that, I think that component of the workforce is going to remain a problem.

I want to come back to the Hispanics and underrepresented minority issue, but I want to contrast that with the data that we have for women scientists and engineers.

In 2009, 72 percent of high school valedictorians in American high schools were girls, 72 percent, and that fraction is increasing.

In 2009, 20 percent more women graduated from college than men did and that difference is increasing.

In the last ten years in the U.S., we have seen a 10 percent increase in the number of Ph.D.s given in science and engineering across all fields. That entire 10 percent increase was due to women getting Ph.D.s in science and engineering. They represent about 40 percent now.

So all of this is very good news. So the good news is that women are increasingly coming into the science and engineering workforce. The problem is that they are leaving before their training and their expertise and wisdom could be tapped into for the country's benefit and for their careers because of a number of issues, complicating issues. One of the key issues is family issues.

So with respect to that segment of the population, we have excellent news with respect to entry into the science and engineering workforce, but not so good news with respect to retention.

MINORITY-SERVING INSTITUTIONS

When we go to African Americans or underrepresented minority populations in the country, Hispanics and Native Americans and so forth, we significantly lag both in the entry with respect to the representation in the population and also in the retention issue.

So I can give you some data from the last eleven years. It is not just one-year data. In the last eleven years, NSF support for minority-serving institutions has grown at double the rate of NSF support for all the institutions in the country.

The second data point that I can give is that in the same time period of eleven years, in dollar value, NSF support for minority-serving institutions has increased by 200 percent. So we are starting to do the right thing, but there is still a very long way to go. There are a number of activities that we can engage to do this.

HISPANIC-SERVING INSTITUTIONS

Just last week, I met with the president of Florida International University, which is the largest Hispanic-serving institution in the country. Two days later I met with the president of Texas A&M University, which is the second largest Hispanic-serving institution in the country. And they have a 90 percent Hispanic population in their community.

So we talked about ways in which those large institutions, which are Hispanic-serving institutions which receive NSF support, can engage the local community, the community colleges and what are the effective ways in which to do this. In fact, they are organizing a major event that will involve 80,000 people at Texas A&M University in September of this year which I will participate in.

So we are looking at different ways in which we can do this. We have $100 million allocated in fiscal year 2012 for community colleges and we can tap segments of those resources to minority-serving institutions and Hispanic-serving institutions.

We have a new program in the fiscal year 2012 budget for $20 million called Transforming Broadening Participation through STEM Education. And there are opportunities there also to target underrepresented minority groups and Hispanic-serving institutions.

Mr. SERRANO. Do I have time for one more?

Let me preface my comment by saying that, and I know Mr. Fattah shares this feeling with me, we have the utmost respect for our chairman. Our chairman is a fiscal conservative, but he is a fiscal conservative with a conscience and heart.

EFFECTS OF REDUCED STEM INVESTMENTS

There is a movement afoot this year, however, and I suspect for a couple of years to cut, cut, cut, cut. Having said that, I have been to 21 State of the Union addresses. And as a person from the south Bronx representing a poor district, born in Puerto Rico, I look for certain things. What is the President going to say about housing, social services.

This time, what stuck with me was not in any of those areas, but it is in your area. When President Obama said, yes, we have to balance the budget, we have to do this, but we have to invest in inventing things and creating scientists. And he said we Americans are good at inventing things.

And so without getting you on one of those cable channels tonight being, you know, insulted because you asked for more money or something, are we in danger here of taking many steps back if in the process of cutting, we do not give agencies like you the opportunity to create the next set of scientists or to create the next set of inventions or, you know, not just you but NASA and all those places that create? Where is the danger?

And, again, you are in front of a chairman who is not—you know, this man, he knows I mean this, has a great heart and he is truly a great American. But there are a couple of guys around here including some on my side who would cut everything to nothing, zero. If we keep going with these CRs, the last one we will have is zero as our number, you know.

What are we in danger of because, like I said, I always look for all these social issues? This time, the thing that stuck with me is he said we have got to invent. We can go back to being the leaders in inventing things and creating things.

Mr. SURESH. Well, thank you. Thank you for asking that question and for the opportunity to address it.

But before I start with that, I also want to express not only my personal appreciation but also the appreciation of the National Science Foundation for Chairman Wolf's strong support of science over the years and your commitment to science and STEM education.

In response to your question, I think one of the things that NSF has done right from the beginning, starting with Dr. Vannevar Bush's "Science, the Endless Frontier" report that led to the creation of the National Science Foundation, is to keep a focus on basic science as the engine of innovation for the country with a long-term focus.

And one of the things that we are particularly in danger of losing sight of in this economic climate is we have severe budget constraints, financial constraints, a nine percent unemployment rate, just below nine percent unemployment rate. But NSF investments are long-term.

If we take a short-term view and cut, I think five years from now, ten years from now when we address all the current problems, we will not be in a position to address what is needed for the country with respect to scientific leadership, with respect to economic leadership, with respect to military leadership.

I mentioned in my opening remarks that even in the short term, the National Nanotechnology Initiative started in 1999. NSF played a leading role in not only creating the National Nanotechnology Initiative but supporting it.

In just ten years, NSF funded nanotechnology centers have led to 175 startups involving 1,200 companies in the country. As recently as the mid to late 1990s, NSF supported two young students at Stanford whose work, purely mathematical work, led to the creation of Google.

So it is not just very long term. Sometimes it is very short term. In terms of long-term things, we supported GPS in the 1960s and the GPS research that NSF funded in the 1960s is now used in everybody's mobile phone for a variety of purposes.

So I think if we lose sight of the long-term focus as we react to the short-term needs of the country, I think it will come back to hurt us. So that is very much in resonance with what you said in your comments.

Mr. SERRANO. Thank you so much, Mr. Chairman.

Thank you for your service.

Mr. SURESH. Thank you very much.

Mr. WOLF. Thank you Mr. Serrano.

DEFICIT REDUCTION

I am going to go to Mr. Fattah, then I have a whole lot of questions. But I do want to comment. I appreciate the gentlemen's comments and your comments, and I agree. I think there is another

thing that I feel strongly about that I want to put on the record, because silence indicates just total acquiescence in everything.

There is another group that will be hurt, and it will be the poor. The poor will be hurt. It says in Proverbs 19, "when you give to the poor, you give to God." But there is another end to the story, and this is for those of you who are writing in the press out there. Until we deal with the issue of entitlements, Medicare and Medicaid and Social Security, this will continue. I think the President and this administration have been AWOL, they have been absent.

I agree with Mr. Serrano on the sciences, and I think I had one question which we will submit for the record about China. The Chinese government has been increasing scientific R&D investing as a fraction of GDP at an annual rate of more than 5 percent, which verifies what Mr. Serrano said. While they are starting from a smaller base, this level of commitment is enormous and we are cutting. We are really going to have to come together in a bipartisan way, and there is just no other way.

In fact, Mark Warner and Tom Coburn and Dick Durbin have put together a group in the Senate that is moving ahead. Some on the left are criticizing them for going after entitlements, and some on the right are going after them for raising taxes, but they are moving ahead. So I really think unless we deal with the fundamental issue of getting control of the entitlements, what Mr. Serrano said will be true. So I think I would rather see us get control. I made a speech on the floor of the House saying if the Simpson–Bowles package comes up, while there are some things I would attempt to change in the process as we go forward, I would vote for it. If Tom Coburn and Dick Durbin—both good people—can come together, then I would hope we can, too.

So we are waiting for the administration, we are waiting for the President. Until the President provides that leadership, I think both sides up here are going to continue to kind of clash.

You know, we have 50 million people that are on food stamps now. Our food banks are fundamentally empty, and as you go after these programs you are really taking food away from poor people. There is just no other way about it. Other people can adjust their budgets, but you have got to go where the money is. Willie Sutton said he robbed banks because that is where the money was, and entitlements are where the money is. So I want to see us plus up math and science and physics and chemistry and biology, and also the food banks and things, but I think we are going to have to come to agreement. We are reaching a tipping point, and Moody's said we will lose our triple A bond rating in perhaps 2012.

Following along on that, "Rising Above the Gathering Storm" stated that improving the nation's K through 12 educational system was the highest priority step we could take to improve scientific and technical competitiveness.

But I said I was going to go to Mr. Fattah. Let me go to Mr. Fattah first, and then I will go to this subject.

Mr. FATTAH. Now let us see, in the 1890s, in the midst of the conclusion thereabouts of the Civil War, we invested in land grant colleges in this country, Penn State and all of the other great land grant colleges. The Morrill Act, it kind of set a benchmark about the kind of nation we were going to be. Even in the midst of chal-

lenges we kind of knew that education and investment in education was critically important.

So yeah, I think that there is a consensus that with innovation in scientific research we are going to have to do more than we are doing. I agree with the chairman totally that we need a comprehensive resolution on the fiscal front, I am for voting for one. In fact there are five different ones, including the present debt commission and at different variations of revenue raising and spending cuts. I would vote for all of them. I think we need to get this to the side, get this resolved, because I actually believe it is a distraction.

First of all, I do not believe that we are not in a position as a country to pay our bills or that we have to be the largest debtor nation in the world. You know, there is a report today about billionaires holding trillions of dollars. There was a story last week about how a quarter of a million dollars was too little money to secure people to serve on boards of directors as a part-time job in our country.

I mean the notion that we as the world's wealthiest country cannot pay our bills, it really is defied by the facts. It is just that we for, whatever reason, have bought in as a generation that somehow we can have this on the cheap, that we can be in two wars, we can do all this other stuff and we do not have to pay for it.

And one of the largest hedge funds decided to remove from its portfolio all the U.S. debt, and that was reported this morning, and I think as we approach a crisis we will obviously react to it. The question is what damage are we doing in the meantime? And especially as we see our competitors. And they are not just economic competitors. Some of these other countries are not just economic competitors. We have to think about our national security and this is—you know, we cannot afford to be short sighted in these matters.

NEUROSCIENCE

But I want to go back to the point that the chairman was talking about, about what age young people—at what point is the concrete not yet hardened in which we can still have an impact on them? Because this whole area of neuroscience is something that the Foundation has spent some time on. It is the area that I have the greatest interest in, and I think that we have arrived at a tipping point in this whole area of understanding on the cognitive side. I mean you have the majority of a child's brain being developed in the third trimester, you have billions of neurons. We know that the brain is not being fully utilized, and I think that the Foundation has worked in this area.

First of all it has been extraordinary, but I know that we are going to do more working together in this area, because I think that this is an area on which we can have a very significant impact, looking at cognitive ability, and it ties into some of the other things that the chairman has said. We know that when we have people who are nutrition challenged and who are going to at some point deliver babies, that the size of the brain will be impacted. And you know, the size of the brain has a impact on ability long term.

So I also know that you have done some work looking at soldiers on the brain injury side. These are two separate subjects, but obviously they tie together. I think this work, if I am not mistaken, is really the largest amount of research looking at brain injury. And obviously we had our own colleague who was shot through the brain and we are watching her and praying for her full recovery.

So if you could talk a little about where we are in neuroscience, and this is my softball question. I am going to come back with a much more challenging one, but I know that you will be able to handle it.

Thank you.

Mr. SURESH. First of all I am delighted to answer that because as you know when we met last time this is a topic of a lot of interest to me. The interesting thing about neuroscience is we are at a point where we have the opportunity to understand the functioning of the human brain from so many different perspectives. From the biology perspective, the tissue level, at the cell level, at the molecular level. And NSF-funded work is about to look at all of those levels in new and interesting ways.

You know, we can take a single molecule and we can model it, pull it, push it, stretch it, twist it to forces of much, much smaller, a thousand times smaller than a nano level force, and those tools and technologies have come into existence very recently. This is why the National Academy of Engineering at the beginning of this century, when they released fourteen grand challenges for the 21st Century, one of the grand challenges for the community is reverse engineering the human brain. And the unique thing about NSF work is that we not only look at the biology of the human brain, we also study the psychology and the cognitive aspects of the human mind. And the combination of the two is absolutely necessary to address this issue.

So you mentioned traumatic brain injury. More than a quarter of the soldiers returning from the first Iraq war, the second Iraq war, and Afghanistan have some symptom of traumatic brain injury, plus we have sports injuries, automobile crashes, and that is an area that is a perfect example of a scientific field that brings together separated communities. For example, you take the war and improvised explosive devices. When there is an improvised explosive device, say some distance from a tank, and the device explodes and the stress wave created from the device hits a human head, that is an engineering problem. This is what our Engineering Directorate has funded since the 1960s and 1970s, engineers know how to do this. Once the stress wave hits the human brain what happens to the tissue and cell, that is the biology, and how being in that situation in the war zone being exposed to this and experiencing trauma is in the realm of cognition. And NSF is uniquely positioned to do this because we have done this for a long time.

And the U.S. Army Research Office, until recently I was part of a research grant that was funded by the U.S. Army Research Office, looked specifically at returning soldiers from our recent wars to see how we can put together medical doctors from Walter Reed with engineers and with clinicians in various hospitals in the Boston area and with psychologists and psychiatrists so that we can come together with the latest tools and technologies.

So on multiple fronts there is a challenge. In a completely different field there is even exciting opportunity. Computer science has progressed to such a point. As you know Watson from IBM won the Jeopardy championship not too long ago, and how do you take information storage and try to mimic that with respect to human cognition and human intelligence? And this is an area of great interest as well.

So I think these are all areas from multiple angles that we address at NSF with the exception of the medical part of it which NIH does.

Mr. FATTAH. Well, if you could—let me make this request formally. I am very interested, and I know the chairman is, in how we can make a non-incremental leap forward, and so if you have thoughts and if the Foundation can help us think through where there may be significant opportunities to penetrate in this area, that would be welcomed.

[The information follows:]

To make significant, transformative advances in our fundamental understanding of the brain we need to explore its many facets, including how the brain develops and adapts during the lifespan, how neuroanatomy relates to brain function, and how different brain areas and systems interact. However, progress toward realizing these advances requires 1) enhanced infrastructure and tools to better understand the working of the brain and 2) greater interdisciplinarity and large-scale efforts in order to gain a meaningful understanding of the brain within the broader physical and social contexts that would have real implications for learning, development, and health and recovery. Enhancing these will be necessary for accelerating the advancement of cognitive and developmental neuroscience.

Current technologies, such as functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and genomics, have led to transformational discoveries, but remain limited. For example, fMRI provides relatively high spatial resolution of brain structures but is inherently limited in its temporal resolution, which is needed to understand how the various brain structures communicate with each other. EEG provides high temporal resolution but does not provide detailed information about the location of cortical generators of neural activity. However, EEG has the advantage of allowing the subject to move relatively freely and thus can be used to explore brain-behavior relations in young infants. For instance, using EEG, NSF-funded researchers have identified patterns of activity in the infant motor cortex that are produced when an infant watches a video of someone performing a particular behavior. These results suggest that infants use some of the same brain regions both to perceive actions of others and to perform these actions themselves, a possible neurological link for learning new behaviors. The current technologies in neuroscience have already led to important scientific discoveries about the brain; however, there is much more to explore.

The limitations in current technologies and approaches are especially relevant to brain development studies. This is because some technologies, such as fMRI, require the subject to be still; thus it is very difficult to study children and infants. NSF has also invested in the development and use of noninvasive pediatric magnetoencephalography (MEG). This new technology has the potential to provide information about brain function and development with both the high spatial and temporal resolution that are needed, even with very young children and infants. Scientists at the Learning in Informal and Formal Environments (LIFE) Center at the University of Washington, Seattle are using MEG technology to monitor brain changes as pre-verbal babies are exposed to language. Intriguingly, it seems that more learning and organized brain activity takes place when human teachers are in the same room, versus video displays of the same instructors: MEG provides a promising new avenue, but currently there are less than a handful of such facilities in the United States. Neuroscientists must look further into the future at what remains unexplored, unknown, and undiscovered, and identify the tools that will lead to advancements. New analytical and computational methods for visualizing how brain activation data interact with behavioral and environmental data will also be necessary in this area. Research is also needed to evaluate the neural dynamics and connections within normally and abnormally developing brains; to follow patterns of plasticity and development; to map out strategies for developmental and edu-

cational interventions; and to monitor and assess brain activity remotely, while a person actively moves and interacts with the surrounding environment.

In addition to improved measurement technologies, scientists need access to better data and data infrastructure—including longitudinal data—to better understand brain development, learning, and plasticity. While many aspects of brain development are complete by the end of the first few years of life, we have learned that important physical aspects of brain development—especially frontal lobe development—continue through adolescence and into adulthood. The frontal lobes have long been associated with "impulse control," something that adolescents exhibit less of than older adults. Understanding how the brain continues to develop and adapt beyond adolescence is particularly important for dealing with traumatic brain injury (TBI), especially as it affects U.S. war fighters who are in young adulthood. In order to understand the brain in more detail, much finer grained analyses are needed, on how particular regions of the brain develop, as well as how the connections and interactions between these areas emerge over the lifespan. Vast data archives such as collections of brain images are needed to fully understand brain functioning and links to cognition and behavior. Innovations in data infrastructure for shared access, interoperability, and data mining techniques will greatly contribute to developmental and brain science.

Neuroimaging technology, no matter how advanced, will not be sufficient to understand how the brain functions within the context of our complex, demanding, social world. Brain science must be fundamentally interdisciplinary, integrating knowledge, methods and technologies from behavioral and cognitive science, neuroscience, engineering, computer science, mathematics, and physics. The next big steps in understanding the brain will require teams of scientists who explore the human mind from many different perspectives. Understanding how the brain develops and adapts over the course of a life is particularly complicated because of inherent interactions between physical, cognitive, behavioral, and emotional changes. Thus, fundamental research on human cognition, perception, social interaction, development, learning, decision-making, and language is needed to support the goal of understanding the brain. Mechanisms such as NSF's Research Coordination Networks have great potential to bring disparate groups of scientists together as a coherent team to tackle important issues.

With advanced knowledge and technologies, enhanced data and data infrastructure, and the collective expertise of newly-formed interdisciplinary teams of scientists and engineers, the U.S. can take advantage of fast-emerging, ground-breaking work in areas such as brain plasticity and brain-computer interface, to make significant advances in our understanding of neuroscience and development.

SCIENTIFIC DATA DISSEMINATION

And finally let me get to my last question for the day. Holding two opposing views at once is what I think the president of Morehouse says is what a first-rate mind is all about, so let me pose two very different viewpoints to you.

One is we have this intellectual curiosity and we also have this kind of notion in which we have this openness in which not only are we doing research, but through NSF this information is then made public after eighteen months in most of your grants, is made public and is available for the entire world to see. I am a little more parochial, at least as it relates to information that is important for our economic prosperity or our national security or cyber security. The idea is that as taxpayers we make an investment of significant sums, and I believe hopefully many more significant sums as we go forward. But how do we reconcile this need to get this information, our own national interest in manipulating and utilizing the information, with this notion of scientists who want to share it freely with the world.

So I am trying to figure how you reconcile that, and it would be helpful for me to hear you respond to that.

Mr. SURESH. I think you raise a very important issue, in fact aspects of this were very much on my mind, all very much on my

mind now in my current job, but also a big part of the things I had to do in my previous job.

You mentioned earlier, when you had the testimony from the Patent Office, the critical need to change patent policies and IP rights and so forth. I think that is a very critical step. Increasingly many universities are filing for intellectual property and having an efficient process that enables innovation to go to the marketplace through filing for patents. Efficient processing of these patent applications and protections that they provide is very critical.

But at the same time science on a global scale has always been an open entity. And the reason it is open is because we have people come up with ideas, it is peer reviewed in the community, and if it is accepted for publication it is not immediately accepted until somebody else can duplicate it. Increasingly that somebody else may not be within the U.S. boundary, it could be a scientist from a different part of the world as more and more other countries increasingly invest in science and engineering.

So given broadening of participation on a global scale into the science and engineering research enterprise, I think your question puts the finger on how do you keep science as open as possible as we have done, which is very good for knowledge creation on a global scale, but how do you keep the boundaries tight?

So I think there are a number of things we can do. One could be addressing the issues of intellectual property processes and making them as efficient as possible so that we give scientists the opportunity to protect their intellectual property without being secretive about it, so that the scientific process can move on. That could be one part of it.

The other part of it, equally important part, could be that as other countries, especially developing countries, start to invest more and more in science and engineering, we have been the beacon for science and engineering for so long it is very important that we do everything possible to convince our international partners to come up with the minimum level of scientific integrity, ethics, and openness that is necessary for science and engineering. There are things that NSF can and should do to do that. We have done the merit review process for the last 60 years and the people around the world, my counterparts in Europe and Asia, they feel that the NSF system is sort of the gold standard. It is important for us to insure that other countries, especially rapidly developing countries, develop a level of merit review and set of standards for selecting scientific proposals, funding scientific proposals, insuring the integrity of the process—they come up to speed. I think it is very important.

So we have started some very preliminary conversations with counterparts in other countries. So there are many things we can do. There is no one particular solution.

How we deal with issues of cybersecurity is very critical. At the same time in the spirit of an open government when we spend taxpayer money, how do we make our research output accessible definitely to all Americans, and most probably to the broader scientific community.

So I think these are all issues that we need to address in tandem to make sure that we address the conflicting issues that you raise in your question.

Mr. FATTAH. Well, it is going to be a challenge as we go forward, and I will not belabor the point. We have another agency under the jurisdiction of the committee, which is the International Trade Commission, and they spend a lot of time litigating issues around IP violations for products coming into the country. The notion before was if you built a mousetrap, I think it was said, you could make your home in the woods and the world would make a path to your door. The problem now is if you make a better mousetrap and put it up online people are going to make it before you can make it, and make money off of it.

And so we are in an economic battle. We have national security issues. Basis scientific research is at one level of our ammunition in this kind of a battle that we are in and we have to think about—and I do not know how we reconcile it. I think it is just a very important issue obviously because again science by its nature is not science unless you can replicate it, and you have to publish it. And so it gets to some very important issues, but we do want to protect the public's investment, and American taxpayers are investing to make sure that America wins and we have to figure how, under these circumstances, we go forward.

Thank you.

Mr. WOLF. Thank you, Mr. Fattah. I have a number of questions, but I do want to follow up.

USE OF HYPERBARIC TECHNOLOGIES

I would appreciate it if you could have your staff put together within a week any information you have on hyperbaric treatments. I went to a conference a while back with regard to hyperbaric treatments for returning vets. Some doctors I have talked to about hyperbaric treatments for a brain injury are not even sure what I am talking about. I think it is kind of a voodoo, others say it has been so successful. So if you could give us the information. I am not asking you to go out and do new research, but perhaps everything you have with regard to hyperbaric applications on brain injuries, on multiple sclerosis, on all the different treatments. Just so we can process it.

[The information follows:]

NSF reviewed its awards made over the past 25 years and identified only one that merits attention to the Chairman's direct question. This three-year award totaling $418,000 was made in 1999 to the University of Southern California to "increase understanding of the basic mechanisms involved in communication between nerve cells in the brain." A link to the award data and abstract follows: *http://nsf.gov/awardsearch/showAward.do?AwardNumber-9818422*

PROTECTING SCIENTIFIC INTELLECTUAL PROPERTY

Secondly, if you would work with the committee to do what Mr. Fattah asked. You really cannot be Pollyannish about the whole thing. You could not trust Hitler, you could not trust Stalin, you could not trust Mao, and you cannot trust Hu Jintao. It is just a fact. The Chinese are going to take this information.

So if you have some ideas within two weeks, send up information that sort of follows along the lines of your exchange with Mr. Fattah. Then we can begin to look at the PTO and changes. Maybe it will be Mr. Fattah and I fighting off the Republicans on the floor, but on this issue I think we are together. I want to create jobs and protect the national security.

I had a person come to my office the other day showing me once Permanent Normal Trade Relations passed to China, the trade imbalance just collapsed, the job loss collapsed. There is a picture of me with Bill Clinton speaking at a joint session opposing giving Most Favored Nation Status to China. I got up and applauded, and my Republican colleagues are looking at me like I am crazy. Then the President flipped, and now China is stealing from us.

So if you can give us some ideas before we mark up the bill along the lines of what Mr. Fattah said, I would appreciate it, because I completely agree with him.

[The information follows:]

A fundamental responsibility of NSF is to ensure the widespread dissemination of the results of its investments, while also protecting the intellectual property and proprietary information associated with NSF-funded projects.

Below are some of the ways that NSF currently protects the content of awarded proposals, which may contain confidential, proprietary information.

Release of Funded Proposals

Awards are publicly announced only after the Grants and Agreements Officer has signed the award and the organization has been formally notified.

Awarded grant proposals (including award notices) are available to the public, subject to Freedom of Information Act (FOIA) exemptions protecting confidential commercial information, personal privacy, and NSF's decision making process. Copies of awarded proposals are provided to requesters according to the procedures and subject to the limitations described below.

Procedures for Releasing Funded Proposals

- Requests for funded proposals are handled by NSF's FOIA Officer in the Office of the General Counsel (OGC) in conjunction with the appropriate Program Office.
- OGC personnel automatically remove any personal information from the proposal under exemption 6 of the FOIA (see Limitations-Personal Information, below).
- OGC personnel also contact the submitter to provide him/her an opportunity to request withholding of proprietary information contained in the proposal (including potentially patentable subject matter, information that would provide unfair advantage to a competitor, etc.) under exemption 4 of the FOIA (see Limitations-Proprietary Information, below).
- Requests for documents in awarded proposal files other than the proposal itself are coordinated by the FOIA Officer.

Information Routinely Released

The following information in NSF proposal, award, and related records is routinely released to all requesters because it is not withholdable under the FOIA:

- the identity, business address, and business phone number of an awardee (PI or Co-PI, and/or Organizational Representative) receiving funding from NSF for a particular award (the identity of unsuccessful proposers is not released);

- titles, proposal numbers, NSF program(s), award amounts, and duration of any awards for which a particular individual is the PI; and
- name, title, business address, e-mail address, and phone number of an NSF employee.

Limitations on Release - Personal Information
The following information routinely will be removed by the FOIA Officer before release of proposal(s): Social Security Number, individual salaries and salary rates; pending support; gender; race/ethnicity; citizenship; disability; and any other information that is personal to the submitting individuals (frequently found on resumes or vita) such as date/place of birth, marital status, dependents, home address, and home telephone number.

Limitations on Release - Proprietary Information, Including Description of Inventions
Some proposals contain descriptions of inventions that, for a variety of reasons, may not be recognized as such or may not be shown to have commercial potential until after the proposal has been submitted and an award made. To ensure that valuable US and foreign patent rights are not adversely affected, NSF prohibits disclosure, except for evaluation purposes, of portions of proposals that describe inventions until a reasonable period of time has passed for the filing of a patent application.

A submitter may indicate (either upon initial submission or after notification by NSF of a request for an awarded proposal) that descriptions of inventions or proprietary or patentable information should be withheld. When contacted by NSF, the submitting PI must specifically identify the pages (or portions of pages) of the proposal that contain the descriptions or proprietary information and describe how release would be harmful. NSF is obligated under the FOIA to determine when the proposed withholding is justified by the exemption for proprietary information. NSF staff will review the justification for the withholding to determine if the agency agrees that the information should be withheld.

Information found to be privileged will be held in confidence to the extent permitted by law, including the FOIA.

NSF reviewers are given the following instruction:

Your Obligation to Maintain the Confidentiality of Proposals and Applicants.
The Foundation receives proposals in confidence and protects the confidentiality of their contents. For this reason, you must not copy, quote, or otherwise use or disclose to anyone, including your graduate students or post-doctoral or research associates, any material from any proposal you are asked to review. If you believe a colleague can make a substantial contribution to the review, please obtain permission from the NSF program officer *before* disclosing either the contents of the proposal or the name of any applicant or principal investigator.

With regard to the broader question of scientific findings, the amount of time given to each NSF-funded researcher in order to protect scientific intellectual property varies by field. NSF values the need for researchers to publish their findings in peer-reviewed journals, but recognizes that this process can take time. All NSF sponsored activities must provide data management plans as part of the merit review process.

NSF's general grant condition number 41 establishes the agency's policy for communication of research results.

> **Sharing of Findings, Data, and Other Research Products**
> a. NSF expects significant findings from research and education activities it supports to be promptly submitted for publication, with authorship that accurately reflects the contributions of those involved. It expects investigators to share with other researchers, at no more than incremental cost and within a reasonable time, the data, samples, physical collections and other supporting materials created or gathered in the course of the work. It also encourages grantees to share software and inventions or otherwise act to make the innovations they embody widely useful and usable.
> b. Adjustments and, where essential, exceptions may be allowed to safeguard the rights of individuals and subjects, the validity of results, or the integrity of collections or to accommodate legitimate interests of investigators.

Below are additional ways that NSF strives to strike the proper balance between open access and limited proprietary use by researchers.

Open Government: Facilitating the free flow of scientific and technological information and maintaining open communication are critical to NSF. NSF participates in the Administration's Open Government Initiative and launched an Open Government Web page in February 2010 (www.nsf.gov/open). A period of public engagement with the IdeaScale tool followed, and NSF published its first Open Government Plan in April 2010. Since then, NSF has updated the plan in response to public comment, external audit results, and corrections/additions. NSF continues to publish high-value datasets such as information on Freedom of Information Act requests, Graduate Research Fellowship Award recipients, and NSF funding rates.

Spending and Results: NSF supports Research.gov, a portal that provides information on research spending and results. Led by the NSF, Research Spending & Results gives the public, the scientific community, and Congress insight into federally funded research. Research Spending & Results provides information about how federal research dollars are being spent, what research is being performed, and how the outcomes of research are benefiting society as a whole. Anyone can easily access, search, and sort information in new ways through Research.gov. Currently, information is available for NSF and NASA awards.

Data Sharing: NSF has had a long-standing policy on data sharing: investigators are expected to share with other researchers, at no more than incremental cost and within a reasonable time, the primary data, samples, physical collections and other supporting materials created or gathered in

the course of work under NSF grants. To clarify the data sharing policy, NSF updated its grant proposal guide in January 2011 to require that all proposals describe plans for data management and sharing of the products of research, or assert the absence of the need for such plans.

Research Outcomes for the Public: Effective January 2010 NSF requires investigators to complete a brief summary, specifically for the public, on the nature and outcomes of their NSF-funded award. The Project Outcomes Report will be published on Research.gov and will be accompanied by the following disclaimer:

> "This Public Outcomes Report for the General Public is displayed verbatim as submitted by the Principal Investigator (PI) for this award. Any opinions, findings, and conclusions or recommendations expressed in this Report are those of the PI and do not necessarily reflect the views of the National Science Foundation; NSF has not approved or endorsed its content." (Proposal and Award Manual, Chpt. XII, B.3.)

NSF plans to enforce this reporting requirement in the early part of FY 2012. If an investigator fails to submit a Public Outcomes Report, the project is not eligible for any additional awards from NSF, nor will the project be eligible for supplements, no-cost extensions or grant transfers until the report is submitted.

SUPPORT FOR K–12 STEM EDUCATION

I am going to go about maybe ten minutes, and then we will go to Mr. Culberson. We have a series we have to cover here. "Rising Above the Gathering Storm" stated that improving the nation's K through 12 educational systems was the highest priority step we could take to improve our scientific and technical competitiveness. Your budget request, however, de-emphasizes the development of K through 12 capabilities. In fact, the budget proposes to decrease K through 12 programs by 15 percent from 2010. Do you believe that a request at this level reflects a significant focus on K through 12 STEM education as envisioned by "Gathering Storm"? Why are you making cuts in virtually every one of the K through 12 programs?

Mr. SURESH. Well, let me offer a couple of points related to that. Increasingly NSF's participation in education activities, especially STEM activities, are not just confined to EHR. They are part and parcel of every part of every directorate, every office across NSF, including K through 12.

For example, the Directorate for Engineering funds a program called UTeachEngineering in Texas, and that program has been very successful for K through 12 students in exciting them about the opportunities in engineering at a very early stage. There is the GEO Teach program that does similar things in our Directorate for Geosciences. So there are various activities that we can engage in. A number of directorates participate in activities beyond it.

So the budget numbers just for one or two directorates do not necessarily mean that our commitment to K through 12——

Mr. WOLF. But the budget is the budget, and it proposes to decrease K through 12 programs by 15 percent from the 2010 level.

Mr. SURESH. So one of the things we are looking at is the following: There are three new programs that are going to be put in place for this year. We have a new program, Teacher Learning for the Future, and what it tries to do is to take the best practices for some of the programs like GK–12, programs like Math and Science Partnership program and also the Noyce Teacher Scholarship program and so forth, bring them together in a much more cohesive way so that we can look at what new opportunities we can provide in concert with other offices and directorates across NSF.

So the numbers just in those program buckets may not fully reflect——

Mr. WOLF. They do not look good. They do not look good.

Mr. SURESH. No, but this does not indicate any wavering commitment on our part for K through 12.

Mr. WOLF. Someone once said "if you really want to find what a person is committed to, look at their checkbook." Words can be one thing, but who they write their check to and what they are spending money on are something else.

I want you to develop it a little bit more. The President's Council of Advisors on Science and Technology released a report last year on K through 12 STEM education. One of its finding was that the NSF K through 12 portfolio is not optimally balanced between programs that support basic education research and those that support the development and implementation of scalable practical education solutions. How do you respond to that criticism?

NSF AND DEPARTMENT OF EDUCATION COLLABORATION

Mr. SURESH. So as you know the PCAST report also referred to ways in which NSF and the Department of Education can work together better.

Mr. WOLF. That was the next question.

Mr. SURESH. Yeah. And also with other agencies.

So the first thing I have done is I am co-chairing an NSTC committee on STEM education along with the OSTP deputy director. And this committee met last week and we are looking into ways in which NSF can play a critical role in STEM education. In fact we will be looking at ways in which we can respond to the PCAST report and also to the America COMPETES Authorization Act language.

Mr. WOLF. Well, they recommend the creation of an advanced education research agency to be headed either by NSF or the Department of Education. Is that something that you are looking at? Do you support that recommendation?

Mr. SURESH. We will work very closely with them when it is approved and comes into existence. There are a number of activities that we are already engaged in with the Department of Education that will position us very well for this new activity.

For example, I mentioned the NSTC subcommittee that was just set up.

Mr. WOLF. But do you support that recommendation?

Mr. SURESH. I think anything we can do to work with other agencies——

Mr. WOLF. Pretty good, you can duck these issues sometimes. The question is, do you support it? It's ok if you want to think about it, but we would like to know if you support that or not.

Mr. SURESH. I think the spirit of this is very good and I would want to make sure that it is supported with the right resources so that it can be successful.

GAO STUDY ON TEACHER TRAINING PROGRAMS

Mr. WOLF. Well, of course. How did you fall out in the GAO study on teacher training that came out last week about duplications between NSF and others? What are your comments about that? Have you read that?

Mr. SURESH. Yes, and in fact Mr. Bonner asked that question.

Mr. WOLF. Well, if he did for the record, then we won't.

Mr. SURESH. Yes.

Mr. WOLF. And your comments about it?

Mr. SURESH. So I have looked at it. In fact there are various programs. NSF has been engaged in this as you know very well for the last several decades and we are continually looking at programs that could be duplicative and try to see what we can do to improve that. In fact there are a number of realignments of programs within EHR currently, specifically with the objective of looking at what is new and what may be done by somebody else so we do not duplicate those things.

Mr. WOLF. Well, we have to do that. I just lost a little confidence in the fact that NSF could not do a basic study on best practices on education. Then I hear about studies and meetings, just meeting

and meeting and meeting. And what happens? Zero. Two years go by.

You are a good witness, and you explain what you are doing, but we want to see more action because this nation is slipping. What are we in math now? Where do we fall in math? What number are we in math for the world?

Mr. SURESH. I think it depends on fourth grade level or eighth grade level, and by some studies we are number twenty and some studies among developed countries——

Mr. WOLF. So what do we do to deal with that issue? And what best practice was working in Philadelphia, was working in Richmond, or working in some other place? The teachers are over worked and they cannot gather all that information. That is your job. So the fact that it took two years and we are still in the process of finding the answer is troubling. You are new, so I do not think you should feel too defensive about it because you have only been on there for four months. But we want to see, not just the verbiage and the rhetoric, but the actual reality of what is going to be done.

Mr. SURESH. So I very much not only appreciate your question, but also your commitment to this topic. So as I mentioned earlier——

Mr. WOLF. Well, we are getting ready to go into decline. The nation is ready.

Mr. SURESH. Absolutely, if you are not careful.

Mr. WOLF. The 20th Century was the American century, and we want the 21st Century to be the American century, not the Chinese century. That is what we are dealing with, and time is critical.

AWARD OVERSIGHT

NSF is increasing the number of grants it makes each year without making corresponding increases in the programs responsible for monitoring grantee compliance. This has caused reductions in basic oversight activities like site visits and increases the likelihood that grantee waste, fraud, or abuse will go undetected.

This year's budget request again proposed an increase of more than 2,000 research grants, but with no apparent increase for award oversight. How will you ensure that each of these new grants receives the appropriate level of monitoring and scrutiny with a static grants management budget?

Mr. SURESH. So one of the reasons for the decrease in last year with respect to site visits was when NSF received $3 billion in the stimulus package funding without any increase in staff, it really strained the system, and now that we are moving away from the impact of the stimulus funding it is our intention in every way to make sure that this oversight is maintained.

The second thing that I have already launched a pilot program for this coming year, where we will look at employing new technology so that site visits can be done using a variety of ways while insuring confidentiality of the process.

For example, we do not necessarily have to fly across the country for a site visit, and there are ways of engaging technology that we could do much more than we have done on the past.

Mr. WOLF. Teleconferencing.

Mr. SURESH. Videoconferencing, but engaging multiple communities. And so we are launching several pilot projects this year for different types of reviews, and our hope is that it will not only lead to better efficiency internally for NSF, it will also lead to engaging the best referees from the community.

Mr. WOLF. Are there some grants that you have looked at afterward and you say, "wow, that was a waste of money. Boy, we really got taken."

Mr. SURESH. Well, actually without spending a lot of money we can do a lot more. For example, we have a Cisco system on loan that we are going to try and see how it works before we spend any tax dollars to buy it or acquire it. There are other things we can do, and hopefully in the future NSF will have the latest technology.

Mr. WOLF. Are there some grants that your staff has come in and said, "Doctor, look at this. We put all this money out and we got garbage back," and you say, "oh my goodness gracious." Are there many like that?

Mr. SURESH. Fortunately because of the merit process we do not have that, but if by human error or some other factor if we have one of these we have mechanisms in place for periodic review. So even a five-year grant is not given without any conditions attached to it.

Mr. WOLF. How many have you pulled back?

Mr. SURESH. I do not have the exact number, but I can get that to you.

MECHANISMS OF AWARD OVERSIGHT

Mr. WOLF. If you would. What kind of evaluations do you conduct on the work of your grantees to ensure that they are not just executing the grants in compliance with financial terms and conditions but also achieving probably the most important thing—significant program outcomes?

Mr. SURESH. So we have annual grantee conferences in most of the areas where they not only report to the program officer or program director, they report to the peer community. In fact these grantee conferences are tracked, hundreds, in some cases many hundreds of scientists, so a scientist has to stand up and defend their NSF funded work in front of other scientists, and if the quality of the science is not good enough they will get shot down in public. So that is one mechanism. The other mechanism is peer reviews. The other mechanism is site visits, reverse site visits.

So we have a number of mechanisms in place. An annual reporting requirement and so forth.

Mr. WOLF. Do you think they have all been successful? Are you about where you think you should be?

Mr. SURESH. Well, if they are not successful, if they are not meeting a particular goal, they will be terminated.

Mr. WOLF. So you are going to give a list of who has been terminated and under what conditions?

Mr. SURESH. I will get that data for you.

[The information follows:]

In response to the Chairman's question, below is detail on all awards terminated by NSF in fiscal years 2010 and 2011 as of March 21, 2011. Three were terminated in FY 2010 and five were terminated as of March 21st in FY 2011. All termination actions were consistent with NSF's *Proposal and Award Policies and Procedures Guide* and the *Award and Administration Guide*, Chapter VII.

Award Date	Termination Date	Awardee	A ard Title	Reason for termination
6/24/2009	04/02/2010	Inframat Corp.	STTR Phase I: Spray-On Nanostructured Metal Oxide Films for Efficient Solar Energy Conversion	Management Action based on OIG Recommendation
04/07/2008	07/21/2010	University of Notre Dame	A Practical Approach Multi-User Channels with Unknown Fading	Management Action based on OIG Recommendation
07/17/2008	07/21/2010	University of Notre Dame	Signal Processing for Digital Analog Interface	Management Action based on OIG Recommendation
07/07/2009	11/16/2010	Advanced Photonics Group	SBIR Phase I: Multi-target, Multi-spectral Explosives Detector	3 Time ARRA Non-Reporter
07/16/2008	11/30/2010	Innegrity LLC	SBIR Phase II: Low Dielectric Fiber for High Frequency Circuit Board Applications	Management Action based on OIG Recommendation
11/10/2010	12/06/2010	Trellis Engineering LLC	SBIR Phase I: Improved Sigma Delta Modulators for Radio Frequencies	Management Action based on OIG Recommendation
07/29/2009	01/12/2011	Veritas CNC, Inc.	SBIR Phase II: Intelligent Tool Wear Monitoring	Management Action based on Non Compliance w/ SBIR terms and conditions, Management and OIG coordination
08/27/2010	03/07/2011	The College of Idaho	Boone Science Hall Renovation	Concerns with Section 1606 ARRA Compliance (Davis-Bacon), no expenditures authorized by NSF, awardee requested that NSF terminate award by mutual agreement

ICEBREAKING SERVICES

Mr. WOLF. Okay. The 2012 budget discontinues the annual transfer of funds from the NSF to the Coast Guard for the operation of Coast Guard icebreakers. While this does relieve pressure on the NSF budget, the DHS Inspector General has suggested that the Coast Guard may be less willing to task its ships for NSF use if NSF is not holding the purse strings. Are you concerned about this?

Mr. SURESH. So obviously the Polar program is a very important part of NSF's activities, so we have three Coast Guard ships, icebreakers that we have had access to. Healy in the Arctic Ocean, and then we had Polar Sea and Polar Star in the Antarctic sites. Now as you may know one of the two has been retired, decommissioned, and the other one needs refurbishment before too long.

So what we have done is we have engaged the Swedish icebreaker Oden to make up for any gaps that may arise. We are continuously working with the Coast Guard on this, and also if necessary we will renegotiate a continuing agreement with our Swedish counterparts for the Oden while we are looking into the long-term implications of this.

Fortunately the lack of availability of either Polar Sea or Polar Star has not had any detrimental effect on our Antarctic operations.

Mr. WOLF. But if you are not paying for it——

Mr. SURESH. No, we will reimburse the Coast Guard for costs involved, and we have been in continuous conversation with the Coast Guard on our needs and their requirements as well. So far it has not been an issue. The director of our Office of Polar Programs, Karl Erb has been in constant touch with them. In fact just last month he was in Sweden to discuss this, he has been in touch with the Coast Guard, and this is something we will continuously monitor.

Mr. WOLF. So basically the U.S. domestic icebreaking capabilities are in decline. If we cannot break ice with our ships, that is decline. Now we have to rent a ship or lease it. We love Sweden, for the record. They are wonderful people. But we have to rent from Sweden? We are a maritime nation, look at the map. Yet we have to rent it out from Sweden? Just for the record, we are not blaming you. Is that what we do? Are we renting this out from Sweden?

Mr. SURESH. So this is only a temporary measure, this is not the long-term solution to this issue. So we are looking at what needs to be done to refurbish——

Mr. WOLF. How long will that take?

Mr. SURESH. They are continuing to look at our needs. Probably within a year we will have an idea.

Mr. WOLF. An idea. So we will be using the Swedes for how long, honestly? You are not under oath.

Mr. SURESH. My estimation is that for the coming year we will be relying on the Swedish.

Mr. WOLF. So next year you will not need Sweden?

Mr. SURESH. We do not know that yet, but this is what is being accessed right with respect to the refurbishment of one of the Polar icebreakers.

Mr. WOLF. I think that goes into what we were talking about. I mean, I think it is a——

Mr. SURESH. So we also commissioned another vessel for which the keel laying ceremony will be held in April, but that is a shallow depth icebreaker, so it can go only up to three feet or so, not the twenty feet or so that we need, so that is more of a research vessel than the icebreaker capability for the Antarctica.

NSF TRAVEL FUNDS

Mr. WOLF. Okay, we have a number of questions on the icebreaker that we are going to ask you for the record. I have a few more on contracting, then we will go to Mr. Culberson.

NSF funds travel, meetings and incidental expenses for thousands of technical experts each year. Can you tell us your travel budget for the last three or four years, and then based on the new technology that you were talking about, teleconferencing and videoconferencing, what you think it will be in 2012? If you can show us trends in 2009 this was it, 2010 this was it, 2011. Now in 2012 we are doing these dramatic things, teleconferencing, video conferencing. What do you think the budget will be so we can actually see that there is an honest savings.

And with that, can you provide how many trips were taken both by NSF people and contract people in 2009–2012 so we can see again if there has been an honest drop or there has not.

Mr. SURESH. We will get that information to you, Mr. Chairman.

[The information follows:]

In a typical year, 18,000 to 20,000 external, technical experts serve on NSF's merit review panels. As a steward of federal dollars, NSF is always seeking ways to reduce costs and maximize resource usage. Currently, NSF is in the process of implementing changes to the administrative aspects of its merit review process that will yield savings for the Foundation by leveraging teleconference and video conferencing technologies as well as revising its travel policy to encourage the usage of non-refundable airline tickets.

Current Use of and Future Plans for Teleconference, Video Conference, and Virtual Technologies

NSF has used virtual technologies to conduct business for the last ten years. As the following table illustrates, customer demand for and use of virtual tools has increased in each of the most recent fiscal years. The percentage of virtual participants engaged in merit reviews has increased from 2.8 percent in FY 2008 to 4.1 percent in FY 2010. Even at these modest levels of virtual technology use, NSF avoided panel travel costs of approximately $400,000 in FY 2010.

Panel Reviewers and Virtual Panel Participants FY 2008 – FY 2010

	FY 2008	FY 2009	FY 2010
Number of Panel Reviewers	17,261	17,963	21,009
Number of Panels with at least one Virtual Participant	292	286	319
Total Number of Virtual Participants	491	636	865
Virtual Participants as a Percent of Total Panelists	2.8%	3.5%	4.1%

With the advent of more and easier-to-use virtual tools, NSF is planning to expand its capabilities in this area and is currently gathering information on the best tools to use for its business processes. A more robust program will enable NSF to broaden panelist participation, increase collaboration, and save NSF time and expense. Assuming that an expanded virtual technology program is implemented to enable increased usage, NSF will aim to have more panelists participate virtually rather than travel to NSF headquarters. Given the average panelist transportation cost of $500, significant savings could be realized over the longer term. NSF also expects to realize savings from increased virtual usage for other meeting types such as advisory committees and site visits.

Use of Non-Refundable Airline Tickets

In FY 2009, a pilot program, on an optional basis, was conducted to determine the costs and benefits of issuing non-refundable tickets for panelist travel. Findings from the pilot data indicates that NSF could potentially save $2.0 million annually with this policy change.

NSF Panel Travel Costs and Number of Trips

	FY 2008 Omnibus Actual	FY 2009 Omnibus Actual	FY 2010 Omnibus Actual
Panel Travel Costs (dollars in millions)	$8.16	$11.71	$11.56
Number of Panel Trips	13,792	15,646	17,461

NSF CONTRACTING

Mr. WOLF. GAO has questioned whether NSF is overly reliant on cost reimbursement contracts, which are risky and costly to administer, and suggested that NSF could transition some of its current contracts to firmer pricing terms. Do you agree that NSF could conduct more contract work under fixed price vehicles?

Mr. SURESH. Obviously the fixed price gives us upfront knowledge of what the commitments are. As you know NSF instituted a no cost overrun policy three years ago for all of our major research equipment and facilities contracts, but the nature of the work for different projects is so very different. Sometimes design changes need to be made during the process for scientific and technical reasons and that has led to some adjustments that are being made.

I am aware of this issue and in fact we have started an internal conversation on how we can address this, keeping in mind that we want the best technology and the best capability to emerge within the confines of our constraints and our policies.

Mr. WOLF. Okay. I am going to Mr. Fattah to see if he has any last questions.

Mr. FATTAH. I am good.

Mr. WOLF. Okay, fine.

Mr. FATTAH. Thank you, Mr. Chairman.

Mr. WOLF. Mr. Culberson.

K–12 STEM EDUCATION REPORT, CONTINUED

Mr. CULBERSON. Thank you, Mr. Chairman, and my apologies for running so far behind, I have got everything happening all at the same time here this morning.

We are all, as the chairman and I know Mr. Fattah has told you, committed to support the NSF and your role is so critical in preserving our leadership as a nation in years to come, you are as an important strategic investment as we have, and Chairman Wolf is exactly right about the importance particularly of science and engineering education.

You really do not have to go very far Mr. Chairman or Mr. Fattah, the Thomas Jefferson High School for Science and Math is about eight miles away from your headquarters. You all are in downtown Arlington, right? Everyone, every study, every analysis that I have seen done of public high schools in America uniformly ranks the Thomas Jefferson School for Science and Math number one in the nation. There is your best practice model.

And I have to tell you I am really disappointed and profoundly disturbed that you were floundering around trying to answer the chairman's very simple question of where is best practice and how do you find it. It is eight miles away. I do not understand, I mean there it is.

Mr. SURESH. Well, we will include all the right models in the report that we will give you and the community, including best practices from anywhere.

Mr. WOLF. Have you been out there?

Mr. SURESH. I met with the principal of Thomas Jefferson School.

Mr. CULBERSON. Well, meeting with them is one thing. You know, we are devoted to you guys. I have to tell you that your testimony and the report of the Inspector General kind of alarms me. We're concerned about making sure that the NSF—that you almost have to be like Caesar's wife—and the responsibilities that you have to insure that, as Mr. Fattah and the chairman quite correctly point out, that you are protecting the vitally important national security information for economic reasons and for the nation's security. I am confident the chairman asked you before I came in about Chinese nationals.

Mr. SURESH. Yes.

Mr. CULBERSON. I hope you are going to respond promptly and thoroughly to his request, because that is really, really disturbing.

The report I have you, Mr. Chairman, that General Mattis prepared, pointed out that there are more People's Liberation Army graduate students in U.S. graduate schools than I think from any other nation. That is a real concern, and to the extent that we want to make sure NSF is protecting vital information from the Chinese, but obviously, in your response to the chairman's questions, you are not focused on STEM education, you are creating all kinds of new programs and initiatives in your testimony, but dropping a couple. You are on page seven recommending terminating or reducing the graduate STEM fellows and the national STEM distributing learning program.

I recall a couple years ago that there was a bill that President Bush pushed that I think actually passed in some form that I remember it. When it came through, Mr. Chairman, several years ago, I see some heads nodding. The bill transferred responsibility for STEM education from NSF to the Department of Education. Does anybody remember that? Wasn't there some statutory change that shifted this responsibility?

Well, who has primary responsibility for developing, establishing, and identifying a best practice, which is clearly Thomas Jefferson High School, you do not need to go but eight miles down the road. I cannot get my Wi-Fi to work or I would have given you an exact number and map. Who has primary responsibility? Is it NSF or the Department of Education for identifying best practices for science, technology, and engineering programs in our public schools? Is it you or the Department of Education? It should be you I would think.

Mr. SURESH. We do research into models and we develop models and test them and validate them, but the implementation, especially a large scale implementation of this, the Department of Education does of course, we interact with them.

Mr. CULBERSON. Well, they are the ones that can roll it out, but I have to tell you it really shakes me up that you could not answer the chairman's question about what is the best practices or model and it is eight miles down the road at Thomas Jefferson High School.

Mr. FATTAH. If the gentleman would yield for one second. I agree with your passion on the point, but the earlier time when it was answered in full was that what they had done with the chairman's request is to take it very serious and they have done an empirical scientific based study with control groups and others looking at all

the practices and so on so that a full report, and we are going to have a roll out. We are going to have a roll out. They have already submitted to the chairman the interim report.

Mr. CULBERSON. Okay.

Mr. FATTAH. We are going to have a roll out in Philadelphia. I am going to get you a cheesesteak. At the Constitution Center we are going to have educators come in and hear this. Because what the chairman has gotten them to do is going to be historically important to teaching STEM.

So you know, Thomas Jefferson is a great school, but aberrations or anecdotal circumstances are not enough to make a scientific judgment on.

So we are going to have a great report.

Mr. CULBERSON. In the report that Mr. Fattah is talking about you have looked at schools all over the United States and you have identified what appear to be the best practices and model programs, and you are going to roll this out as he says at the Constitution Center?

Mr. FATTAH. In Philadelphia, I'll get you a cheesesteak.

Mr. SURESH. So, Mr. Culberson, I thank you for the question. Let me repeat some of the aspects.

Mr. CULBERSON. Forgive me for running late if I missed you earlier.

Mr. SURESH. No, no, no, no problem at all.

Mr. CULBERSON. But I was just so disturbed when you could not answer Mr. Wolf's very simple question.

Mr. SURESH. No, no, I answered it earlier, so I did not want to repeat myself.

Mr. CULBERSON. I understand. Okay.

Mr. SURESH. So let me reiterate some of the points I made.

We have set up a National Research Council committee involving the best teachers in the country and educators in the country to provide us input on various best practices. That is step number one. On May 10th and May 11th there will be a symposium, which we have invited the chairman to kick off this year.

The second thing we have done is to engage the Urban Institute, one of the centers of the Urban Institute, to pick two states, and it may well be Virginia and Thomas Jefferson, but we did not want to do it, we wanted an independent organization to do this professionally with all the details, and they will provide input on best practices from two states based on input they have received from a larger sampling from across the country.

Mr. CULBERSON. Who is the Urban Institute?

Mr. SURESH. There is the name of a center call——

Mr. CULBERSON. Why wouldn't you do this?

Mr. SURESH. Because they have been engaged in a number of studies related to this in the past and we wanted an independent study.

Mr. CULBERSON. Educrats do not give me a lot of confidence, that just is the reason I ask. I do not want to dwell on this, since you answered earlier, and you were very gracious. You know we are devoted to you, and I do not want to dwell on it, but you are going to give a detailed report to the chairman and the Committee?

Mr. SURESH. Absolutely.

Mr. CULBERSON. You are going to roll out what you believe are the best practices and identify the schools that are really doing it right.

Mr. SURESH. That is correct. And one other point that we discussed was not just a report to this committee, but also on ways in which we can roll it out to the community at large so that the best practices that are identified are disseminated to the school districts and others in the most efficient way.

Mr. CULBERSON. Okay, and the Department of Education will be responsible for that?

Mr. SURESH. But we could make it available to them through the media that we have.

Mr. CULBERSON. Okay. Well, that is something I really want to help the chairman and Mr. Fattah follow up on. We are in an environment where we are facing—it is an age of austerity unlike anything the nation has ever faced and all of us are going to be working hard to protect NSF and firewalling off core functions. We are, I think, going to be entering an era where we are going to have to retrench as a nation and focus on core missions, and this is clearly one of your core missions, to identify and then help disseminate best practices in science and technology and engineering education, because it is just vital. I know the Chairman pointed out the Chinese are graduating ten times more engineers than we are.

I also noticed that the Inspector General's report pointed out that you have had real problems with confirming whether or not grant recipients are actually performing and completing the work that ensures effective oversight throughout the life cycle of an award. You mentioned to the Chairman that you were doing site visits and inspections, but the Inspector General says you have actually performed 20 percent fewer site visits than you had originally planned, so you are doing fewer site visits. All of us want to be sure that you are following the Inspector General's recommendations. Are you aggressively doing everything you can?

Mr. SURESH. Absolutely. In fact we are looking at every means possible to increase the site visit methods, and one example of that is what I mentioned with respect to engaging the latest technology to do the site visits. There are other things that we can do with respect to frequency of grantee conferences and so forth.

Mr. CULBERSON. The IG mentioned Second Life which is the——

MERIT REVIEW PANEL PILOT PROJECT

Mr. SURESH. Second Life is a virtual site visit process and there are a number of ways in which we can do that. We already have a pilot project under way to look at what the best practices are.

Mr. CULBERSON. Does that allow you to see virtually somebody pick up this glass of water and look at it and examine it?

Mr. SURESH. Absolutely. The technology——

Mr. CULBERSON. Is it secure?

Mr. SURESH. That is why we are doing a pilot program.

Mr. CULBERSON. To keep anybody else in the cloud from diving in from Peking to Beijing, I guess they call it, and looking at what you are doing.

Mr. SURESH. That is exactly why we are doing the pilot project to make sure. It is absolutely critical that we insure the confiden-

tiality of the review process, so we want to make sure that whatever systems we use—just to go a little bit further, just three days ago I met with the senior research officers of the AAU, American Association of Universities, to talk about ways in which universities can help us with regional hubs so that we can engage reviewers without having them fly into Arlington, Virginia.

Mr. CULBERSON. Sure. Just make sure it is secure, please.

Mr. SURESH. Absolutely.

Mr. CULBERSON. Year before last, I had been using iGoogle's map service. I just temporarily played around with the thing that allowed my staff to see where I was. Then I woke up one morning, Mr. Chairman, and my location was in downtown Beijing. It was because they had hacked the Google site, and then hacked all of the Google accounts. I immediately terminated it.

I mean the Chairman is right, there is a very aggressive and hostile cyber warfare going on from the Chinese.

Let me also just wrap up and mention, I am also concerned, Mr. Chairman, that you are not spreading yourselves too thin. You received a lot of money from the Stimulus Package, and looks to me that you are spreading that pretty thin.

I mean, you are cancelling a lot of important work that you have been doing on education. It looks like you started building a telescope, an Alaska region research vessel, an ocean observation initiative, and an advanced technology solar telescope. All noble efforts, but we are in an area where you are going to have to really focus on your core mission. I suspect those are tremendously expensive projects, and you just made a down payment on all of them and they are going to go over their life cycle cost by a lot.

And by the way, Mr. Chairman, and I will just wrap up on this, the icebreakers are going to cost upwards of a billion dollars to completely rebuild them, won't they?

Mr. SURESH. I do not know the exact price of this, but——

FOCUSING ON NSF'S MISSION

Mr. CULBERSON. I have looked at it, it is about a billion dollars if you were to rebuild those Coast Guard ships, Mr. Chairman, and you do not have the money. When Mr. Wolf was Chairman last time, this was something I worked on with Frank LoBiondo, to get the Coast Guard to transfer responsibility for the icebreakers. President Bush has shifted them over to you, and you did not have the money. You do not have the money to refurbish those ships, it was about a billion dollars. They are finally back in the hands of the Coast Guard. They are ancient ships, are in very back shape. It may actually be more cost effective at this point to rent, as aggravating as it would be, from the Swedish. You are doing all these other new things.

I just worry, do not get yourself spread too thin. The IG says you do not have good safeguards in place to monitor these major investments while you are doing in these big capital construction projects.

There is a lot or worry here, Mr. Chairman, that this is going to require a lot of oversight from us. You do not necessarily need to get into all this right now, but I think everything I have said is essentially accurate, right?

Mr. SURESH. Well, let me——

Mr. CULBERSON. I have not misstated anything have I or misstated anything?

Mr. SURESH. Let me add a couple of points to that.

So along with new commitments that have been made, there are also things that have been terminated.

For example, one of the projects that has been terminated is DUSEL. The potential cost of DUSEL would have been over a billion dollars over many years.

Mr. CULBERSON. Right.

Mr. SURESH. They were for underground science research. This is in high energy and particle physics underground.

Mr. CULBERSON. Oh, okay. So you cancelled that. I am just concerned, I know the Committee is. I do not want to dwell on it, because I have got to get to my Texas lunch as well, and the Chairman is very gracious to let me come in so late and ask questions, but please do not get spread too thin.

Mr. SURESH. I appreciate that.

Mr. CULBERSON. It is a real source of concern.

Mr. SURESH. Right. If I could just add one point to your question on the telescopes. The reason for supporting these telescopes, every ten years there is a survey that involves the top scientists in the country on what needs to be done, and the telescope work is very carefully done so that the planning process and the implementation process takes about ten years with a lot of community input. So this is not an NSF decision to do something, but——

Mr. CULBERSON. Sure, I understand.

Mr. SURESH. And this is to keep the U.S. at the forefront of the astrophysics research that no single institution in the country is capable of funding.

So what you say is absolutely true, we cannot spread ourselves too thin, especially at tight financial times, but I want to assure you that we will do everything possible to make sure that dollars are spent wisely and for the right purposes.

Mr. CULBERSON. Thank you, Mr. Chairman.

Mr. WOLF. Thank you, Mr. Culberson.

ROLL OUT OF K–12 STEM EDUCATION REPORT

Before I end, I want to second what Mr. Culberson said about the STEM report conference. Mr. Fattah, I hope we can do it. Maybe we can look at the schedule for July and maybe pick a Friday to do it.

Mr. FATTAH. I am going to work it in a way in which we can get you in there for the July 4th holiday. So we are going to do it right. You can be there for the fireworks and the whole bit and cheesesteaks. And we want to bring our colleague from Texas along with us.

Mr. WOLF. Now does Geno's or Pat's, have the best cheesesteak anyway?

Mr. FATTAH. There is no doubt, this is a scientific fact, all right, quantified, qualified, empirical: Pat's is the best in Philadelphia.

Mr. WOLF. Okay. That is who I have gone to. I used to play football at that field directly across the street from Pat's. So I want to

pick a time that we can do that, hopefully a Friday, and we can tie it in.

I think what Mr. Culberson has said was accurate. The Urban Institute, they are good, but I'm kind of worried that the Department of Education now is going to be involved. And I am worried that you are going to have two states, being looked at. Maybe the best school is in North Dakota. So rather than looking at two states, maybe you should look at the top 50 schools. "U.S. News and World Report" publishes the top 50 schools. One may be in Pennsylvania, one may be in New York, one might be here.

So I think he makes a legitimate point. Here we are going to get the Urban Institute to have a grant and then they are going to look at two states. Maybe they are going to be the wrong two states. I think Thomas Jefferson does an incredible job, but maybe they should be looking at schools rather than states.

And lastly, once we bring the Department of Education in, and I guess they are going to have to be brought in, but then you got a new agency involved.

I think we should do the rollout in Philadelphia, certainly by the end of July so it can at least be processed. Although that will be late for the next school year. I think curriculum is set pretty much. But it ought to be just whatever is working, wherever it is working. That knowledge ought not to be hoarded, it ought to be shared. Ben Franklin's house is two blocks from that center—you could call it the Ben Franklin whatever. But I want to do it. And I do not want you to do it because we asked you to do it. I do not want to speak to your conference, because I do not want to look like I am lobbying or you gave me something. I just want you to do it because it is good for the country.

My wife and I have 5 kids, 15 grandkids. I am worried that this Nation is getting ready to go into decline. If you find one idea that impacts one student at Overbrook and one student at Vienna High School and one student in Houston, Texas, it electrifies. So that is what we want to do is do. You have got to be working with—what is the association of school administrators? They ought to be part of it. I think Ed Hatrick is the head of that. When you come out with, whatever you are going to come out with, it should be so profound that it really makes the difference. When we look back, this could be the one thing that literally gave us the opportunity to make America continue.

So we are going to really make an effort to work it out, but I do agree with what Mr. Culberson said. I would feel more comfortable if you were doing it without other groups involved, but you should do it however you think it is best.

I worry, too, that is has taken NSF so long that it is almost scary.

And frankly, if it could not be in July—and I want to do it with Mr. Fattah—I would rather do it in September or do it so that it really has a maximum impact for the following year. I do not know when curriculum is established. I have a daughter that is a teacher, but when do they begin in the City of Philadelphia, when do they begin looking at the next year? So maybe you should do it in September or October. Do not feel rushed. We are going to do it in Philadelphia. Do it right. Do not feel like "we have got to get this

thing done in July," because maybe that would rush it and make it not so great. One of the greatest Presidents we have ever had, Ronald Reagan, said the words in the Constitution adopted in Philadelphia in 1787 were a covenant with the rest of the world. Maybe this could be another covenant. Mr. Fattah is going to be one of the leading deciders, but think about when you can really do it and do it well. Take into consideration Mr. Culberson's comments.

Mr. CULBERSON. And if I could, Mr. Chairman, they have been working on this since I was placed on this Committee in 2003. I asked for this subcommittee so I could work with Chairman Wolf on protecting the National Science Foundation and NASA.

Mr. FATTAH. I thought you wanted to work with me?

Mr. CULBERSON. Well, of course, you too my friend.

But I mean, this is where I wanted to be, to help with the sciences and NASA, and you all have been talking about this and NSF has been working on this literally, Mr. Chairman, since 2003. This should not be that complicated. You should be ready to go.

Mr. SURESH. Well, we will get you the best outcome of things.

Mr. WOLF. And we are not going to hold you to the July deadline.

Mr. SURESH. I appreciate that. You know the spirit of setting up this process to begin with was to do the right thing.

Mr. WOLF. I understand, I understand, we do not have to go back and do that.

Mr. Fattah do you have any other questions?

Mr. FATTAH. No, I want to thank you for your testimony, and you said you were out at Texas A&M, you met with doctor—is it Garcia? It is a great university and I participated in that program last year and I am glad that you are working in Texas. My colleague did not hear that, but you are working in Texas. Thank you. Thank you for your testimony.

Mr. WOLF. Thank you, Dr. Suresh, thank you very much.

Mr. SURESH. Thank you, Mr. Chairman, thank you, Mr. Fattah.

UNITED STATES HOUSE OF REPRESENTATIVES
Committee on Appropriations
Subcommittee on Commerce, Justice, Science, and Related Agencies
HEARING ON
03/10/2011
Dr. Subra Suresh, Director, National Science Foundation

QUESTIONS FOR THE RECORD SUBMITTED BY
Frank R. Wolf

International Competition

Question 1: The budget request proposes a 13% increase for NSF over the fiscal year 2010 enacted level. While this is a significant investment, many of our international competitors are also investing aggressively in science and technology. How does NSF's budgetary growth pattern over the last five years (2008 enacted through 2012 proposed) compare to the growth patterns of similar scientific research agencies/entities in other countries, including China?

Answer: There are no internationally comparable funding data available for science research agencies in other countries. It is possible to compare the growth of NSF support for R&D with growth in total government support for nondefense R&D by our international competitors, defined as the G-7 countries, the European Union (EU), China, and Korea (see Table 2).

In recent years, the rate of growth in NSF R&D funding has been higher than that for government nondefense R&D funding in some countries (France and Japan), and lower than in other countries (China and Korea).

For the U.S., the rate of growth in NSF support for R&D has been higher than in total federal support for nondefense R&D between 2006 and 2012.

Data Notes.

- The most recent internationally comparable data are available for 2008 or 2010, and are reported in the OECD's *Main Science and Technology Indicators*, released in February 2011.
- "Science and technology investments" is defined here as "R&D investments". Because the comparison is with NSF, only government-funded nondefense R&D is compared.
- For most countries, prospective R&D budget data are not available.
- The data provided in the table below are total government budget appropriations or outlays for nondefense (i.e., civilian) R&D except for China. Data for China are derived from R&D expenditure surveys, rather than from government budget documents.
- The data are reported in millions of current purchasing power parity dollars.

Table 2. Total Government Budget Appropriations or Outlays for Nondefense R&D (million current PPP $)

											Average annual percent change		
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2006-08	2008-10	2010-12
United States*	51,818	55,927	56,618	57,282	59,889	60,185	80,372	62,683	63,518	66,756	2.5%	2.1%	3.2%
NSF*	3,926	4,123	4,102	4,183	4,440	4,506	7,547	5,445	5,374	6,320	3.8%	9.9%	7.7%
Canada	5,679	5,947	6,499	6,608	7,307	..	..	..	..	..	..	..	..
China**	13,748	15,274	18,721	21,416	25,198	28,452	..	..	..	..	15.3%	..	..
France		13,170	14,316	11,652	11,256	11,593	..	..	..	..	-0.3%	..	..
Germany	17,415	17,800	18,722	19,654	21,168	22,765	24,391	26,636	..	..	7.6%	8.2%	..
Italy	..	..	10,649	10,764	11,621	12,465	12,471	11,742	..	..	7.6%	-2.9%	..
Japan	24,602	25,472	26,502	27,210	27,912	28,984	29,924	30,656	..	..	3.2%	2.8%	..
Korea	6,014	6,702	7,290	7,851	8,730	9,825	11,009	12,213	..	..	11.9%	11.5%	..
United Kingdom	8,939	9,085	10,067	10,672	10,917	11,525	12,566	..	..	..	3.9%	..	..
EU-27	74,895	80,043	82,923	87,110	93,479	97,900	..	..	..	..	6.0%	..	..
EU-15	71,218	76,186	78,034	81,353	87,022	90,736	..	..	..	..	5.6%	..	..

=not available; PPP=purchasing power parity

*For U.S., FY 2010-2012 data from *Analytical Perspectives, Budget of the United States Government*, FY 2012.
U.S. totals for FY 2009 include $15,106 million in ARRA funds; NSF totals include $2,780 million in ARRA funds.

**R&D budget data are not available for China. Data reported here are government R&D funding totals derived from R&D expenditure survey.

Source: OECD, Main Science and Technology Indicators, February 2011; and U.S. sources.

NSF Headquarters Move

Question 2: Your 2012 budget request includes $45 million for tenant customization and IT installation at a future NSF headquarters site. How did you derive this estimate? Does it tie directly to the GSA prospectus?

Answer: Yes, NSF's FY 2012 budget request of $44.65 million ties directly to the GSA new lease prospectus.

With respect to the derivation of the estimate:

- The tenant improvement customization estimate ($34.71 million) was derived from standard market rates coupled with an independent government cost estimate.
- The information technology (IT) design, equipment, and installation estimate ($8.07 million) was derived from comparable GSA new lease projects, and
- The balance of the estimate ($1.87 million) reflects cost studies related to the lease award and contractor technical support.

Question 3: What is the estimated total cost, across all years, of moving NSF out of its current location and in to a new facility?

Answer: NSF's current total relocation estimate is approximately $130 million for FYs 2010-2015. This estimate assumes a one-time move to a future location in Northern Virginia. Should multiple swing-space moves be required additional funds would be needed.

K-12 STEM Education

Question 4: *Rising Above the Gathering Storm* identified K-12 STEM education as the most pervasive concern affecting the nation's scientific and technical competitiveness, and you testified that a student's elementary school years are among the most crucial for developing long term interest in STEM subjects. Despite these indicators of the importance of K-12 programs, however, NSF's educational activities are largely geared toward undergraduate and graduate school. How does NSF view its role in promoting K-12 STEM education?

Answer: NSF views itself as having a critical role across the federal government for providing the evidence-based tools, resources, and models for improving K-12 STEM education. Three broad national priorities drive the EHR FY 2012 Request, and they are: "improving K-12 STEM student and teacher learning, with more dramatic results in student outcomes; building a diverse and highly qualified STEM workforce, at a more rapid pace in areas of national need; and advancing evaluation methods, designs, and approaches to ensure strategic investment in promoting K-12 STEM education."[1] With these goals, NSF views its investments as essential in advancing an innovation agenda for STEM education. A crucial factor in doing so requires identifying best practices and disseminating this information widely so that school leaders and teachers can make use of this knowledge to improve STEM learning for all students. Key programs for improving K-12 STEM education include the Math and Science Partnership program (MSP); Discovery Research K-12 (DR-K12); Research and Evaluation on Education in Science and Engineering (REESE) (including research in disabilities education and research on gender in science and engineering); and the Robert Noyce Scholarship (NOYCE) Program. The challenges in improving STEM education evolve over time, and NSF's role is to provide building

[1] National Science Foundation's FY 2012 NSF Budget Request to the Congress, February 7, 2011, p. EHR -1.

blocks that can be used to help solve the problems of today and tomorrow. A new research and development program is proposed in FY 2012, named Teacher Learning for the Future (TLF). TLF will catalyze new lines of research and development needed for rapid improvement of the preparation and continued professional learning of the K-12 STEM teachers of tomorrow. Additionally, it will support concept development and prototype proposals to encourage research about new modes of teacher learning.

Question 5: The President's Council of Advisors on Science and Technology released a report last year on K-12 STEM education. One of its findings was that NSF's K-12 portfolio is not optimally balanced between programs that support basic education research and those that support the development and implementation of scalable, practical education solutions. Does your 2012 request take steps to increase your focus on packaging and disseminating proven practical solutions?

Answer: NSF is the lead federal agency providing funding for research and development (R&D) in STEM education and the majority of the K-12 portfolio comprises projects that are developing new learning tools, instructional materials, and models or resources for students. We view the research and development enterprise as a continuum with embedded cycles, and so the basic educational research informs the development of education solutions (also a research enterprise in itself, as iterations are tested, refined, and studied for efficacy). It is essential that NSF PIs "design for scale," so that NSF-funded education interventions are well-tested, rest on a basis of solid evidence, and are ready for widespread deployment. We continue to focus on the challenges of dissemination, translation, and "hand-off" of those NSF-developed learning materials that demonstrate efficacy and promise. Increased investment in cyberlearning and enhanced collaboration with the U.S. Department of Education are two strategies planned for FY 2012 as a means to work toward scaling of materials produced by NSF.

Question 6: The PCAST report also recommended the creation of an advanced education research agency to be headed either by NSF, the Department of Education or both. Has there been additional discussion about creating this entity since the report was released?

Answer: The President's FY 2012 Budget proposes the creation of "ARPA ED" as part of the budget of the U.S. Department of Education (http://www.ed.gov/technology/arpa-ed).

Setting Annual Scientific Priorities

Question 7: Your budget request contains hundreds of millions of dollars of increases for basic research across a variety of disciplines, including clean energy technology, advanced manufacturing and next generation cyber infrastructure. When this request was being developed, how did you determine which types of research would be the focus of the increases? Are the priorities determined internally by NSF, or is there active participation by OSTP and other parts of the Administration?

Answer: NSF determines and sets scientific priorities based on a myriad of considerations. While NSF does have its own internal priorities and initiatives each year, it recognizes the importance of aligning these with both the communities served and the Administration's goals and priorities. To ensure that research is focused on the needs of the scientific community, NSF obtains feedback through workshops, Advisory Committee meetings, outreach efforts, and everyday interactions between NSF program staff and their peers and colleagues in the science

and engineering community. The Foundation also closely follows guidance and priorities identified by OMB and OSTP in official documents, such as the annual joint memorandum on Science and Technology Priorities, and Congressional guidance and statutes.

Question 8: Can you briefly describe how the areas of research investment that are highlighted in your budget reflect the greatest scientific and technical needs of the country? How did you settle on this particular group of investments?

Answer: As described above, NSF priorities are determined based on a variety of inputs and considerations. NSF supports basic research in all areas of science and engineering and is therefore in an ideal position to make significant contributions to knowledge in many areas of national need. In keeping with the Administration's *Strategy for American Innovation,* NSF is focusing on key national priority areas that require expertise across many disciplines, including clean energy research and comprehensive, integrated, sustainable, and secure cyberinfrastructure. NSF also seeks to support research that will translate and transform basic research discoveries into applications for the benefit of society and the economy; one such area is advanced manufacturing, which holds tremendous potential for short-term and long-term economic impact.

Cyber Security

Question 9: How would you assess the security threat from outside intruders to NSF's computer networks and other information technology systems? What do we know about where these threats are coming from?

Answer: NSF's successful delivery of information technology (IT) services is dependent upon a safe, secure, and resilient infrastructure of computer networks and IT systems. NSF has had relatively few security incidents in comparison to other federal agencies due to a combination of factors, including the Foundation's comprehensive and strong security program and NSF's lower threat profile relative to agencies that produce or transmit classified information or large departments involved in national security. Nonetheless, threats to NSF's IT infrastructure continue to grow in number and sophistication. From a broader perspective, reports from the United States Computer Emergency Readiness Team (US-CERT) indicate the number of incidents faced by the government increased approximately 39 percent from FY 2009 to FY 2010. US-CERT notes that these cyber-security threats arise from many sources including criminal elements and nation-states. Leading information security vendors such as Fortinet, McAfee, and Symantec indicate that the greatest number of spam and malware threats to U.S. networks come from China, Russia, Brazil, India, and South Korea.

Question 10: Although NSF generally receives good marks for cyber security, there have still been several incidents where your networks were successfully infiltrated. What additional steps do you believe are necessary to improve the protection of your cyber infrastructure?

Answer: NSF continuously works to improve the protection of the Foundation's cyber infrastructure in response to emerging threats. NSF is making additional investments in new and emerging preventative and detective technologies. For example, the Foundation is investing in new access control technologies; improved intrusion detection and intrusion prevention technologies; new tools and processes to support continuous monitoring and assessment activities; and data loss prevention technologies to monitor and prevent data from exfiltration.

NSF is also utilizing federal information technology (IT) reform initiatives to improve protection of agency networks and systems. The Foundation is transitioning to the DHS-managed secure internet initiative (Trusted Internet Connection), which consolidates the federal government's external network access points. This initiative will allow NSF to acquire higher levels of standard security services, including intrusion detection to analyze internet traffic and identify unusual activities, a 24/7 security operations center to supplement agency-specific security services, and security filtering for protection against the introduction of undesirable content into local networks.

Impact of NSF Stimulus Funding

Question 11: Two years ago, NSF received $3 billion through the stimulus bill. Today, only about a third of that has actually been spent, and substantial portions of the remaining balance won't be spent for another year or two. How would you describe the "stimulating" impact of these much-delayed funds?

Answer: NSF's ARRA portfolio has spurred economic activity by enabling the universities and institutions that received awards to add scientific and technical personnel and develop the infrastructure associated with ARRA-funded projects. The expenditures to date – roughly $1 billion of the $3 billion provided to NSF through ARRA – are consistent with the terms of these awards, as nearly 75 percent of these projects have durations of three years to five years. This allows awardees to establish appropriate frameworks for the activities, notably staffing, acquisition of equipment and instrumentation, and infrastructure modifications that are necessary for successful project implementation. Consistent with clauses (3) and (4) under Section 3(a) of the Act, NSF's ARRA projects represent long-term investments in science and engineering research and education, and they therefore speak directly to the "reinvestment" aspects of ARRA.

Question 12: The previous Congress used the opportunity provided by the stimulus to meet short term funding goals of the America COMPETES Act. The stimulus, however, was a temporary, one-time measure, and didn't institutionalize those funding increases. Looking solely at your regular budget as represented by your 2012 request, are you still on track with the goals of America COMPETES?

Answer: Yes. NSF is still on track with the goals of the America COMPETES Reauthorization Act of 2010. The legislation authorizes FY 2012 appropriations of $7.8 billion. NSF's FY 2012 Request to Congress is $7.767 billion, consistent with the authorized level.

Question 13: The passage of the stimulus artificially inflated your budget over a relatively short finite period, leading many people to be concerned that the research community would experience a sharp and severe drop in funding support when stimulus funds ran out. What has NSF does to avert a post-stimulus "cliff" of research funding?

Answer: Before the ARRA was enacted, NSF recognized that there were a number of potential concerns inherent in increasing the NSF budget by 50 percent in one year, including downstream effects such as increased renewal requests as stimulus-funded awards came to an end. Increasing the funding rate dramatically in FY 2009 could have potentially forced the funding rate to plummet in FY 2012, as about 40 percent of all NSF awards are 3 year awards.

NSF addressed this concern through two major mechanisms. First, NSF increased the number of standard awards made with regular FY 2009 appropriations so that out-year "mortgages" could be minimized. In an average year, 40 percent of NSF programmatic funds are already committed for annual increments on awards. By making more standard grants (full funding for an entire multi-year award obligated at once, rather than in yearly increments), NSF ensured that there was more freedom in FY 2010, FY 2011 and FY 2012 to make new awards.

Second, NSF recognized that regardless of minimized mortgages, renewal requests would increase. To address this, NSF chose to change award duration by increasing the number of 4 and 5 year awards supported by ARRA funding. This served to redistribute the expected renewal requests and prevent a spike in requests in any one year; while many 3 year awards will be up for renewal in FY 2012, the 4- and 5-year awards will be up for renewal in FY 2013 and FY 2014. The shift in average award duration from 2.5 and 2.6 years in FY 2007 through FY 2009, to 2.9 years for the ARRA portfolio, reflects that this strategy was successfully executed and NSF was able to increase both award duration and funding rate as a result of ARRA funding.

Research Equipment and Facilities Construction

Question 14: If the assumptions made in your 2012 request about prior year appropriations for major research equipment and facilities construction prove to be inaccurate, you will have to re-plan the work you anticipated for 2012. What criteria would you use to determine which of these projects to defer and which to keep on their current schedules and funding paths?

Answer: NSF's highest priority will be to complete those projects farthest along in construction, and to minimize disruption so that any replanning affects the smallest number of projects. For early-phase construction projects and new starts, NSF will assess their plans to see where funding reductions would produce the least impact on project performance and risk, and result in the best overall outcome under the circumstances. Changes to current funding plans – which were based on technically limited cost profiles (i.e. the requested funding profile was a result of planning each project at the maximum rate technical work could be accomplished, since that results in the overall lowest cost to the government) – could result in net increases to total project cost for a number of projects. NSF is engaged in quantifying these cost impacts in order to generate its options to act according to the above principles as the funding situation becomes clearer.

Question 15: If work is deferred, there may be an impact on overall project costs. NSF has a fairly recent policy in place requiring projects to offset cost increases through reductions in project scope. Do you believe that you can continue to hold to this policy, or would you propose making exceptions for projects that would be re-planned?

Answer: As discussed in our answer above, NSF projects are planned and implemented according to a "technically limited" profile which assures the lowest cost to the government, but which also assumes that the multi-year funding profile will be available in the MREFC account. Our "no cost overrun" policy, coupled with risk-based budgeting for contingency, is intended to hold projects to best planning and management practices – and to descope when costs increase beyond that provided in the risk-based total project cost. However, unplanned funding delays on any large project naturally increase the potential risk of cost increases. Since this is a new situation for NSF in its management of the MREFC account, we will need to proceed on both a portfolio-prioritization and a case-by-case basis to determine how to proceed as the

funding situation becomes clearer. Our answer above provides NSF's principles and approach for doing so.

Polar Logistics Contract Competition

Question 16: Are you still on schedule to make an award for the new Antarctic support contract this year?

Answer: Yes. It is anticipated that award of the Antarctic Support Contract (ASC) will be made in the fall of 2011.

Question 17: Will your close-out of the current support contract include a full reconciliation of costs and payments from all prior years?

Answer: It is planned that NSF will obtain a contract closeout audit to determine that all costs charged to the Antarctic Logistic Support contract were allowable, allocable, and reasonable.

Question 18: The NSF Inspector General has made several recommendations for improving cost controls on the next Antarctic support contract, including requiring bidders to undergo business and financial audits in advance to prove that they can comply with billing and cost tracking requirements. Have you adopted this or other recommendations to improve the management of the contract?

Answer: The acquisition strategy for the Antarctic Support Contract (ASC) includes measures to ensure the ASC awardee will be able to comply with billing and cost tracking requirements. Specifically, pre-award audits have been initiated and include a review of business systems, disclosure statement compliance and financial capability, as well as verification of proposed rates.

Changes in Merit Review Criteria

Question 19: NSF has been undergoing a process to evaluate the effectiveness and impact of its merit review criteria. What is the status of that evaluation? Do you anticipate that changes will be made to either of the criteria as a result of this review?

Answer: The National Science Board (NSB) has established a task force to assess the utility of the current merit review criteria (i.e., Intellectual Merit and Broader Impacts) and, if necessary, to make recommendations to the full Board on possible modifications. In addition, Section 526 of the America COMPETES Reauthorization Act of 2010 requires NSF to develop and implement a policy for the Broader Impacts criterion that meets requirements specified by the Act. The NSF and the NSB task force are coordinating these efforts. Currently, the NSB task force is collecting data from various stakeholder groups. These data will help inform the work of both the task force and NSF. Section 526 states that NSF must develop and implement a Broader Impacts policy within 6 months of enactment of the Act (e.g., July 4, 2011). The NSB task force will discuss its draft findings during the May 2011 Board meeting. At this stage of the process, it is premature to speculate on whether the existing criteria will be modified. It is clear, however, that the Broader Impacts criterion will need to be modified to reflect the requirements of Section 526.

Question 20: Late last year, you made some comments suggesting that the merit review criterion requiring research proposals to demonstrate the broader impact of their work is

problematic. Why do you believe changes to this criterion might be in order? Can any concerns with this criterion be mitigated by adjusting the existing standard, or would you eliminate broader impact as a criterion entirely?

Answer: NSF's two-criteria merit review system — Merit Review and Broader Impacts — was instituted in 1997. The NSB task force assessment will shed much light on how it is being used and how it might be modified. Concerns stem from the fact that proposals vary greatly in how they address the Broader Impacts criterion. In some instances, it might be more effective to have institutional support for a specific Broader Impacts activity. In other cases, certain Broader Impacts may flow more readily from the proposed integrated research and education activities and may not benefit as much from directed institutional support. In fact, some of these same concerns are reflected in Section 526 of the America COMPETES Reauthorization Act of 2010. The Broader Impacts policy developed and implemented as required in Section 526 should address many of the existing criterion's limitations.

Contracting Problems

Question 21: The NSF IG has highlighted the use of advanced contract payments as a high risk practice. What is the benefit to NSF of providing advanced payments to contractors, and do you believe this benefit outweighs the associated management risk? Are you taking steps to reduce your use of advance payments?

Answer: While the general default is *not* to use advanced contract payments, there are a variety of situations in which advanced payments may be of benefit to the government in obtaining a timely, quality product or service from a provider that is adequately financed. The Federal Acquisition Regulations (FAR) delineate a variety of circumstances wherein it is considered useful and appropriate to include advance payment terms in a contract. FAR 32.403 delineates advance payment terms as appropriate in:

"(a) Contracts for experimental, research, or development work with nonprofit educational or research institutions.
(b) Contracts solely for the management and operation of Government-owned plants.
(c) Contracts for acquisition, at cost, of property for Government ownership.
(d) Contracts of such a highly classified nature that the agency considers it undesirable for national security to permit assignment of claims under the contract.
(e) Contracts entered into with financially weak contractors whose technical ability is considered essential to the agency. In these cases, the agency shall closely monitor the contractor's performance and financial controls to reduce the Government's financial risk.
(f) Contracts for which a loan by a private financial institution is not practicable, whether or not a loan guarantee under this part is issued; for example, if --
  (1) Financing institutions will not assume a reasonable portion of the risk under a guaranteed loan;
  (2) Loans with reasonable interest rates or finance charges are not available to the contractor; or
  (3) Contracts involve operations so remote from a financial institution that the institution could not be expected to suitably administer a guaranteed loan.
(g) Contracts with small business concerns, under which circumstances that make advance payments appropriate often occur (but see 32.104(b)).
(h) Contracts under which exceptional circumstances make advance payments the most advantageous contract financing method for both the Government and the contractor."

Furthermore, please note that the NSF Act (42 U.S.C. 1870(d)) explicitly provides that advance, progress, or other payments which relate to scientific activities or scientific information may be made without regard to the provisions of section 3324 of title 31 of the United States Code. [49 FR 46745, Nov. 28, 1984, as amended at 61 FR 51022, Sept. 30, 1996].

NSF believes that the use of advance payments should be limited to the circumstances set forth above. Furthermore, where an agency has instituted adequate controls to mitigate management risk, advance payment contract terms can be advantageous to the government. In instances where NSF has contracts with advance payment terms, NSF has instituted controls to protect the government's interest. Specifically, NSF has engaged the Defense Contract Audit Agency (DCAA) to execute reviews of the contractor's Quarterly Expenditure Reports for all NSF's contracts with advanced payments. NSF has also initiated requests with DCAA for incurred costs audits for its largest cost reimbursement contract that includes advance payment terms. Also, for NSF's largest advance payment contract, there is a letter of credit in place to secure the government's interests.

It should be noted that NSF currently has a very limited number (three) of contracts with advance payment terms. NSF will continue to closely scrutinize the appropriate use of the advance payment authority. Furthermore, NSF plans to augment its contracting manual with additional guidance regarding the use and approval of advance payment contract terms.

Question 22: NSF has a number of contractors whose financial systems don't meet federal accounting control standards. As a result, neither NSF nor the contractor can ensure that costs are being appropriately billed. Have you implemented policies to ensure that any future contractors can prove their compliance with accounting standards prior to receiving funds? What are you doing to reconcile costs and payments on existing and closed contracts and to recover any overpayments made as a part of those contracts?

Answer: NSF has recently added and implemented new policies to ensure contractors have proven their compliance with accounting standards prior to contract award. Specifically, NSF has updated its contracting manual to include additional policy guidance in the following areas: pre-award audit requirements, responsibility determinations, disclosure statement requirements, and post award audit requirements. The policy guidance emphasizes the requirement that prior to award of a cost reimbursement contract, the contractor's accounting system shall be deemed adequate for determining cost applicable to the contract as required in FAR 16.301.

NSF monitors payments for existing contracts by ensuring that appropriate personnel are assigned as performance monitors (i.e., Contracting Officer's Technical Representatives (COTRs)) and through periodic audits during contract performance. For example, complex service contracts are required to have certified COTRs assigned to monitor performance and approve payments under the contracts. Most recently, NSF has engaged the Defense Contract Audit Agency (DCAA) to conduct incurred cost audits of its largest cost reimbursement contract for Fiscal Years 2005 through 2010. Also, for contracts with advance payment terms, NSF has engaged DCAA to conduct Quarterly Expenditure Reviews to ensure payments are appropriate throughout contract performance. Furthermore, NSF is working closely with the Defense Contract Management Agency (DCMA) to ensure that Cost Accounting Standard compliance issues are addressed to prevent future overpayments and to recover any funds owed. Lastly, Contracting Officers may also seek an audit of invoices any time before final payment if there are concerns. Therefore, in the event that an unallowable cost is identified as a result of these

audits, the subsequent invoice in accordance with FAR 42.801 may be reduced to account for the amount identified as unallowable.

NSF is not aware of instances where closed contracts have improper payments. To assist contract specialists with the contract closeout, NSF has developed a "Contract Closeout Guide" that instructs contracting officers on instances to request audits to assist in reconciling payments at the conclusion of a contract. The guide instructs contracting officers to seek assistance from the cognizant auditor to determine final indirect cost rates for cost reimbursement contracts. Also, the contract closeout guide provides instruction on the appropriate methodology to determine audit requests based on the dollar level and complexity of the contract requirement.

QUESTIONS FOR THE RECORD SUBMITTED BY
Robert B. Aderholt

STEM Education

Question 1: More and more emphasis has been placed on STEM education over the years. A well-educated population, especially in STEM education, is needed to ensure the United States remains competitive. Many studies have shown that more women and young people are needed in STEM fields. Can you please expand on steps NSF is taking to reach young people regarding STEM education so that students in all 50 states have an opportunity?

Answer: The FY 2012 Budget Request to Congress (i.e., Summary Tables-11) shows NSF's investment of $1,210 million ranging from K-12 to Postdoctoral Fellowship programs that will make direct investments to grow a strong, educated, diverse, and talented STEM pool of individuals. It is through this coherent set of programs and outreach activities, unique in government because of their unified focus on STEM, that NSF takes steps to ensure that people in all states have access to inspiring STEM opportunities and a high quality STEM education. Currently, NSF's Directorate for Education and Human Resources (EHR) has active awards in all 50 states, including the District of Columbia and three territories.

Several NSF programs are specifically aimed at reaching young people and providing groups traditionally underrepresented in STEM with opportunities. Key examples include: *Broadening Participation in Computing (BPC), Opportunities for Enhancement of Diversity in the Geosciences (OEDG), Transforming Broadening Participation through STEM (TBPS), Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), Louis Stokes Alliances for Minority Participation (LSAMP), Tribal Colleges and Universities Program (TCUP), and Widening Implementation and Demonstration of Evidenced-based Reforms (WIDER).*

In EHR, the *Informal Science Education (ISE)* and *Innovative Technology Experiences for Students and Teachers (ITEST)* programs invest specifically in activities to inspire young people and engage them in exciting STEM activities. Through its museum and television programming the ISE program is estimated to reach over 200 million young people annually across the Nation. Through summer workshops and academic year experiences, ITEST-funded activities reach about 11,000 after-school students per year.

Refreshment Purchases

Question 2: Dr. Suresh, in these difficult budget times, we must all do what we can to tighten our belts. In her recent testimony to this subcommittee, the Inspector General for NSF, Allison Lerner, highlighted the need for increased oversight of refreshment purchases at NSF. While this is a small expenditure in the overall picture, it is important we save every dollar we can. What are you doing to ensure taxpayer money is not wasted on unneeded refreshment purchases?

Answer: Based on the Office of Inspector General's recommendations, NSF will:

- Set a cost ceiling per panelist per day that can be spent on light refreshment based on current prices for reasonable, limited light refreshment menus;
- Reissue guidance (including keeping records, ensuring price reasonableness, and rotating vendors when practical, consistent with Federal Acquisition Regulation requirements) to

those responsible for ordering light refreshment to ensure menus are appropriate and light refreshment is not used to replace meals;
- Collect agency purchase card and panelist data every 6 months to ensure adherence to ordering guidance;
- Explore the costs and benefits (including distributed vs. centralized staffing as well as any cost savings through pre-negotiated pricing) associated with further centralization of purchasing light refreshment along with other NSF supplies and services;
- Establish fully centralized purchases of light refreshment if benefits are determined to outweigh the costs; and
- Continue to review agency supply and service requirements to determine strategies for cost savings through consolidations, consistent with federal strategic sourcing requirements.

Oversight of Grant Funds

Question 3: Dr. Suresh, the Inspector General also mentioned problems with the NSF grant process. Specifically, she mentions that only about 7 percent of institutions receiving NSF funding received Award Monitoring and Business Assistance Program (AMBAP) desk or site reviews. What are you doing to ensure more institutions that receive funding are reviewed to ensure grant money is spent properly?

Answer: NSF's award monitoring approach is comprised of baseline monitoring, and advanced monitoring. 100% of institutions receiving NSF funds receive baseline monitoring and oversight to ensure grant money is spent properly. NSF focuses advanced monitoring activities (desk reviews and site visits) on institutions managing the highest-risk awards.

To ensure that the institutions with the highest risk portfolios receive advanced monitoring, NSF conducts a risk assessment that ranks institutions based on awards and award portfolio (type, size), institution characteristics, prior monitoring activities, results from baseline monitoring activities, and input from program offices and other stakeholders.

Using this risk assessment, NSF focuses its efforts on the 30% of NSF recipient organizations which administer 81% of the total award portfolio dollars. After determining which institutions should receive a current year site visit, the remaining higher risk institutions generally receive desk reviews within 5 years, depending on the findings from advanced oversight activities and available resources.

This combination of post-award monitoring activities supplements other NSF award administration activities. For example, NSF reviews the financial management capabilities of new and potential awardees prior to issuing an award, and the Office of the Inspector General (OIG) conducts audits on a variety of issues related to awardees' management practices. BFA also reviews the Negotiated Indirect Cost Rate Agreement (NICRA) proposals for awardees for which it is cognizant. For specific awards, NSF programs review technical and cost proposals prior to making the award, as well as technical and financial reports and other deliverables after issuance of the award. This combination of activities provides internal checks throughout the grant's lifecycle, facilitating both the administration and monitoring of awards and of institutions receiving those awards.

UNITED STATES HOUSE OF REPRESENTATIVES
Committee on Appropriations
Subcommittee on Commerce, Justice, Science, and Related Agencies
HEARING ON
03/10/2011
Dr. Subra Suresh, Director, National Science Foundation

QUESTIONS FOR THE RECORD SUBMITTED BY
Jo Bonner

OPP Procurement

Question: Dr. Suresh, the NSF Division of Polar Programs recently amended a competitive RFP to allow for vessels of foreign construction to be considered for the contract award. I am concerned this development represents a change in the longstanding procurement policies of NSF and is contrary to the stated policy of Congress that, barring extraordinary circumstances, only U.S.-built vessels should be eligible for federal funding for this program. Please indicate whether NSF has undertaken a change to its longstanding procurement policies.

Answer: It is our understanding that the solicitation by our contractor to lease a research vessel with icebreaking capabilities has resulted in the receipt of only one offer, which was U.S.-based. The domestic offeror has proposed a U.S.-built ship for lease. The solicitation, as proposed by our contractor, was conducted with full and open competition and included, among other criteria, that any refurbishments be performed in the U.S. and that the vessel be under U.S. flag and registry at the commencement of the time charter. The concerns raised by your question for the record were met by the terms of the solicitation in a manner that also allowed us to seek the most cost-effective lease in a constrained budget environment.

QUESTIONS FOR THE RECORD SUBMITTED BY
Chaka Fattah

Investment in Basic Research

Question 1: One of the major recommendations in the Rising Above the Gathering Storm report was to boost the federal investment in basic research by 10 percent annually over the 7-year period after the report's release. With regard to NSF's research budget, how much closer to the report's goal would the FY 2012 budget request bring NSF?

Answer: The President's FY 2012 Budget continues on the path to double federal investment in NSF and other key basic research agencies (e.g., Department of Energy Office of Science and the laboratories of the Department of Commerce National Institute of Standards and Technology). For NSF, when compared to the FY 2008 level, the funding for basic research in NSF's FY 2012 Request represents an average annual rate of growth of 9.3 percent.

Question 2: How does the current federal investment in basic research compare to our major competitors? How does the annual rate of growth of this investment compare to our major competitors?

Answer: Comparable international data on government funding of basic research are not available to answer this exact question. Comparisons can be made about levels and growth in total expenditures (federal and non-federal) for basic research among major international competitors, defined as the G-7 countries as well as Korea and China (see Table 1).

Total (federal plus non-federal) U.S. investment in basic research far exceeds that of any of these countries. The rate of growth in such expenditures for the U.S. in recent years (2003-2008) trailed that of China, France, and Korea. For 2007-2008 (when data were available for more countries), U.S. growth in basic research expenditures was below that for Italy and the United Kingdom as well as for China, France, and Korea.

For the U.S., the rate of growth of federal funding for basic research (3.3 percent average annual rate for 2003-2008) has been slower than the rate of growth for total basic research expenditures (4.7 percent average annual rate for 2003-2008).

Data Notes:

- The most recent internationally comparable data are available for 2008, and are reported in the OECD's *Main Science and Technology Indicators*, released in February 2011.
- The OECD does not collect or have available data on government funding of basic research.
- Several large R&D-performing countries do not collect data on basic research expenditures. Some countries that do collect total expenditures on basic research performance do not collect the sources of funding for basic research.
- Therefore, the data provided below (for the years 2003-2008) are total national basic research expenditures for the U.S. and eight additional countries. For the U.S., performer-reported federal basic research funding is also shown. The data are reported in millions of current purchasing power parity dollars.

Table 1. Total (Government plus Non-government) Expenditures on Basic Research (million current PPP $)

							Average annual percent change		
	2003	2004	2005	2006	2007	2008	2003-08	2006-08	2007-08
United States	54,839	55,868	59,462	61,038	65,988	69,146	4.7%	6.4%	4.8%
Federal Gov.	33,497	34,686	36,115	36,983	38,590	39,379	3.3%	3.2%	2.0%
Canada	..	..	..	..	..	..	..	..	..
China	1,968	2,511	2,896	3,384	3,441	4,016	15.3%	8.9%	16.7%
France	8,873	9,026	9,396	10,028	10,966	11,752	5.8%	8.3%	7.2%
Germany	..	..	..	..	..	..	..	..	..
Italy	..	..	4,987	5,792	5,832	6,608	..	6.8%	13.3%
Japan	14,161	14,066	15,443	16,137	17,068	16,932	3.6%	2.4%	-0.8%
Korea	3,473	4,272	4,699	5,348	6,402	7,047	15.2%	14.8%	10.1%
United Kingdom	..	..	..	..	4,091	4,342	..	..	6.1%

..=not available; PPP=purchasing power parity

NOTE: Data reported here based on performer-reported R&D expenditure surveys, including for the United States.

Data on Government funding of basic research are not available for most countries.

Source: OECD, Main Science and Technology Indicators, February 2011; and U.S. sources.

Meritorious Research

Question 3: How does NSF define which research proposals are meritorious and to what extent have funding increases in recent years allowed NSF to fund more of the meritorious research proposals it receives each year?

Answer: NSF relies on its long-established merit review process to determine the proposals that warrant funding. Annual reports on this process are available at http://www.nsf.gov/nsb/publications/index.jsp.

This process relies on the extensive use of knowledgeable experts from outside NSF. NSF programs obtain external reviews by mail review (reviewers are sent proposals and asked to submit written comments to NSF through NSF's web-based system), panel (reviews are solicited from panelists who convene to discuss their findings), or a combination of these two processes. In addition, site visits by NSF staff and external members of the community are often used to review proposals for facilities and centers. The NSF merit review system emphasizes reviewer narratives in addition to categorical ratings. The written comments provided by reviewers, the summary of panel discussions, and the expert opinions of program officers and division directors are important components of the merit review system. NSF program officers are experts themselves in the scientific areas that they manage. They have advanced educational training (e.g., a Ph.D. or equivalent credentials) in science or engineering and relevant experience in research, education, and/or administration. Consequently, categorical ratings are not the sole measure used to determine which proposals are funded.

Because the number of proposals that NSF receives increases each year, and the requested amount per proposal also increases each year, the funding rate remained relatively constant between 2006 and 2008 (25% in 2006, 26% in 2007, and 25% in 2008). Funding that NSF received through the American Recovery and Reinvestment Act (ARRA) in 2009 allowed the Foundation to fund more proposals (32%). Due to the sizeable increase in the number of proposals in 2010 (22.9% higher than in 2009), the funding rate was actually lower (23%) than pre-ARRA funding rates.

A key aspect of the annual reports on the merit review process is a review of the number of "potentially-fundable" proposals that are declined each year. This analysis shows that in FY 2002, the ratio of awards to highly rated declines was 6.5:1; in FY 2009, that ratio was 7:1. However, in comparison, the ratio was 4:1 in FY 2008 indicating the impact of ARRA in reducing the ratio of awards to highly rated declines.

Question 4: For the last five fiscal years, how many meritorious proposals has NSF received each year, and what percentage of meritorious proposals has the agency been able to fund?

Answer: Over the last five fiscal years NSF received between 7,500 and 8,900 potentially fundable proposals per year. Approximately two-thirds of these proposals were funded in four of the five years. In FY 2009, approximately three-quarters of the potentially fundable proposals were supported, chiefly due to resources provided by the American Recovery and Reinvestment Act of 2009.

Question 5: How much additional funding would be required to enable NSF to fund all of the meritorious proposals it expects to receive in FY 2012?

Answer: Annual reports on the merit review process provide estimates on the additional amount of funding needed to support those potentially fundable proposals that were declined. For example, in FY 2010, an additional $1.98 billion would have been required to support the potentially fundable proposals that were declined. The FY 2010 merit review report is expected to be available in May 2011.

NSF expects funding rate trends indicated in the annual merit review reports to continue in FY 2012.

Education Funding

Question 6: The FY 2012 budget proposes healthy increases for undergraduate (8.8%) and graduate (12.7%) education programs, but proposes to reduce K-12 education by 15%, including a 16% reduction to the Discovery Research K-12 Program and a 17% cut to the Math and Science Partnership Program (MSP). Does this represent a prioritization by NSF in favor of undergraduate and graduate programs and away from K-12 programs?

Answer: The NSF is deeply committed to improving K-12 STEM education and to ensuring that NSF is sharply focused on investing in new ideas for solving the Nation's most challenging STEM education problems. This means that we must invest strategically in programs that provide strong evidence about the best ways to improve STEM teaching and learning. In some cases, NSF is proposing reductions to programs as a way to focus investments on building solid evidence about how to improve student STEM learning. In other cases, we have proposed a realignment that reduces some programs to introduce new efforts in understanding the conditions under which great K-12 STEM teachers are prepared and fostered. The realignment of our K-12 STEM education portfolio will be a multi-year process, and this year's reductions allow the Directorate for Education and Human Resources (EHR), in partnership with all of NSF and the field, a chance to develop new ideas and approaches for subsequent portfolio direction. Regarding the 8.8% overall increase in undergraduate STEM education programs, several of these programs include a focus on the disciplinary content preparation of teachers, and thus are a part of the more broadly defined K-12 STEM education portfolio. In summary, NSF maintains its strong and historical leadership in K-12 STEM education while continuing to grow its focus on evidence-based improvement at the undergraduate and graduate levels as well.

Teacher Learning for the Future

Question 7: The budget justification suggests that the $10 million cut from the MSP program is being reallocated to a new Teacher Learning for the Future (TLF) Program. How will this new program be administered and how will it be different from the MSP program and other programs that support K-12 teaching?

Answer: TLF will catalyze new lines of research and development needed for rapid improvement of the preparation and continued professional learning of the STEM K-12 teachers of tomorrow. This activity will be complementary to the US Department of Education's assurance on "great teachers and leaders". Additionally, it will support concept development and prototype proposals to examine new modes of teacher learning. It also will fund implementation and evidence-building proposals where demonstration projects will be designed, implemented, and studied. TLF will provide the needed research base to support efforts across government to help ensure quality in implementing the President's goal of preparing 100,000 STEM teachers in the next ten years. Although the introduction of TLF will result in fewer MSP awards, the new program will grow a visible and complementary portfolio that is likely to involve

current MSP Principal Investigators (PIs), particularly those who have been part of the MSP-Research and Technical Assistance (RETA) program. The TLF focus on teacher preparation will support the ongoing investments in MSP in this area. TLF will aim to ensure that teachers are ready for tomorrow's science and tomorrow's learners and learning environments. For example, the nature and practice of science is becoming more computationally intensive, data-rich, and interdisciplinary; this will have implications for K-12 teaching. As technology becomes ubiquitous in K-12 classrooms, teachers need to be prepared to use that technology in innovative ways. TLF will complement the Robert Noyce Scholarship Program (NOYCE) by providing the underlying research base to ensure that program innovation is built on the best evidence. Finally, aspects of the Discovery Research K-12 (DR-K12) program that have focused on recruitment and development of teachers will be addressed in TLF. TLF will be co-administered by the Division of Research on Learning in Formal and Informal Settings and the Division of Undergraduate Education in EHR by expert scientific and education staff.

Broadening Participation at the Core

Question 8: What is the intent of establishing a "Broadening Participation at the Core" framework for the Historically Black Colleges and Universities Program, the Louis Stokes Alliances for Minority Participation Program, the Tribal Colleges and Universities Program (TCUP), and the new Transforming Broadening Participation through STEM program?

Answer: This framework will allow for more synergy among the Human Resource and Development (HRD) programs in this area (HBCU-UP, LSAMP, TCUP, and TBPS) and will position the group of programs in this area for partnering and leveraging across NSF. The intent of BPAC is to develop a framework within which to highlight emerging and exciting new directions in disciplinary and interdisciplinary science as key resources for attracting and retaining students from groups traditionally underrepresented in STEM. BPAC places science learning opportunities "at the core" of undergraduate education. Ultimately, BPAC's purpose is to transform education practice and learning opportunities at the undergraduate level to broaden participation and to engage undergraduate students with frontier research in emerging fields to retain them as key participants in the STEM workforce.

Question 9: How will the new framework change the way the first three programs work?

Answer: We expect that this new framework will ensure additional synergy among the broadening participation programs as well as collaborations with other premier programs such as the Advanced Technological Education (ATE) and STEM Talent Expansion Program (STEP), within EHR, and a range of programs beyond EHR.

Question 10: How will the new Transforming Broadening Participation through STEM program be administered, and how will it differ from the existing programs?

Answer: The FY 2012 Budget Request proposes to maintain LSAMP, HBCU-UP, and TCUP as separate programs along with the proposed Transforming Broadening Participation through STEM (TBPS), within the Division of Human Resource Development's Broadening Participation at the Core (BPAC) area. All four programs will be administered through HRD, by the team of scientific and education staff engaged in the BPAC area. TBPS is designed to complement the existing programs with its particular focus on attracting and retaining a diverse population of STEM undergraduates by constructing compelling opportunities to engage in science at the core of the undergraduate curriculum. The TBPS program will require in-depth collaborations

among awardee institutions and universities, research laboratories, businesses, science museums, scientific research facilities, and government agencies to strengthen the core STEM curriculum and research experiences in the awardee institutions. The ultimate goal is to accelerate the process of building and sustaining a diverse science and engineering workforce that draws on all sectors of the Nation. The new proposed program, TBPS, will seek innovative solutions for broadening participation in STEM at the undergraduate level, including increased engagement with Hispanic-serving institutions (HSIs). NSF will gather expert and stakeholder input that will inform the development of TBPS. Lessons learned and evidence-based models from the LSAMP, HBCU-UP, and TCUP programs will be key to the planning of TBPS.

NSF Role in STEM Education

Question 11: A recent GAO report on duplicative federal programs identified nine programs across the government focused on improving the quality of teaching in STEM subjects. What does NSF believe is its role with regard to STEM education? How does that role differ from the role of the Department of Education (DOE) and other federal agencies?

Answer: NSF is the principal source of federal support for strengthening STEM education through research and development. STEM education, and specifically, the quality of STEM teaching and teacher education, has been part of NSF's mission from the very beginning of the agency and the primary role that NSF has played in the support of STEM education research has been to build the knowledge base that is available today. From the early days of the Foundation, NSF has funded institutes and learning experiences for K-12 pre- and in-service teachers of mathematics and science along with studies to examine their impact, consistent with the goals of the Foundation to support the development of a high-performing scientific workforce. Building on its past accomplishments and anticipating the future, NSF is uniquely situated among federal agencies to advance this kind of education by drawing on its strong connections with the nation's leading STEM researchers, faculty, education researchers, science, technology, and education policy makers, and other professionals. NSF programs supporting STEM education encompass a wide range of disciplines, including biology, chemistry, engineering, mathematics, physics, computer science, social science, economics, behavioral science, geological sciences, Arctic and Antarctic studies, and a range of interdisciplinary areas. This immediate access to such a broad range of leading-edge research for activities in teacher education is unique to NSF among federal agencies. Complementary programs at other agencies focus on mission-oriented areas of science, technology, engineering, and mathematics. These programs, as well as those at NSF, complement the more general and wide-ranging investments of the U.S. Department of Education, where specific programs focus on key aspects of the major challenges (e.g., capacity building in states and districts; teacher recruitment and retention).

Question 12: In what ways do NSF and other federal agencies work together to ensure not only that there is no overlap between programs, but that they complement one another?

Answer: Multiple mechanisms exist to coordinate programmatic activities that may span the missions of more than one agency. Coordination takes place through both informal and formal mechanisms. Some of the most productive collaborations occur through informal program officer contact with their counterparts in other agencies. No program officer is interested in funding work that is already being funded by another agency. More formal mechanisms include: agreements reached through the development of memoranda of understanding, research plans

developed through the National Science and Technology Council, and reviews by the Office of Management and Budget. Currently, for example, NSF Director Subra Suresh co-chairs, with Dr. Carl Wieman of OSTP, the newly formed NSTC Committee on STEM Education, which is preparing a report required by the America COMPETES Reauthorization Act of 2010 concerning government-wide strategic planning for STEM education coordination.

Question 13: What are specific examples of how NSF and DOE work together to prevent overlap and promote complementarity?

Answer: NSF has a long history of cooperation with various programs and offices within the US Department of Education (ED), including the Office of the Secretary, the National Center for Education Statistics (NCES), and the Institute of Education Sciences (IES). EHR and the Department of Education's Institute of Education Sciences (IES) have been engaged in designing and planning a study of mathematics professional development for teachers. There have been productive collaborations between the NSF's and ED's Math and Science Partnership (MSP) programs. The coordination of MSP occurs at the agency, program, and project levels. Almost two-thirds of NSF-funded partnerships report direct collaboration with ED's state MSP sites.

NSF/EHR is leading a multi-agency effort to ascertain whether and how to design an impact study on immersive science research experiences for teachers by gathering information about programs across government that focus on authentic research experiences for teachers. Collaborations with National Center for Education Statistics (NCES) include NSF support in funding of the High School Longitudinal Study and regular oversight discussions concerning international comparative studies in STEM education. There is an ongoing activity currently with IES and EHR to develop common standards of evidence for STEM education initiatives, with particular focus on defining what "rigorous evidence" means for development projects.

In the FY2012 Budget Request, the proposed NSF Teacher Learning for the Future effort is a planned complement to the proposed ED Teacher Pathways effort, in which NSF would fund basic R&D that would in turn support large-scale efforts by ED to attain the President's goal of reaching 100,000 new teachers over the next ten years. This plan would leverage established interactions among staff at the two agencies. In particular, NSF staff meet regularly with counterparts at the Department of Education to ensure that relevant programs are coordinated.

Audit Resolution Process

Question 14: In December 2009, the NSF OIG issued a report on NSF's audit resolution and corrective action process, which found a number of shortcomings. The OIG's most recent semi-annual report suggests that a new audit resolution process was put into place last fall. What does that process entail, and what progress NSF has made in implementing it?

Answer: Recent efforts to enhance NSF's system for end-to-end grants management focus on strengthening post-award oversight, including audit resolution. The OIG's report on audit resolution afforded the opportunity to revisit dated policies, procedures, and most importantly practices that have inhibited effective collaboration between NSF and the OIG.

To date, progress on implementation has been as follows:

- In January 2010, NSF's Acting Director and Inspector General charged an Audit Resolution Working Group, comprised of NSF and OIG managers, to develop a new strategy for improving the audit resolution process.
- On September 27, 2010, NSF management and the OIG jointly issued a shared policy for an enhanced post-audit protocol that would lead to best practices in the post-audit process, define appropriate levels of organizational involvement for ensuring federal compliance, and facilitate effective collaboration, understanding, and performance. As a result of this effort, a collaborative process for audit resolution and instructions for handling external audits were codified.
- On September 30, 2010, NSF's Acting Director and Inspector General established a standing Stewardship Collaborative. Comprised of NSF and OIG senior managers, its mission is to improve the audit resolution process, address emerging and outstanding issues, and train staff through active engagement. To date, it has addressed issues surrounding process, language, clarity of roles, and oversight of NSF's American Recovery and Reinvestment Act (ARRA) investments.
- NSF has also revised its methodology for measuring the time taken for issuance of external audits and is working on revision of its internal operating guidance for audit report issuance and resolution.

To reinforce a culture change, NSF management and the OIG are instituting a program of on-going staff training and engagement. In addition to the mandatory training of NSF and OIG staff to initiate implementation of new policies and procedures, staff of both organizations have participated in a conference on cooperative audit resolution and an interactive session on development, use, terminology, and statistical methodologies used to develop the OIG *Semi-Annual Report to Congress.*

Question 15: Have the audit resolution policy changes made by NSF resulted in improved resolution of audits and grantee compliance with corrective action requirements? If so, what metrics indicate such progress?

Answer: The revised policy governing the audit resolution process was issued by NSF and the OIG only six months ago in late September 2010. Our goals are to clarify organizational roles; foster open communication and coordination; effectively draw on the unique skills and perspectives of each organization; productively discuss issues around the severity, impact, scope, and substance of findings and recommendations; and facilitate mutually acceptable solutions when disagreements arise. Over time, we see the outcomes of this effort as improved stewardship of NSF investments through increased audit quality, and a more efficient and effective audit resolution process, with benefits to the agency, the OIG, and the awardee community.

Large Facilities

Question 16: In September 2008, the NSF OIG issued a report on performance measurement and evaluation of large facilities and instruments. What steps has NSF taken in responding to the OIG recommendations, particularly with regard to ensuring that cooperative agreements contain performance and evaluation components?

Answer: In FY 2009 NSF established a policy requirement that all new or existing cooperative agreements (CAs) for NSF's major multi-user research facilities incorporate performance measurement and evaluation components, including goals and objectives, performance

measures/targets, periodic reporting and evaluation, and feedback to assess progress. These goals and metrics are set annual through an Annual Work Plan, and subsequently reported to NSF via an Annual Report. NSF has now fully implemented this new policy by adding the required language to the CAs of all existing large facilities (where such language was not already present), and now has the standard practice of including the required language in CAs of new facilities.

Question 17: Has NSF given the Large Facility Office the authority to effectively oversee the operations phase of large facility projects to ensure that NSF can track whether these projects are meeting their performance goals, as recommended by the OIG?

Answer: The Large Facilities Office (LFO) contributes significantly to this oversight. Oversight authority for each of NSF's supported facilities is the responsibility of the sponsoring directorate or office through which the facility receives budgetary support, assisted by the various staff functions that exist within NSF, including LFO. LFO provides overarching guidance and policies on facility management, participates in a number of site visits and NSF-led reviews, coordinates Business Systems Reviews of facilities and is a resource to the National Science Board on facilities related matters and policy.

QUESTIONS FOR THE RECORD SUBMITTED BY
Michael Honda

DUSEL - Underground Laboratories

Question 1: Over the last decade, a series of reports outlined compelling questions in modern science that can be answered only in a deep underground environment. In response to this, the scientific community has overwhelmingly supported the construction and operation of a national underground laboratory. Research communities in physics, geosciences, engineering, biology, and other fields have further refined the questions and defined the critical experiments that would require access to scientific facilities deep underground. As planning continues for a deep underground facility, early and formal continued participation by the NSF is critical. Recognizing the importance of this facility and the overwhelming support of the scientific community, how does the National Science Foundation, which supports research across science and engineering fields, intend to continue to be formally involved in the development and construction of the Deep Underground Science and Engineering Laboratory (DUSEL) in partnership with the Department of Energy?

Answer: NSF will continue to consider grant proposals for future particle physics research and other fields, including underground experiments that might be conducted at Homestake, should DOE decide to support the core infrastructure there, or at other sites in the United States and around the world.

Question 2: In the America COMPETES Act enacted in 2010, Congress recognized the need for NSF "in its planning for construction and stewardship of large facilities, to coordinate and collaborate with other Federal agencies, including the Department of Energy's Office of Science, to ensure that joint investments may be made when practicable." Given that the National Science Board has encouraged the NSF to work with the White House and Department of Energy to identify a different stewardship model, what is the current status of negotiations and participation of NSF with the DOE in the future of the Long-Baseline Neutrino Experiment (LBNE) and the development of an underground laboratory? How is the White House coordinating with you on these efforts?

Answer: DOE has initiated a scientific assessment to determine the optimal location for a potential Long Baseline Neutrino Experiment (LBNE) far detector. This assessment is expected to conclude in time to inform preparation of DOE's FY 2013 budget request.

Pending a DOE decision on the location of the LBNE far detector, NSF and DOE are working together to preserve the viability of the Homestake site in FY 2011. NSF has agreed to provide $4.0 million during the remainder of FY 2011 to sustain pumping operations at the Homestake site. DOE has included $15.0 million in its FY 2012 budget request, presently before Congress, to extend pumping operations through FY 2012.

NSF and DOE are keeping the Office of Science and Technology Policy apprised of our progress in defining appropriate roles and responsibilities going forward.

Question 3: Will NSF complete its funding of the 15 awards it has made to date to study initial experiments for early science which could be conducted in such a unique underground laboratory environment?

Answer: Yes. The final allotment (third year) of funding for the Directorate for Mathematical and Physical Sciences, Physics Division (MPS/PHY) component of the DUSEL Solicitation 4 (S4) awards are included in the FY 2011 Budget Request. These nine continuing awards in MPS/PHY will be made and the S4 commitments completed. The Directorate for Geosciences intends to fund the final year of the seven DUSEL S4 awards that were co-funded with the Directorate for Engineering and Directorate for Biological Sciences.

Question 4: The implications of the future research at DUSEL go far beyond the science discoveries themselves, as opportunities to attract students at all ages have been built into the plan, with the potential to redirect future scientists to the U.S. rather than our foreign competitors. Is NSF working with the relevant partners to identify ways to ensure that activities, such as summer scholarships and internships, and our nation's commitment to science education continue while the federal agencies are working on the appropriate stewardship model?

Answer: NSF continues to be committed to workforce development in all fields that may benefit from underground research. NSF will continue to consider grant proposals for future particle physics research and other fields, including underground experiments that might be conducted at Homestake, should the Department of Energy decide to support the core infrastructure there, or at other existing sites in the United States and around the world.

Question 5: How is NSF prepared to work with the university community to ensure that the research needs will still be met with any proposed changes to the existing plans for DUSEL?

Answer: NSF will continue to support the nuclear and particle physics university communities as they pursue underground research through the normal grant and proposal peer-review process.

QUESTIONS FOR THE RECORD SUBMITTED BY
Jose E. Serrano

Arecibo Observatory

Question 1: Has the National Science Foundation formalized a joint funding relationship with NASA to ensure sufficient funding for the Arecibo Observatory?

Answer: Following the NSF Director's approval of an award recommendation for the next cooperative agreement to manage and operate the National Astronomy and Ionosphere Center (NAIC-Arecibo Observatory), NSF will formalize a memorandum of understanding (MOU) with NASA regarding joint funding and oversight of the facility. The award recommendation, to be considered at an April 2011 meeting of the NSF Director's Review Board, follows the solicitation and merit review of proposals to manage and operate NAIC. The NASA Near-Earth Object Observation Program has been kept apprised of each stage of the management competition and is prepared to develop an appropriate MOU with NSF.

Question 2: The Arecibo Observatory management solicitation published by the NSF stated that upon award, the Arecibo facility will be decertified as a Federally Funded Research and Development Center, or FFRDC. What is the funding impact of this decertification decision? Will it endanger NSF funding for the facility beyond the 5 year time frame of the contract?

Answer: Decertification of NAIC as an FFRDC reflects a change only to the federal administrative regulations applicable to NAIC and does not imply any change in NAIC's continuing status as a center of excellence for multidisciplinary scientific research. Without restrictions imposed by FFRDC status, NAIC will have greater freedom to establish partnerships beyond those permitted by government regulations applicable to FFRDCs. More information about the decertification of NAIC as an FFRDC can be found at: www.nsf.gov/funding/pgm_summ.jsp?pims_id=5652.

Hispanic Serving Institutions-Undergraduate Program

Question 3: The FY 2010 CJS Conference Report directed the National Science Foundation to establish a Hispanic Serving Institutions-Undergraduate Program, and to request significant funding for said program in the FY 2011 budget. The language from the Conference Report is as follows: "The conferees direct NSF to provide a report detailing plans to establish a Hispanic Serving Institutions-Undergraduate Program no later than 90 days following enactment of this Act. The conferees expect a significant funding request for such a program to be included in NSF's fiscal year 2011 budget request." Unfortunately, neither the FY 2011 nor FY 2012 budget requests included such a program. Although the NSF is making important efforts to expanding opportunities for underrepresented minorities, including through the establishment of a new program in this year's budget request, it is troubling that the NSF has not started a dedicated Hispanic Serving Institutions Undergraduate program. Hispanics are now the largest minority group in the United States, and are severely under-represented in the STEM fields. More importantly, Congressional instruction was very clear in this regard. Does the National Science Foundation have plans in the works to establish such a program, above and beyond what is already being offered?

Answer: In FY 2008 and 2009, NSF initiated a series of listening sessions with the Hispanic Serving Institution (HSI) community to understand the diverse needs and opportunities for broadening participation of Hispanic students in STEM fields. From those sessions, NSF learned that many of the challenges facing HSIs in increasing participation are the same challenges faced by other minority-serving institutions, and that many of the strategies that have been most promising in engaging Hispanic students in STEM show promise for engaging all students. NSF continues to analyze, engage, and inform the higher education communities' direction and approach to workforce development and broadening participation in science, technology, engineering and mathematics (STEM). NSF's ongoing study includes a thorough analysis of underrepresented group STEM enrollment and graduation over time in institutions of higher education in the United States. As a result of this work, NSF will develop strategies for strengthening STEM education at the undergraduate level in colleges and universities throughout the Nation. Data about the particular needs and contexts in the wide range of HSIs across the Nation will be essential in this future planning. NSF will also address these opportunities through the new Transforming Broadening Participation through STEM (TBPS) program included in the FY 2012 budget request. This new program will seek innovative solutions for broadening participation in STEM at the undergraduate level in anticipation of tomorrow's changing demographics including increased engagement with HSIs.

WEDNESDAY, MAY 4, 2011.

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

WITNESS

DR. JOHN P. HOLDREN, DIRECTOR

Mr. WOLF. Good morning. We want to welcome you this morning to the hearing on the fiscal year 2012 budget of the Office of Science and Technology Policy.

Our witness is Dr. John Holdren, the director of OSTP.

We appreciate you being here.

OPENING STATEMENT OF CHAIRMAN WOLF AND RANKING MEMBER FATTAH

The Administration and the Congress are in broad agreement about the need for significant investments in science and technology programs next year.

I think where there are some differences is that many do not agree on how the President's budget distributes the science and technology money used for fiscal year 2012.

I am not sure that the Administration is doing enough to ensure that all of the various elements of the science and technology budget are well-coordinated and are formed into a coherent over-arching program.

And I question sometimes whether the Administration takes seriously the threat posed to us by China and our other economic competitors.

Dr. Holdren, you are here today not only to defend your own budget request but also to discuss these larger issues with the Government's research and development agenda because you have one of the most important positions within the Government on these science and technology issues.

But before we get to your testimony and questions, I would like to turn it over to Mr. Fattah, the ranking member.

Mr. FATTAH. Thank you.

Let me welcome you also, and let me thank the chairman for conducting this very important hearing.

Needless to say, there is a very, very significant challenge for our country in this space. Many years ago we had absolute advantages that are now relative advantages over our economic competitors in a variety of these areas. Innovation and technology is critically important and our investments in science are important. Larger countries like China are making very significant investments and smaller countries like Singapore and others are making, relative to their size, very significant investments in these areas.

This Administration has done more than any administration or actually more than a number of administrations combined in terms of investment in science, technology, and innovation.

The chairman's efforts and this committee's efforts in terms of the report around the Gathering Storm I think have helped generate more interest here on The Hill around our critical needs.

And I think that there is a combination of issues that create some synergy related to energy independence that also have spurred some interest.

So I am very interested in your testimony and look forward to an opportunity to interact.

Thank you.

Mr. WOLF. Thank you.

You may proceed. Your full statement will appear in the record.

TESTIMONY OF OSTP DIRECTOR HOLDREN

Dr. HOLDREN. Well, thank you very much, Chairman Wolf, Ranking Member Fattah.

It is certainly a privilege for me to be here today to talk with you about the President's fiscal year 2012 budget proposal for science and technology. And I will try to address the broader concerns. I am certainly not here just to talk about the OSTP budget request. The premise behind this budget is one that, as both of you have already stated, is something we really all share and that that is that creating the American jobs and industries of the future, creating the quality of life that we all want for our children and their children does require investing in the creativity and the capacity to innovate of the American people.

We think that the 2012 budget proposal that the President has put forward does that with responsible and targeted investments in the foundations of discovery and innovation, that is in research and development, in science, technology, engineering, and math education and in 21st century infrastructure.

And it does that with increases in the highest priority focuses being offset by reductions in lower priority ones. It is a budget that is aimed at helping us win the future by out-innovating, out-educating, and out-building the competition, but doing it in a way consistent with the need to reduce the deficit, to trim budgets overall.

Now, clearly we need the continued support of the Congress in order to get this done. And I stress continued support because the strengthening of the national effort in science, technology, and innovation has for a very long time been very much a joint venture of the Congress and the Administration. It has been that way over the past two years and we certainly hope it will continue to be a joint venture.

As you know, the President's budget proposes a record $66.8 billion for civilian research and development, but we are committed, as I have already suggested, to reducing the deficit even as we prime the pump of discovery and innovation.

We have made in developing the President's budget strategic decisions to try to focus the resources on those areas where the payoff for the American public, for the American taxpayer is likely to be highest.

Mr. Chairman, I know the committee is already familiar with the details of the President's budget proposal. I just want to very briefly highlight a couple of key points for the agencies that are under the jurisdiction of this subcommittee.

First of all, consistent with the America COMPETES Reauthorization Act, which was passed by Congress, as you know, in December, signed by the President in January, the budget calls for continuing on the doubling trajectory for the National Science Foundation, the DoE Office of Science, and the NIST, that is National Institute of Standards and Technology, laboratories that the President originally committed to in his speech at the National Academies in April of 2009.

Two of those three agencies that are especially important to the future economic leadership of this country are under the jurisdiction of your subcommittee, as you know.

In the case of NASA, the President's budget holds that agency to the 2010 appropriated level of $18.7 billion while still funding every initiative that was called for in the 2010 NASA Authorization Act.

The President's budget also helps NOAA improve critical weather and climate services, invest more heavily in restoring our oceans and coasts, and in ensuring continuity in crucial earth observation satellite coverage.

The 2012 budget also emphasizes STEM education to prepare our children to be the skilled workforce of the future. It does that in part by providing $100 million as a down payment on a ten-year effort to prepare 100,000 new highly effective STEM teachers. That is part of a broader Administration commitment to look carefully at the effectiveness of all of our STEM programs and find ways to improve them.

And to further that goal, I have established a committee on STEM education under the National Science and Technology Council which, as you know, deals with interagency efforts relating to science and technology. STEM education is certainly very much an interagency effort.

And that committee, which is being co-chaired by OSTP's associate director for Science, the Nobel Laureate in physics, Carl Wieman, has already begun its work. It began its work in March and involves all the federal agencies that are involved in different ways in STEM education.

The budget also includes investments for a wireless innovation and infrastructure initiative that will help extend the next generation of wireless, we hope, to 98 percent of the U.S. population.

Of course, it does, getting to my own office's budget, request under this subcommittee $6.65 million for OSTP operations. That is five percent below the 2010 funding level and slightly below the 2011 funding level. And that is in recognition of the need to share the sacrifice and to freeze non-security discretionary spending.

So let me reiterate in closing the guiding principle that underlies this budget and that is that America's strength, our prosperity, our global leadership all depend directly on the investments that we are willing to make in R&D and STEM education and in infrastructure.

Only by sustaining these investments are we going to be able to assure future generations of Americans a society and a place in the world that is worthy of the history of this great Nation which has been building its prosperity and its global leadership on a foundation of science, technology, and innovation since the days of Jefferson and Franklin.

Now, I know that staying the course in the current fiscal environment is not going to be easy, but I believe that the President's 2012 budget for science and technology provides a blueprint for doing that that is both visionary and responsible.

The support of this committee, which has been the source itself of so much visionary and at the same time responsible legislation in this domain in the past, is obviously going to be essential if we are going to stay on course.

And I very much look forward to working with all of you, Chairman Wolf, Ranking Member Fattah, Members of the committee, in working toward that end.

Thank you very much.

[The information follows:]

Statement of Dr. John P. Holdren
Director, Office of Science and Technology Policy
Executive Office of the President of the United States
to the
Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States House of Representatives
on
Science and Technology Funding in the 2012 Budget
March 31, 2011

Chairman Wolf, Ranking Member Fattah, and Members of the Committee, it is my distinct privilege to be here with you today to discuss investments in Federal research and development (R&D) in the President's fiscal year (FY) 2012 Budget.

Administration Initiatives in Education, Innovation, and Infrastructure

President Obama, in his most recent State of the Union address, called on all of us to help create the American jobs and industries of the future by doing what this Nation does best – investing in the creativity and imagination of the American people. The President identified this time in history as our generation's Sputnik moment. And just as investments in science and engineering research and development (R&D) turned the original Sputnik moment into a Golden Age of American technological and economic dominance, so new investments in science, technology, and innovation (STI) will be the foundation for continued American leadership in the future. Targeted investments in the most promising frontiers of science, made in the context of responsible reductions in less productive endeavors, will fuel this trajectory and allow us, in the President's words, to "out-innovate, out-educate, and out-build the rest of the world."

President Obama understands that our ability to meet the grand challenges before us is intimately dependent on robust research and development; superior science, technology, engineering, and mathematics (STEM) education; and 21st century transportation, telecommunications, and energy infrastructure. His 2012 Budget provides strategic investments in these domains while also streamlining aspects of the Federal government and responding responsibly to the deficit. At a difficult time in America's history, the President's 2012 Budget proposes to invest intelligently in innovation, education, and infrastructure today to generate the industries, jobs, and environmental and national security benefits of tomorrow. Obviously, we need the continued support of the Congress to get it done. I say "continued support" because much of the President's Federal research and education investment portfolio enjoyed bipartisan support during the first two years of the Administration. And in this 112th Congress, we hope to extend this partnership with both the House and the Senate across the entire science and technology portfolio. Such a collaboration to stimulate scientific discovery and new technologies will take America into this new century well-equipped for the challenges and opportunities that lie ahead.

In the remainder of this testimony, I elaborate on the reasons the President and I are most hopeful you'll provide that support.

The Federal R&D Budget

In his State of the Union address, the President said: "The first step in winning the future is encouraging American innovation," and he promised to deliver a budget that would ensure the Nation's ability to achieve that goal. Last month, the President released that budget. It proposes a record $66.8 billion investment in civilian research and development, an increase of $4.1 billion or 6.5 percent over the 2010 funding level, reflecting the Administration's firm belief that investment in civilian research is a key ingredient for cultivating the innovation that is so important to growing the American economy of the future.

(Because of the uncertainty around the outcome of 2011 appropriations, all the comparisons in my testimony are between the 2012 Budget and the enacted 2010 appropriations. My testimony discusses changes in current dollars, not adjusted for inflation. The latest economic projections show inflation of 2.7 percent between 2010 and 2012 for the economy as a whole, using the GDP deflator.)

These important R&D investments will bolster the fundamental understandings of matter, energy, and life that are at the root of much innovation, and they will foster significantly new and potentially transformative technologies in areas such as biotechnology, information technology, and clean energy.

The Obama Administration's investments in innovation, education, and infrastructure fit within an overall non-security discretionary budget that would be frozen at 2010 levels for the second year in a row and would stay frozen to 2015. The Budget reflects strategic decisions to focus resources on those areas where the payoff for the American people is likely to be highest, while imposing hard-nosed fiscal discipline on areas lacking that kind of promise. For example, the 2012 Budget proposes $79.4 billion for development within the Federal R&D portfolio—a decline compared to the 2010 funding level primarily because of reductions in development funding in the Department of Defense. Across government, important programs will have to make do with less, as noted in several of the program descriptions below. The total (defense and nondefense) R&D budget would be $147.9 billion, $772 million or 0.5 percent above the 2010 enacted level. That modest increase is difficult to accept, of course, given the many needs that could potentially be addressed by an expanded Federal R&D portfolio. But the Administration is committed to making tough choices and it has made many such in this Budget.

Budgets of Science Agencies

Three agencies have been identified as especially important to this Nation's continued economic leadership by the President's Plan for Science and Innovation, the America COMPETES Act, the Administration's Innovation Strategy, and the America COMPETES Reauthorization Act, passed by the Congress in December and signed by the President in January. Those three jewel-in-the-crown agencies are the National Science Foundation, a primary source of funding for basic academic research; the Department of Energy's (DOE's) Office of Science, which leads fundamental research relevant to energy and also builds and operates the major research infrastructure—advanced light sources, accelerators, supercomputers, and facilities for making nano-materials—on which our scientists depend for energy research breakthroughs; and the National Institute of Standards and Technology laboratories, which support a wide range of pursuits from accelerating standards development for

health information technology and "smart grid" technologies to conducting measurement science research to enable net-zero energy buildings and advanced manufacturing processes.

In recognition of the immense leverage these three agencies offer and their key role in maintaining America's preeminence in the global marketplace, Congress and this Administration have worked together to put these agencies on a doubling trajectory. The FY2012 budget maintains that trajectory, as newly authorized in the America COMPETES Reauthorization Act (Public Law 111-358), with a 12.2 percent increase between 2010 and 2012 for their combined budgets, totaling $13.9 billion. I want to emphasize that the proposed increases for these three agencies are part of a fiscally responsible budget focused on deficit reduction that holds overall non-security discretionary spending flat at 2010 levels for the second year in a row, meaning these increases are fully offset by cuts in other programs.

I now turn to the budgets of individual agencies in a bit more detail. I will focus primarily on the agencies under the jurisdiction of this subcommittee.

National Science Foundation (NSF)

The National Science Foundation (NSF) is the primary source of support for academic research for most non-biomedical disciplines, and it is the only Federal agency dedicated to the support of basic research and education across all fields of science and engineering. NSF has always believed that optimal use of federal funds relies on two conditions: ensuring that its research is aimed – and continuously re-aimed – at the frontiers of understanding; and certifying that every dollar goes to competitive, merit-reviewed, and time-limited awards with clear criteria for success. When these two conditions are met, the nation gets the most intellectual and economic leverage from its research investments. In recognition of the time-proven truth that today's NSF grants are tomorrow's billion dollar, job-creating companies, the 2012 Budget request for NSF is $7.8 billion, an increase of 13.0 percent above the 2010 funding level. This keeps NSF on track to double its budget as promised in the President's Plan for Science and Innovation.

NSF puts the greatest share of its resources in the nation's colleges and universities. Universities are the largest performers of basic research in the United States, conducting over fifty percent of all basic research. Basic research funding such as that provided by NSF is important not only because it leads to new knowledge and applications but also because it trains the researchers and the technical workforce of the future, ensuring the Nation will benefit from a new generation of makers and doers. In order to maximize this dual benefit to society and NSF's special contribution, the 2012 Budget sustains the doubling of new NSF Graduate Research Fellowships to support 2,000 new awards. The 2012 Budget also includes $64 million for the Advanced Technological Education (ATE) program to promote partnerships between higher-education institutions and employers to educate technicians for the high-technology fields that drive our nation's economy; ATE is the centerpiece of an overall $100 million NSF investment in community colleges, an important part of the higher education system.

NSF also proposes to increase research funding to promote discoveries that can spark innovations for tomorrow's clean energy sources with a cross-disciplinary approach to sustainability science. The Science, Engineering, and Education for Sustainability (SEES) portfolio will increase to $998 million in the 2012 Budget for integrated activities involving energy and environment. NSF is also committed to enhancing U.S. economic competitiveness

with Science and Engineering Beyond Moore's Law (SEBML), a multidisciplinary research program that aims to extend the technological and conceptual limits on computer processing, with an investment of $96 million in the 2012 Budget. NSF is also investing $76 million in a multi-directorate initiative on research at the interface of the Biological, Mathematical, and Physical Sciences (BioMaPS) that aims for an accelerated understanding of biological systems and the opening of new frontiers in biotechnology. The Administration proposes $15 million in the 2012 Budget for NSF's contribution to a new interagency initiative called Enhancing Access to the Radio Spectrum, or EARS, to support research into new and innovative ways to use the radio spectrum more efficiently so that more applications and services used by individuals and businesses can occupy the limited amount of available spectrum.

National Aeronautics and Space Administration (NASA)

This past October, the President signed the 2010 NASA Authorization Act (the "Act", Public Law 111-267), which stands as a statement of bipartisan agreement by Congress and the Administration regarding NASA and its many programs. NASA's programs not only support the grand and inspiring adventures of space exploration, scientific discovery, and aeronautical advancement, but also provide an indispensable platform for observing the Earth to ensure that we have the information we need to cope with weather-related and other environmental threats to human well-being. NASA programs also fuel new technology development and innovation and help launch new products, services, businesses, and jobs with enormous growth potential. The Act will further our joint goal of placing NASA's programs on a more stable footing and enhancing the long-term sustainability of these exciting endeavors as we chart a new path forward in space.

The FY2012 NASA budget reaffirms the Administration's commitment to a bold and ambitious future for NASA. Every initiative called for in the Act is funded, including: a robust program of space science and Earth science, including a commitment to invest in new satellites and programs of Earth observation; a strong aeronautics research program; the Space Launch System (SLS) heavy-lift launch vehicle and Multi-Purpose Crew Vehicle (MPCV) needed to support human spaceflight and exploration missions beyond Earth's orbit; a vigorous technology development program; extension of International Space Station (ISS) activities through at least 2020, coupled with a plan to use this orbiting outpost more effectively; and the development of private-sector capabilities to transport cargo and crew into low Earth orbit, thus shortening the duration of our reliance solely on Russian launch vehicles for access to the ISS.

Within the context of a difficult budget environment and the President's decision to freeze non-security discretionary spending at 2010 levels for five years, NASA's budget remains at $18.7 billion in the 2012 Budget. This budget level demands difficult choices, and those choices were made while keeping in mind the priorities of the Act as well as the collective desire of the Congress and the Administration to have a balanced program of science, research, technology development, safe spaceflight operations, and exploration. One such difficult choice was limiting the budget for the James Webb Space Telescope, keeping the project funded at $375 million in 2012, to assure NASA the opportunity to begin work on new scientific opportunities identified in the National Academies' most recent decadal survey in astronomy and astrophysics. Similarly, the 2012 Budget reduces the planned increases in Earth-science research outlined in the 2011 Budget. The Budget demonstrates the President's continued commitment to our shared priorities even when difficult decisions are required, providing $1.8 billion in FY2012 funding for the Space Launch System and $1.02 billion for the Multi-Purpose Crew Vehicle, thereby

laying the critical foundation for these exploration programs. As NASA reported in January of this year, it is still in the process of shaping these efforts and will discuss them in more detail in a report to Congress this spring. Similarly, the Budget provides a solid foundation for the commercial crew and cargo transportation programs that are necessary to provide safe and cost-effective access to low Earth orbit, including sufficient support for the operations of the ISS.

Department of Commerce National Institute of Standards and Technology (NIST)

The hugely complex web of technology that keeps this Nation's equipment and economy running smoothly depends on largely invisible but critical support in the fields of measurement science and standards. The National Institute of Standards and Technology (NIST) laboratories stand at the core of this Nation's unparalleled capacity in these areas, helping ensure that America remains the world leader in measurement innovation and systems interoperability. Reflecting NIST's vital role in supporting the economy and infrastructure, the 2012 Budget of $764 million for the Institute's intramural laboratories amounts to a 15.1 percent increase over the 2010 enacted level. That increase will support high-performance laboratory research and facilities for a diverse portfolio of investigations in areas germane to advanced manufacturing, health information technology, cybersecurity, interoperable smart grid, and clean energy. For NIST's extramural programs, the 2012 Budget requests $143 million for the Hollings Manufacturing Extension Partnership (MEP), an $18 million increase over the 2010 enacted level. The 2012 Budget also requests $75 million for the Technology Innovation Program (TIP), a $5 million increase over 2010, and $12 million for the Advanced Manufacturing Technology Consortia program, a new public-private partnership that will develop road maps for research that will broadly benefit the Nation's industrial base. All of these NIST programs are important components of *A Framework for American Manufacturing*, a comprehensive strategy for supporting American manufacturers announced in December 2009, and the Administration's revised Innovation Strategy released in February.

Department of Commerce National Oceanic and Atmospheric Administration (NOAA)

NOAA plays a vital role supporting research on the Earth's oceans, atmosphere, and marine habitats. The NOAA budget of $5.5 billion is an increase of $749 million over the 2010 enacted level. This will allow NOAA to strengthen the scientific basis for consequential environmental decision-making, improve critical weather and climate services that protect life and property, invest more heavily in restoring our oceans and coasts, take advantage of high-performance computing to manage weather and climate data, and ensure continuity in crucial Earth-observation satellite coverage. The 2012 Budget proposes a restructuring of NOAA, including the creation of a Climate Service line office in NOAA that will focus on the delivery of climate services while sustaining research on oceans, atmosphere, and climate.

NOAA satellite systems are critical for our Nation's ability to forecast severe weather, such as blizzards or hurricanes, and as such can save lives and property. Ensuring that we retain these capabilities remains a top priority in the 2012 Budget. The former National Polar-orbiting Operational Environmental Satellite System (NPOESS) program had a troubled history, as illustrated by numerous Congressional hearings and GAO reports. Because of this, in early 2010 the Administration announced a significant restructuring of the program, and this plan was endorsed by Congress as part of the 2010 NASA Authorization Act (Section 727). This restructuring was accompanied by significant increases in NOAA's 2011 Budget request in order to expedite the launch schedule of these essential weather satellites and reduce the risks of a gap

in forecasting data. However, because the current continuing resolution allows for only a fraction of the funding necessary in FY2011 to continue work on the instruments and spacecraft for the first of NOAA's satellites (the first Joint Polar Satellite System mission, or JPSS-1), work on the first JPSS satellite has been slowed down considerably. Under current funding scenarios, the JPSS-1 mission could be delayed by up to two years, thus forcing the weather forecasting community to rely solely on satellites that will be operating well past their planned mission life. The 2012 Budget request provides $1.1 billion to continue the development of the Joint Polar Satellite System, a significant increase over the 2010 enacted level which reflects the need for NOAA to fully fund the acquisition of satellites for the afternoon orbit within its own budget. NOAA recognizes the magnitude of the requested investment for environmental operational satellites. However, given the impact of weather on society and the nation's economy, the ability to warn and protect our citizens from harm is well worth the cost.

White House Office of Science and Technology Policy (OSTP)

The 2012 Budget requests $6.65 million for White House Office of Science and Technology Policy (OSTP) operations, 5 percent below the 2010 enacted funding level, in recognition of the need for shared sacrifice to freeze non-security discretionary spending. OSTP works with OMB to ensure that the President's S&T priorities are appropriately reflected in the budgets of all the executive branch departments and agencies with S&T and STEM-education missions. OSTP also provides science and technology advice and analysis in support of the activities of the other offices in the Executive Office of the President and supports me in my role as the Assistant to the President for Science and Technology, with the responsibility to provide the President with such information about science and technology issues as he may request in connection with the policy matters before him. In addition, OSTP coordinates interagency research initiatives through administration of the National Science and Technology Council (NSTC), serves as the lead White House office in a range of bilateral and multilateral S&T activities internationally, and provides administrative and technical support for the very active 21-member President's Council of Advisers on Science and Technology (PCAST). This work is accomplished with approximately 34 full-time equivalent staff supported by the OSTP appropriation, which includes the OSTP Director, four Associate Directors (for Science, Technology, Environment, and National Security and International Affairs), additional technical experts, and a small administrative function. In addition, there are approximately 40 scientific and technical experts detailed to OSTP from all across the executive branch along with approximately a dozen other experts brought in under the Intergovernmental Personnel Act or various fellowship arrangements. This mix of personnel allows OSTP to tap a wide range of expertise and leverage all available resources to ensure that the science and technology work of the Federal government is appropriately resourced, coordinated and leveraged.

I will now provide some selected highlights of R&D investments in Federal agencies outside the jurisdiction of the subcommittee.

Department of Energy (DOE)

The Administration is directing Federal innovation incentives to one of the most important, job-creating, innovation-inspiring challenges of our time: making clean energy affordable and abundant. The DOE R&D portfolio is a key part of this effort, which is why DOE R&D increases to $13.0 billion in the 2012 Budget. This represents targeted growth of 19.9 percent and does not include DOE's non-R&D cleanup, weapons, and energy-deployment

programs. The 2012 Budget also proposes significant resources for demonstration and deployment incentives as part of a comprehensive framework for moving the United States toward a clean-energy future. The Administration's clean-energy R&D priorities focus on developing cutting-edge technologies with real-world applications to advance a clean-energy economy, increase energy efficiency in industry and manufacturing, reduce energy use in buildings, and reach the goal of having 1 million electric vehicles on the road by 2015. To help pay for these priorities, we are proposing to cut inefficient subsidies that we currently provide, unnecessarily, for fossil fuels.

The 2012 Budget proposes $550 million in appropriations for the Advanced Research Projects Agency-Energy, or ARPA-E, and another $100 million in mandatory funding under the Wireless Innovation Fund. The Budget will advance ARPA-E's portfolio of transformational energy research with real-world applications across areas ranging from grid technology and power electronics to batteries and energy storage. First funded as part of the American Recovery and Reinvestment Act (ARRA), ARPA-E is a signature component of the America COMPETES Act, which was recently reauthorized.

The 2012 Budget also doubles the number of Energy Innovation Hubs to solve key challenges that require cross-cutting inputs from diverse disciplines. The three new Hubs will focus on Batteries and Energy Storage, Smart Grid Technology and Systems, and Critical Materials. In early February, the President visited the existing Energy Efficient Building System Design Hub, which will accelerate the development of innovative designs for cost-effective lighting, sunlight-responsive windows, and smart, thermodynamic heating and cooling systems, which together will help make America home to the most energy-efficient buildings in the world. The other two existing Hubs focus on Fuels from Sunlight and Modeling and Simulation for Nuclear Reactors.

The Department of Energy's Office of Science pursues fundamental discoveries and supports major scientific research facilities that provide the foundation for long-term progress in economically significant domains such as nanotechnology, advanced materials, high-end computing, energy supply and end-use efficiency, and climate change. The 2012 Budget of $5.4 billion, more than 10 percent above the 2010 enacted level, increases funding for facilities and cutting-edge research geared toward addressing fundamental challenges in many areas including clean energy and climate change, as well as multi-scale carbon cycle research to underpin measurement, reporting, and verification of greenhouse gas emissions.

Environmental Protection Agency (EPA)

The R&D portfolio of the Environmental Protection Agency (EPA) is $584 million in the 2012 Budget, a decline of $13 million or 2.2 percent compared to the 2010 funding level. With this investment, EPA will focus on enhancing and strengthening the planning and delivery of science by restructuring its research and science programs to be more integrated and cross-disciplinary. This request supports high-priority research of national importance in such areas as endocrine disrupting chemicals, green chemistry, e-waste and e-design, green infrastructure, computational toxicology, air monitoring, drinking water, and STEM fellowships. In addition, by way of strategic redirections, EPA will significantly increase—by $25 million—its outreach to the broader scientific community through its Science to Achieve Results (STAR) program. This investment will bring innovative and sustainable solutions to 21st century environmental science challenges by engaging the academic research community.

United States Geological Survey (USGS)

The total 2012 budget of the United States Geological Survey (USGS), Interior's lead science agency, is $1.1 billion or a $6 million increase from the 2010 enacted level. The Budget includes a total of $126 million in program increases, offsetting a total of $120 million in program reductions and savings, reflecting shifting priorities towards climate variability research and ecosystem restoration. There are significant decreases in minerals and water resources research as well as targeted increases, including $11 million to complete the network of climate science centers that will develop research-based decision support tools for use by Federal land managers. The 2012 Budget also proposes an addition of $60 million over the 2010 level for Landsat operations and the development of a new operational Landsat satellite program, which will continue to collect remote sensing data that are invaluable for many purposes, including climate and land-use change research.

Department of Homeland Security (DHS)

Department of Homeland Security (DHS) R&D totals $1.1 billion in the 2012 Budget, up $167 million or 18.8 percent from the 2010 enacted level. Within the DHS Science and Technology Directorate, the 2012 Budget proposes $150 million to begin construction of the National Bio and Agro-defense Facility (NBAF), which will serve as a new, state-of-the-art biosafety level 3&4 facility for the development of vaccines and anti-virals and enhanced diagnostic capabilities for protecting the United States against emerging agricultural diseases. The Budget also proposes $64 million for research to support the Comprehensive National Cybersecurity Initiative (CNCI), an increase of $22 million from the 2010 enacted level.

Department of Transportation (DOT)

The 2012 Budget provides $1.2 billion for Department of Transportation (DOT) R&D, an increase compared to the 2010 funding level. One significant part of DOT's R&D activities is the Federal Aviation Administration's (FAA) Research, Engineering, and Development program. The Budget includes funding for several R&D activities in FAA's Next Generation Air Transportation System, known as NextGen. The Joint Planning and Development Office coordinates this important effort with NASA and other participating agencies. The Federal Highway Administration (FHWA) also manages a comprehensive, nationally-coordinated highway research and technology program, engaging and cooperating with other highway research stakeholders. FHWA performs research activities associated with safety, infrastructure preservation and improvements, and environmental mitigation and streamlining.

Interagency Initiatives

A number of priority interagency S&T initiatives are highlighted in the President's 2012 Budget. These initiatives are coordinated through the NSTC, which as noted above is administered by OSTP.

Networking and Information Technology R&D

The multi-agency Networking and Information Technology Research and Development (NITRD) program plans and coordinates agency research efforts in cyber security, high-end computing systems, advanced networking, software development, high-confidence systems,

information management, and other information technologies. The 2012 Budget provides $3.9 billion for NITRD, an increase of $74 million over the 2010 funding level.

Networking and computing capabilities are more critical than ever for a range of national priorities, including national and homeland security, reforming the health care system, understanding and responding to environmental stresses, increasing energy efficiencies and developing renewable energy sources, strengthening the security of our critical infrastructures including cyberspace, and revitalizing our educational system for the jobs of tomorrow. The 2012 Budget includes a focus on research to improve our ability to derive scientific insights and economic value from enormous quantities of data that heretofore would have been too large to take full advantage of, and continues to emphasize foundations for assured computing and secure hardware, software and network design, and engineering to address the goal of making Internet communications more secure and reliable.

National Nanotechnology Initiative

The 2012 Budget provides $2.1 billion for the multi-agency National Nanotechnology Initiative (NNI), an increase of $201 million over the 2010 funding level. Research and development in the NNI focuses on the development of materials, devices, and systems that exploit the fundamentally distinct properties of matter at the nanoscale. NNI-supported R&D is enabling breakthroughs in disease detection and treatment, manufacturing at or near the nanoscale, environmental monitoring and protection, energy conversion and storage, and the design of novel electronic devices. In 2012, NNI agencies will be moving forward, using close and targeted program-level interagency collaboration, on three signature initiatives in areas ready for advances: Nanoelectronics for 2020 and Beyond; Sustainable Manufacturing—Creating the Industries of the Future; and Nanotechnology for Solar Energy Collection and Conversion.

In addition, agencies continue to maintain a focus on developing nanotechnology responsibly with attention to potential human and environmental health impacts, as well as ethical, legal, and other societal issues. I will also add that I recently submitted to the Committee a revised strategic plan for the NNI reflecting the changing opportunities for frontier research at the nanoscale.

U.S. Global Change Research Program

The Budget includes an expanded commitment to global change research, with the understanding that insights derived today will pay off with interest in the years and decades ahead as our Nation works to limit and adapt to shifting environmental conditions. Investments in climate science over the past several decades have contributed enormously to our understanding of global climate. The trends in global climate are clear, as are their primary causes, and the investments in this research arena in the 2012 Budget are a critical part of the President's overall strategy to mitigate U.S. greenhouse-gas emissions and move toward a clean-energy economy even as we adapt to those changes that are inevitable. Specifically, the 2012 Budget provides $2.6 billion for the multi-agency U.S. Global Change Research Program (USGCRP)—an increase of 20.3 percent or $446 million over the 2010 enacted level—to continue its important work of improving our ability to understand, predict, project, mitigate, and adapt to climate change.

As you are no doubt aware, the USGCRP was mandated by Congress in the Global Change Research Act of 1990 (P.L. 101-606) to improve understanding of uncertainties in climate science, expand global observing systems, develop science-based resources to support policymaking and resource management, and communicate findings broadly among scientific and stakeholder communities. Thirteen departments and agencies participate in the USGCRP. OSTP and the Office of Management and Budget (OMB) work closely with the USGCRP to establish research priorities and funding plans to ensure the program is aligned with the Administration's priorities and reflects agency planning. In 2011, the USGCRP is undertaking a comprehensive process that will result in an updated strategic plan, which will be submitted to Congress later this year.

Funding in the 2012 Budget will support an integrated and continuing National Climate Assessment of climate change science, impacts, vulnerabilities, and response strategies as mandated by Congress. The Budget also prioritizes an interagency research effort for measuring, reporting, and verifying greenhouse-gas emissions.

Innovation, Entrepreneurship, and Job Creation

The President believes we must harness the power and potential of science, technology, and innovation to transform the Nation's economy and to improve the lives of all Americans. In addition to the investments in research and development (R&D) I have described, the President's 2012 Budget targets strategic investments to spur innovation in the public and private sectors and to maximize the impact of the Federal R&D investment for innovation. Last month, the President released a revised Strategy for American Innovation, building on an earlier version released in September 2009. This strategy describes how investments in R&D work together with other Federal investments and policies to support American innovation. Let me share with you a few highlights that are reflected in the Budget.

The Budget proposes a permanent extension of the research and experimentation (R&E) tax credit to spur private investment in R&D by providing certainty that the credit will be available for the duration of the R&D investment. In December, the President and Congress worked together to extend expiring tax breaks for Americans; as part of that agreement, the current R&E tax credit was extended through the end of this year. The 2012 Budget proposes to expand and simplify the credit as part of making it permanent.

In addition, earlier this year the Administration announced Startup America, a campaign to inspire and accelerate high-growth entrepreneurship throughout the Nation. This coordinated public/private effort brings together an alliance of the country's most innovative entrepreneurs, corporations, universities, foundations, and other leaders, working in concert with a wide range of Federal agencies to increase the prevalence and success of American entrepreneurs. A broad set of Federal agencies will launch a coordinated series of policies that ensure high-growth startups have unimpeded access to capital, expanded access to quality mentorship, an improved regulatory environment, and a rapid path to commercialization of federally-funded research.

The 2012 Budget sustains the Administration's effort to promote regional innovation clusters as significant sources of entrepreneurship, innovation, and quality jobs. These efforts are taking place in several agencies working together, including the Small Business Administration (SBA), DOE, and especially the Economic Development Administration (EDA) within the Department of Commerce. EDA will be pursuing several programs in research parks, regional

innovation clusters, and entrepreneurial innovation activities, as authorized recently in the America COMPETES Reauthorization Act. And as mentioned earlier, the 2012 Budget continues to increase funding for the Hollings Manufacturing Extension Partnership (MEP) in NIST to disseminate the latest advanced manufacturing techniques and innovative processes to small- and medium-sized manufacturers around the Nation. Taken together, these investments will help ensure that Federal investments in innovation, education, and infrastructure translate into commercial activity, real products, and jobs.

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

In his State of the Union address, the President said: "If we want innovation to produce jobs in America and not overseas, then we also have to win the race to educate our kids." To help win that race, the 2012 Budget emphasizes science, technology, engineering, and mathematics (STEM) education, building on two strong years of progress. Through his past budget requests and actions—including his recent hosting of the first White House science fair, his launch of the "Educate to Innovate" and "Change the Equation" initiatives, and his challenging the Nation's 200,000 Federal scientists and engineers to get more involved in STEM education—the President has shown that he is deeply committed to improving STEM education. These efforts have engaged not only the Federal government but also the private, philanthropic, and academic sectors. The Educate to Innovate campaign has resulted in over $700 million in financial and in-kind private-sector support for STEM education programs. And the Change the Equation program has brought together over 100 corporations in a historic effort to scale up effective models for improving STEM education. The Administration has also integrated STEM education into broader education programs. For example, the Race to the Top competition provided a competitive advantage to states that committed to a comprehensive strategy to improve STEM education.

Building on these efforts, the 2012 Budget proposes an investment of $100 million as a down payment on a 10-year effort to help prepare 100,000 new highly effective STEM teachers. This coordinated effort between NSF and the Department of Education will help prepare teachers with both strong teaching skills and deep content knowledge. The Administration proposes $80 million for the Department of Education in the 2012 Budget to expand promising and effective models of teacher STEM preparation within the new Teacher and Leader Pathways program—for example, ones that provide undergraduates with early and intensive field experience in the classroom along with extensive STEM subject coverage. At the same time, NSF proposes to launch a $20 million teacher-education research program called Teacher Learning for the Future. In cooperation with the Department of Education, this NSF program will fund research that will increase our understanding of what makes a great STEM teacher and how to best prepare, support, and retain highly effective STEM teachers in the most cost effective manner. The coordination of these two programs will ensure that there is continual innovation and improvement in teacher preparation that is grounded firmly in evidence.

This is part of a broader Administration commitment to look carefully at the effectiveness of all STEM programs and find ways to improve them. To further this goal, I have established a Committee on STEM Education under the National Science and Technology Council. The STEM Education Committee is co-chaired by OSTP's Associate Director for Science, Carl Wieman, a Nobel Prize-winning physicist renowned for his work on improving STEM education, and involves participation from the many Federal agencies involved in STEM education activities.

The work of this Committee is closely aligned with the vision for STEM education outlined by Congress in the America COMPETES Reauthorization Act and focuses on improving the coordination and effectiveness of all Federal STEM education programs. In this spirit, the Department of Education and 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; (2) clarifying evidence standards used to assess program impact; and (3) identifying the most promising STEM efforts for further validation, testing, and suitability for scaling up.

All told, the 2012 Budget requests $3.4 billion for STEM education programs across the Federal government. This is $200 million lower than the 2010 funding level and reflects some difficult choices. However, we feel this budget is better focused on programs that will make an impact.

OSTP looks forward to working with this Committee on our common vision of improving STEM education for all of America's students.

21st Century Infrastructure

I've talked about innovation and education, and now I would like to talk briefly about the third step in winning the future: rebuilding America. In his State of the Union address, the President established a vision of rebuilding America for the 21st century. This vision is reflected in the 2012 Budget in investments that will not only rebuild the roads and bridges of the 20th century but will also help build the new infrastructure needed for America to remain competitive in this century.

Within science and technology, the 2012 Budget proposes a Wireless Innovation and Infrastructure Initiative to help businesses extend the next generation of wireless coverage to 98 percent of the U.S. population. This Initiative will enable businesses to grow faster, students to learn more, and public safety officials to access state-of-the-art, secure, nationwide, and interoperable mobile communications. It will also foster the conditions for the next generation of wireless technology, nearly doubling the amount of wireless spectrum for mobile broadband and providing critical support for R&D in wireless innovation. The Initiative builds upon the Presidential Memorandum on spectrum released last year, which proposes to reallocate a total of 500 megahertz of Federal agency and commercial spectrum bands over the next ten years to increase the Nation's access to wireless broadband.

As part of the Initiative, the 2012 Budget proposes the creation of a $3 billion Wireless Innovation (WIN) Fund to be funded out of receipts generated through electromagnetic-spectrum auctions. This Fund will advance our economic growth and competitiveness goals, supporting key technological developments that will enable and take advantage of the private sector's rollout of next-generation wireless services and pave the way for new technologies. The WIN Fund will support basic research, experimentation and testbeds, and applied development in a number of areas including public safety, education, energy, health, transportation, and economic development.

The 2012 Budget also proposes investments in novel, game-changing physical infrastructure systems including a national high-speed rail system, an improved civil aviation

system taking advantage of the NextGen air-traffic-control innovations, and new standards for smart-grid technologies.

Conclusion

The investments in research and development, innovation, STEM education, and 21st century infrastructure proposed in the President's FY2012 Budget reflect his clear understanding of the critical importance of science and technology, STEM education, and 21st century infrastructure to the challenges the Nation faces. Recognizing the importance of responsibly reducing projected budget deficits and holding the line on government spending, the President has made difficult choices in order to maintain and in some cases increase critical investments that will pay off by generating the American jobs and industries of the future. Indeed, the science and technology investments in the 2012 Budget are essential to keep this country on a path to revitalized economic growth, real energy security, intelligent environmental stewardship, better health outcomes for more Americans at lower costs, strengthened national and homeland security, and continuing leadership in science and in space.

As this Committee has long understood over the decades, the best environment for innovation in all technologies is a broad and balanced research program for all the sciences. Such a broad base of scientific research will provide the foundation for a cornucopia of multidisciplinary discoveries with unimagined benefits for our society. The truth is that this country's overall prosperity in the last half-century is due in no small measure to America's "innovation system" – a three-way partnership among academia, industry, and government.

One of President Obama's guiding principles is that America's present and future strength, prosperity, and global preeminence depend directly on fundamental research. Knowledge drives innovation, innovation drives productivity, and productivity drives America's economic growth. And so it logically follows that economic growth is a prerequisite for opportunity, and scientific research is a prerequisite for growth.

That is why President Obama believes that leadership across the frontiers of scientific knowledge is not merely a cultural tradition of our nation – today it is an economic and national security imperative. This Administration will ensure that America remains at the epicenter of the ongoing revolution in scientific research and technological innovation that generates new knowledge, creates new jobs, and builds new industries.

By sustaining our investments in fundamental research, we can ensure that America remains at the forefront of scientific capability, thereby enhancing our ability to shape and improve our Nation's future and that of the world around us.

I look forward to working with this Committee to make the vision of the President's FY2012 Budget proposal a reality. I will be pleased to answer any questions the Members may have.

Mr. WOLF. Well, thank you.

INTERNATIONAL TRAVEL

I have a number of questions and we will go through the panel. But before I do, one, I am committed to doing everything we can with regard to funding the sciences.

Secondly, if you look at the CR, the sciences did very, very well. We protected them.

Thirdly, I am very concerned about the fact that our country is beginning to fall behind. I am particularly concerned about China.

Let me ask you a couple of questions. I reviewed your international travel itineraries for last year and found that you were overseas for nearly two full months over a sixteen month period.

Why is it necessary to be out of the country so often? Can you effectively manage the office if you are out of the country that much?

Dr. HOLDREN. First of all——

Mr. WOLF. I have your itinerary, your travel schedule.

Dr. HOLDREN. Yeah, I know. I am going to have to——

Mr. WOLF. Fifty-three days, 35 business days. China, Norway, Japan, South Korea, China, Denmark, Russia, England, China.

Dr. HOLDREN. Let me explain, first of all, that most of those trips were in my capacity as the high level representative of the U.S. Government in joint commission meetings on science and technology cooperation under agreements that we have with all of those countries.

We have those high level joint commission agreements with India, Russia, China, Brazil, South Korea, and Japan. And it is my——

Mr. WOLF. You were never in Brazil, and you were in China.

Dr. HOLDREN. I have not done Brazil yet. We do have such an agreement with China.

I was also in China for the strategic and economic dialogue at the request, the specific request of secretaries Clinton and Geithner because of the importance of dialogue with China on innovation to get them to roll back their discriminatory and unfair policies with respect to procurement, with respect to intellectual property rights, and with respect to a number of other issues disadvantageous to American business and to our exports.

So I was on all of these trips basically acting as the President's agent, pursuing the priorities of this country as reflected in important aspects of international cooperation in science, technology, and innovation that we believe are in the U.S. interest.

Mr. WOLF. During that year, your most frequent destination by far was China. You took three separate trips covering a total of three weeks.

Can you go into detail of what you were doing there during those three weeks? Maybe you just covered some of that. Then if you could elaborate in a written statement by the end of this week, I would appreciate it—who you met with, what your purpose was, where you went, when you left, when you came back?

Dr. HOLDREN. No, I would be very happy to do that, sir.

The meetings were, as I mentioned, some in connection with the strategic and economic dialogue, some in connection with the U.S./

China dialogue on innovation policy, which is the forum in which we have been pursuing with the Chinese and making some considerable progress, I should say, in getting the Chinese to step back from the most discriminatory practices that they have put in place under the label of indigenous innovation.

Some of those conversations as well were at the request of the State Department in the company of Todd Stern, the U.S. ambassador to the climate change talks, to try to work on the Chinese, particularly Minister Xie Zhenhua, to get them to take more reasonable positions in climate negotiations.

Mr. WOLF. Well, let us look at this. Fifty-three days, 35 business days, three trips to China for 21 days. I think this is a little too much to be gone from the office, but I will take a look at it when you send it.

Dr. HOLDREN. Be happy to provide it.

[The information follows:]

Request for details on Dr. Holdren's trips to China

At the May 4, 2011 House CJS Appropriations Subcommittee hearing, Chairman Wolf requested a detailed summary of Dr. Holdren's three trips to China, indicating the dates of travel, who he met with and the subject of the discussions

June 6-10, 2009*: Participated in the U. S. Delegation to China regarding Clean Energy and Climate Change, led by the State Department.

- June 6, 2009 – Dr. Holdren traveled from the United States to China.

- June 7, 2009 – Dr. Holdren arrived in Beijing, China. Dr. Holdren co-led a small U.S. delegation on energy and climate change with State Department Special Envoy Todd Stern and Department of Energy Assistant Secretary David Sandalow. The aims of this delegation were to advance US-China clean-energy-technology cooperation and to discuss US and Chinese commitments on greenhouse-gas reductions prior to December's Copenhagen climate meeting. Dr. Holdren attended a dinner with Embassy representatives, Departments of Energy, and Treasury.

- June 8, 2009 – Dr. Holdren met with the Minister of Environment, Zhou Shengxian. He then met with China's chief climate negotiator, National Development and Reform Commission's (NDRC) Vice Chairman Xie Zhenhua. Dr. Holdren met with Minister of Science and Technology Minister Wan Gang. He then Met with Vice Premier Li Keqiang. Finally, he attended a dinner hosted by Charge' d'Affaires Piccuta and discussed China's response to the financial crisis and how to promote a green recovery.

- June 9, 2009 – Dr. Holdren attended a meeting at which David Sandalow spoke to the China Energy Group and a deputies-level meeting with National Energy Director Zhang Guobao. Dr. Holdren met with Minister of Foreign Affairs He Yafei. He then attended a Brookings-Tsighau lunch roundtable with academics including representatives from Tsinghau University, the Chinese National Academy, Peking University, Renmin University, the Central Party School, and the Development Research Center. He then met with energy scholars Zhou Dadi and Li Zheng. Dr. Holdren led a meeting with State Councilor Liu Yandong. Finally, he attended a dinner with a member of the Central Committee of CPC and the Chairman of the China Institute of Strategy and Management.

- June 10, 2009 – Dr. Holdren met with the American Chamber of Commerce and the US-China Business Council. He attended a briefing with the China Green-Tech Initiative. Dr. Holdren attended a roundtable with NGO representatives including, the Energy Foundation, the Environmental Defense, the World Resources Institute, the NRDC, the World Wildlife Fund, and the Global Environment Institute, among others. Dr. Holdren met with representatives of BP, Goldman Sachs, and Alcoa. He attended a deputies-level meeting with the Minister of Construction, Qiu Baoxing. He attended Todd Stern's press interviews and departed Beijing, China for the United States.

*The dates formerly provided to the Committee for this trip were inaccurate. They mistakenly included business and personal trips within the United States that were on either end of the U.S.-China Trip, which encompassed only June 6-10, 2009.

May 22-26, 2010: Participated in US-China Strategic & Economic Dialogue, led by the State Department and Treasury Department.

- May 22, 2010 – Dr. Holdren traveled from the United States to China

- May 23, 2010 – Dr. Holdren arrived in Beijing, China as part of the U.S. Delegation to the Strategic and Economic Dialogue (S&ED). The S&ED U.S. Delegation included NSS, Treasury, State, DOE, USDA, DOC, USTR, Labor, HHS, DHS, Justice, Transportation, DoD, Council of Economic Advisers, Federal Reserve Chairman, Export Import Bank, Federal Deposit Insurance Corporation, U.S. Trade and Development Agency, Energy Information Administration, Securities and Exchange Commission, and Commodity and Futures Trading Commission. That evening, Dr. Holdren had dinner with members of the US delegation.

- May 24, 2010 – Dr. Holdren participated in a series of meetings throughout the day as part of the U.S. Delegation. He met with his Chinese counterpart in the Ministry of Science and Technology, Minister Wan Gang. They discussed the state of cooperation and the upcoming tasking by the S&ED for them to lead a dialogue on innovation. Dr. Holdren also met with the NDRC Vice Chairman, Xie Zhenhua, to discuss the continuing climate negotiations. This meeting was led by Todd Stern from the State Department and included David Sandalow of the Department of Energy. Dr. Holdren addressed the science of climate change.

- May 25, 2010 – Dr. Holdren joined Secretary Clinton and her Chinese counterpart, State Councilor Liu Yandong, for the launch of the People-to-People event. Dr. Holdren did not have a speaking role in this event. Dr. Holdren then returned to the S&ED final wrap up, which included a full US Delegation meeting with Chinese President Hu.

- May 26, 2010 – Dr. Holdren went to Tsinghua University in Beijing for a roundtable discussion on climate science, which included Todd Stern from the State Department, Chinese University staff and faculty, and a Ministry of Science and Technology staffer. The event was an open event for Chinese students and faculty. Dr. Holdren had lunch with the President of the Chinese Academy of Sciences Lu Yongxiang, met with U.S. Ambassador Huntsman, and then departed for the airport.

October 12-16, 2010: Led interagency U.S. delegation on indigenous innovation.

- October 12, 2010 – Dr. Holdren departed the United States for China.

- October 13, 2010 – Dr. Holdren arrived in Beijing, China. Upon his arrival, Dr. Holdren met with the NDRC's Vice Chairman, Xie Zhenhua, regarding the upcoming IPCC climate talks in Mexico. This meeting was also attended by David Sandalow of the Department of Energy. The US interagency delegation led by Dr. Holdren for the US-China Innovation Dialogue, consisting of senior officials from the U.S. Trade Representative, Department of Commerce, Department of the Treasury, Department of Energy, U.S. Patent and Trademark Office, Department of State, and outside U.S. innovation experts attended a dinner hosted by their Chinese counterparts. Following the dinner, Dr Holdren met privately with Minister of Science and Technology Wan Gang.

- October 14, 2010 – Dr. Holdren co-chaired with Minister Wan an all-day meeting of the Innovation Dialogue. The other Chinese participants included Cao Jianlin, Vice Minister of Science and Technology; Zhu Zhigang, Vice Minister of Finance; Professor Xue Lan, Dean of Public Management College, Tsinghua University; Mu Rongping, Director, Policy Research Institute, Chinese Academy of Sciences; a representative from the Ministry of Foreign Affairs; the Vice Chairman of National Development and Reform Commission; the Vice Minister of the Ministry of Industry and Information Technology; the Vice Minister of Ministry of Commerce; Vice Chairman of the State-owned Assets Supervision and Administration Commission of the State Council; and the Deputy Commissioner of the State Intellectual Property Office. Private sector representatives included Ren Zhengfei, President of Huawei Technologies Co.; Li Xiaopeng, CEO of Huaneng Group; Liu Chuanzhi, Chairman of the Board of Lenovo Group Limited; Li Shufu, Chairman of Geely Automobile Holding Co. Ltd.; Liu Zhenya, President of State Grid Chairman of BYD Co.; Ma Yun, Chairman and CEO of Alibaba Group; Li Xiaopeng, CEO of Huaneng Group; and Liu Chuanzhi, Chairman of the Board of Lenovo Group Limited. In the evening Dr. Holdren flew to Shanghai following a further private meeting with Minister Wan Gang.

- October 15, 2010 – Dr. Holdren, along with officials from Treasury, Energy, and State, had breakfast with US companies doing business in Shanghai, sponsored by the American Chamber of Commerce China. After breakfast, Dr. Holdren gave an interview with the *Shanghai Oriental Morning Post*. Dr. Holdren then spoke to students and faculty at Tongji University in Shanghai on the Obama Administration's science and technology priorities. Dr. Holdren then toured the University's automotive research facility and learned about the Chinese government's investments in clean energy vehicles. Dr. Holdren met with Chinese press and conducted a Phoenix TV interview while at the University. Dr. Holdren also toured Suntech Power, China's largest manufacturer of solar panels, to assess its manufacturing facility and capabilities. Officials from Commerce, Treasury, and State accompanied Dr. Holdren throughout the day.

- October 16, 2010 – A U.S. Delegation, including DOE, Treasury, Commerce, and Dr. Holdren visited the U.S. Pavilion at the Shanghai Expo. The U.S. Delegation visited the Expo, at the request of the US Embassy, to show support for the U.S. high-tech companies exhibiting there, including Cisco and General Motors. In the afternoon, Dr. Holdren departed China for the United States.

Mr. WOLF. Did you take your BlackBerry with you?

Dr. HOLDREN. Yes, I did, with the permission of the security authorities. I did. The BlackBerry, of course, was scrubbed before and after, but I did take it with me and I did——

Mr. WOLF. Are you sure you can really scrub it?

Dr. HOLDREN. I am not an expert in information technology, but I am assured by the people who are in the White House that that is——

Mr. WOLF. Well, why don't we have a joint meeting with you and me and the FBI.

Dr. HOLDREN. That would be fine.

Mr. WOLF. Okay.

Dr. HOLDREN. I would be happy to do that.

Mr. WOLF. We will schedule it. I will ask the staff to set up a time.

Dr. HOLDREN. I would be happy to.

Mr. WOLF. Have you ever been out to the FBI and had a briefing with regard to China stealing any of our technology?

Dr. HOLDREN. Oh, I have had those briefings, but not at the FBI. I have had them in the situation room. I have had them in SCIFs.

Mr. WOLF. Have you been out to the cyber center out in Northern Virginia?

Dr. HOLDREN. We are going to visit that in a couple of weeks actually.

Mr. WOLF. To date, you have not been there.

Dr. HOLDREN. I have not, but I have been briefed by its director in the situation room.

Mr. WOLF. I think you have to see it.

Dr. HOLDREN. We are going to do it.

Mr. WOLF. Can you tell us when you are going to go out there? Maybe I can get a staff person——

Dr. HOLDREN. Okay.

Mr. WOLF [continuing]. To go with you.

Dr. HOLDREN. Good. Happy to do that.

[The information follows:]

RESPONSE TO CHAIRMAN WOLF'S REQUEST FOR DR. HOLDREN TO VISIT THE CYBER CENTER (NCIJTF) IN NORTHERN VIRGINIA

OSTP staff is working with the FBI to schedule a visit to the facility in Chantilly, VA. Once a date has been set, OSTP will notify Chairman Wolf's staff of the date.

Mr. WOLF. Thank you.

COMPLIANCE WITH CHINA LANGUAGE FROM FISCAL YEAR 2011

The recently enacted fiscal year 2011 appropriations bill contained a legislative prohibition on bilateral activities between your office and the Chinese Government or Chinese-owned business.

What steps are you taking to live within the terms of this prohibition during the fiscal year?

Dr. HOLDREN. Well, it is our intention to live within the terms of that prohibition insofar as doing so is consistent with my responsibilities for executing the President's constitutional authority——

Mr. WOLF. What does the——

Dr. HOLDREN [continuing]. In foreign relations.

Mr. WOLF. What does the language in the bill mean to you?

Dr. HOLDREN. I am instructed after consultation with counsel and with appropriate—who in turn consulted with appropriate people in the Department of Justice that that language should not be read as prohibiting interactions that are part of the President's constitutional authority to conduct negotiations and at the same time, and there are obviously a variety of aspects of that prohibition that very much apply, we will be looking at that on a case-by-case basis in OSTP to make sure we are in compliance.

Mr. WOLF. Well, can you keep the Committee informed on a case-by-case basis of any time you do anything at all with regard to China where you think that perhaps your activity will be in confrontation with the language.

Dr. HOLDREN. Be happy to do that.

Mr. WOLF. Great. Thank you.

COMPETITION FROM CHINA

China's government sponsored R&D investments as a fraction of GDP have grown by more than five percent annually while the American rate of growth have actually been negative in recent years.

How does the 2012 budget address this imbalance?

Dr. HOLDREN. Well, first of all, as I mentioned, Mr. Chairman, the President committed the country in his speech in April 2009 to trying to reach three percent of GDP in the combined public and private investments in R&D in this country. And that represents an effort to maintain the U.S. lead over our competitors including China because as you correctly point out, China's investments have been growing very rapidly, in some cases more than ten percent per year.

We are very concerned about that. We want to be sure we maintain the U.S. lead, which does remain large, I should say, across the range of critical science and technology domains, but China is trying to close the gap and we are interested in maintaining our lead.

And the challenge we all face, and I reassert that we face it together, is how in this time of budget stringency we can find ways to increase the U.S. investments in science, technology, and innovation in ways that allow us to stay ahead.

I would say one important aspect of that since the private sector comes up with almost 70 percent of the national R&D expenditures is we have to do more to encourage the private sector to continue to increase its investments in R&D. And one of the ways we have proposed to do that is by making the research and experimentation tax credit both simpler, more effective, and permanent in order to provide a reliable incentive for the private sector to lift their game in R&D.

Clearly in a country where 70 percent of the R&D is financed by the private sector, we have to attend to that as well as to the government's expenditures.

Mr. WOLF. If the existing trend continues, do we run the risk of China pulling even with or exceeding us in government R&D investments? And if that is the case, when could that happen?

Dr. HOLDREN. I have got some projections. I mean, none of us has a clear crystal ball on this issue because we do not know how fast the Chinese economy will continue to grow.

And there are a lot of people arguing that it will be slowing down soon for a variety of structural reasons, but we cannot be sure. We do not know if they can sustain the rates of increases in R&D expenditures that they have been making. And so it is very hard to predict with any confidence.

I do not believe that it is likely that the Chinese could equal U.S. expenditures in this domain any time before 2015, but it also depends on whether you count those investments at market exchange rate or at purchasing power parity.

The other point that I would emphasize, though, is it is not just the sheer amounts, but it is the quality of the work that is done with those investments. And as I think many authorities have pointed out, the greatest Chinese universities remain light years behind U.S. universities in terms of the quality of their faculty, their facilities, their students.

A large fraction of Chinese engineering graduates would not qualify for entry-level engineering jobs in the United States because the level of their engineering training is simply not up to ours.

So we need to remember that quality as well as quantity is important and we need to continue to focus both on adequate resources in terms of our own investments and in the various elements of the U.S. system which maintain our qualitative advantages.

Mr. WOLF. They graduated 700,000 engineers last year. We graduated 70,000. It is not engineer for engineer, but 35 percent, 40 percent, 45 percent of our graduates were foreign students, many of them Chinese who are going back.

Dr. HOLDREN. That is true.

Mr. WOLF. You were recently quoted as saying that major scientific advancements will allow China to "eat our lunch" economically. At the same time, however, you continue to advocate for U.S. assistance to Chinese scientific agencies and expanding joint research opportunities.

If you acknowledge that Chinese scientific advancements are a threat to our economy, why would you want to improve their capabilities and further speed up their advancements?

Dr. HOLDREN. First of all, Mr. Chairman, with respect, they will eat our lunch if we do not continue our own investments in the strength of our science, our technology, our innovation, and our STEM education. I do not believe they will eat our lunch if we stay the course.

Mr. WOLF. Well, sure.

Dr. HOLDREN. I will take the second part of your question. I am happy to address that as well. I just wanted to be clear——

Mr. WOLF. You go ahead.

Dr. HOLDREN [continuing]. In terms of my quote that I was not predicting that they will eat our lunch. I was saying avoiding their eating our lunch is the reason that we need to stay the course.

Now, the question of why then if we are even worried about competition with China should we cooperate with them. The answer to

that question is that there are a variety of domains in which cooperation with China is very much in our national interest.

One of those domains is the prediction and the control of epidemics which, of course, know no boundaries. A lot of the scientific and technological cooperation we have done with China has been in that domain.

Another domain in which it makes great sense for us to cooperate with China is nuclear safety, the prevention and the mitigation of nuclear reactor accidents. China is building nuclear reactors very rapidly. The consequences of nuclear accidents also know no boundaries. And it is in our interest to work with them to reduce the likelihood of accidents at their reactors as well as, of course, our own.

China's oil imports are one of the reasons that gasoline prices are so high in the United States today. It is the rising demand from China and other developing countries and it is pressure on the world oil market which has pushed gasoline prices as high as they are.

It is in our interest to cooperate with China in activities in alternative energy which will help them reduce their pressure on the global market because it is a global market. And we have an interest in China reducing its oil imports just as we have an interest in reducing our own.

In the area of environmental problems that cross national boundaries, again it is in our interest to work with China to accelerate the pace at which they reduce the emissions that are affecting our environment as well as theirs.

Mr. WOLF. In terms of specific joint scientific ventures, the President has advocated for cooperation between NASA and China's space program.

Does the PLO run the Chinese space program? Am I correct there, the PLO?

Dr. HOLDREN. The PLA?

Mr. WOLF. Yeah.

Dr. HOLDREN. They certainly have a lot to do with it. I do not think we fully——

Mr. WOLF. The dominant one?

Dr. HOLDREN [continuing]. Understand. My guess would be yes, but, again, I do not understand and I am not sure anybody understands exactly the way the tentacles of the PLA interact with other activities. But they do certainly have a major influence. There is no question about that.

Mr. WOLF. Since our space capabilities exceed theirs by virtually all measures, how does this cooperation benefit anyone but China? What is the technical or scientific benefit to NASA of cooperating with the Chinese Space Administration?

Dr. HOLDREN. I will give you a couple of examples. One is the question of space debris where we are all threatened by junk in space that our satellites and the International Space Station might run into.

And collaborating in the area of minimizing space debris and making sure that we all know where all the debris is is very much in our interest, in the interest of the safety of our astronauts. That is one domain.

A second domain which is much more long term, much more speculative, there is certainly nothing in place now, but the President has deemed it worth discussing with the Chinese and others is that when the time comes for humans to visit Mars, it is going to be an extremely expensive proposition. And the question is whether it will really make sense at the time that we are ready to do that to do it as one nation rather than to do it in concert.

And nobody knows the answer to that question at this point. It will depend, since nobody is going to be ready to go to Mars before 2030, whether it makes sense to do that jointly or not very much depends on the state of political relations, economic relations, and so on at the time.

But many of us including the President, including myself, including Administrator Bolden believe that it is not too soon to have preliminary conversations about what involving China in that sort of cooperation might entail.

If China is going to be by 2030 the biggest economy in the world as some think it may be or even if it only is still the second biggest economy in the world, it could certainly be to our benefit to share the costs of such an expensive venture with them and with others.

Mr. WOLF. An IMF report which I am sure you saw came out last month showing that, when measured in purchasing power parity, the Chinese economy will overtake the American economy in 2016, which is much earlier than any previous estimates.

What is your reaction to that finding of the IMF?

Dr. HOLDREN. Well, I looked at that finding with interest. I have actually long been one of those arguing that we should be paying more attention to purchasing power parity in many contexts as the appropriate metric. There are obviously respects in which market exchange rates are more meaningful, other respects in which purchasing power parity is more meaningful.

But I think if China passes us by 2016 in purchasing power parity GDP, that will be a big deal. It will still be true at that time that their per capita GDP will be a quarter of ours or less, but I am not denying the significance of the possibility of the United States becoming the second largest economy in the world by any measure.

And, again, I would simply say, Mr. Chairman, that what the President's 2012 budget is advocating is investments in science, technology, innovation, STEM education, and infrastructure which will postpone the day when China passes us and perhaps postpone it indefinitely.

Again, I would say none of us has a clear crystal ball. China has many problems. You yourself have been in the forefront of pointing out some of the problems that China has created for itself in the domain of human rights and the domain of a government in which the citizens do not have anything resembling real participation. And that could come to bite them.

We do not know what China is really going to be like and what problems they are going to be struggling with in 2015. But in the meantime, we should be doing what we can do to strengthen the United States' economy, to build jobs, to build sustainable industries, to develop new products, to innovate. We should be doing all we can in that domain and that is what this budget is about.

Mr. WOLF. Well, I agree. And I would say that this committee, and I would say in a bipartisan way, is really doing that. I am not going to put you in a spot by asking you this question, but I am going to state it as a fact.

It concerns me very deeply that this Administration is tone deaf to the human rights violations taking place in China. I think Ambassador Huntsman has done a good job. Short of that, I think this Administration has been relatively weak.

The Chinese people are wonderful people; it is the evil government that is doing these things. When the dissidents come to the U.S., they tell me that based on what this Administration is doing, many of the people are being demoralized there.

We have a situation. The Catholic Cardinal from Hong Kong was in to see me three weeks ago. The Catholic church is being persecuted, and there are a number of Catholic Bishops that are under house arrest.

I attended a house church on Easter Sunday as some of the people were taken away and arrested. There are hundreds of house church leaders in jail.

And when you talk about doing things "in concert", does it sort of bother you? It bothers me, that that would be the case.

Rebiya Kadeer, who is head of the Uighurs, has two children that are in prison and a daughter under house arrest. The Chinese have even spied against her here in this country. The Uighurs are going through a very difficult time. I think that should really bother the Administration.

The 2009 Nobel Prize winner put on a dinner for Hu Jintao when the 2010 Nobel Prize winner was in jail and could not even get out to go to Oslo to get his award, and his wife was under house arrest and would not be allowed to go.

That, I think, troubles me. I would hope it would trouble the Administration and produce more than just a press release or a spokesman at the State Department saying something. Your actions make all the difference.

President Reagan called the Soviet Union an evil empire. President Reagan went to Moscow with Gorbachev and he spoke out for human rights and religious freedom with Gorbachev there at that time.

The reason I ask you with regard to the People's Liberation Army is that they also run a major organ donor program. They go into prisons and take the blood type, and then they also bring people over who want to buy kidneys for fifty or fifty-five thousand dollars. For fifty or fifty-five thousand dollars, you can buy a kidney of somebody who is executed by the People's Liberation Army that you would have this kumbaya relationship with.

Now, that ought to bother anyone. That ought to bother the President. It ought to bother you. I have been there. I have been to Tibet. I snuck into Tibet with a young Buddhist monk and I have seen what they have done, torturing the Buddhist monks. We went by Drapchi Prison.

The Administration initially would not even meet with the Dalai Lama. That should bother you. The Dalai Lama is a peaceful person. And what is taking place with regard to the Tibetans, they lit-

erally turned Lhasa into a no longer Tibetan city. The Chinese run it and are trying to undertake ethnic cleansing.

And, lastly, should it not bother you about this cooperation with the number one supporter of genocide? I was the first member of the House to go Darfur. There is genocide in Darfur. The genocide in Darfur continues to this day.

The AK–47s and the weapons, much of that has come because of the Chinese helping the Bashir Government, which is under indictment by the International Criminal Court. Here is a man who is under indictment by the International Criminal Court and his number one support is the Chinese Government. They have the largest embassy in Khartoum.

So as you say "in concert with", doesn't that bother you? Or is it the Simon and Garfunkel theory—man hears what he wants to hear and disregards the rest?

We cannot disregard the Catholic Bishops that are in jail or under house arrest, the Protestant Pastors that are under house arrest, the organ donor program where they are killing people to sell kidneys, the persecution of the Muslims and the Uighurs in that portion of the country. We cannot deny what they are doing with regard to the genocide.

I was with two young women who told me as they were raped by the Janjaweed that circle the camps in Darfur, many of them carry weapons coming from China. You cannot separate this out. I cannot separate it out. And this Administration should not separate it out.

When you look at the human rights report that just came out, this Administration does not have a very good record. When you say you want to work "in concert", it is almost like you are talking about Norway or England or something like that.

And, lastly, and you should know and you should have been out to the cyber center before, China is spying against us and stealing economic information that is stripping this country and taking jobs away. So I am not going to ask you if it bothers you. It bothers me.

I believe in doing what Ronald Reagan did with regard to the Soviet Union—standing up, speaking out. When I asked Secretary Locke the other day whether he would agree to attend—not worship, but attend—a house church, he would not even tell me that he would attend the church, go with a Buddhist and stand with him, go, meet, and ask to meet with Rebiya Kadeer's kids who are in prison, go and ask to talk to the Catholic Bishops that are under house arrest, talk to the Protestant Pastors who have taken away, advocate on behalf of the people that are being ethnicly cleansed in Darfur.

So I am not going to ask you if it bothers you, but it bothers me. And as long as I have breath in me, we will talk about this. We will deal with this issue whether it be a Republican administration or a Democratic administration. It is fundamentally immoral.

I saw those two young girls that I interviewed. And if you want to see the tape, come by my office. They said as they were raped by Janjaweed, the Janjaweed said it was to create lighter skinned babies.

The Chinese Government is the number one supporter of the genocidal government of Sudan, and these are all facts. And if you

want to get briefed on the facts, we can give you the briefing of the facts.

So you say "in concert with" like you're talking about working in concert with Mr. Culberson, or with Mr. Yoder, not in concert with somebody that is fundamentally evil. You can do it. This Administration can do it in an appropriate way. President Reagan, to his credit, called the USSR the evil empire in 1983. He said "tear down this wall".

And then, if you recall his speech at the Danilov Monastery, he advocated for human rights and religious freedom. Yet, he did it in such a way that at the funeral for Ronald Reagan, Gorbachev came. This Administration is failing on this issue. And I think people are expecting you to advocate, to stand up, to speak out. And, quite frankly, we are not seeing that.

When I hear you say you will work in concert with China, I am not going to ask you if it bothers you, but it bothers me.

Dr. HOLDREN. Mr. Chairman——

Mr. WOLF. You can comment.

Dr. HOLDREN [continuing]. May I comment, please?

Mr. WOLF. Yes.

Dr. HOLDREN. I want to say first of all, it does trouble me. It does bother me. And I need to say as well, Chairman Wolf, that I admire you for the leadership that you have shown in calling attention to human rights abuses in China. I admire you for that. And I agree with you that these abuses are reprehensible.

I would only remind you that when Ronald Reagan called the Soviet Union the evil empire, he also continued cooperation with the Soviet Union in science and technology domains that we judged were in the U.S. national interest to cooperate with them on. And we continued to do that not because we were doing a favor to the Soviet Union, which President Reagan had called the evil empire. We did it because it was in our interest.

And I would similarly say that the efforts that we are undertaking to do things together with China in science and technology are very carefully crafted to be efforts that are in our own national interest. We have been, I think, very strategic about that, very careful about that.

I mentioned the kinds of areas in which we are engaged. That does not mean that we admire the Chinese Government. It does not mean that we are blind to the human rights abuses which you have shown so much leadership in calling attention to.

But it is, I have to say, it is not my position, I am the science and technology advisor, I am not advising the President on what his stance should be in balancing the various national interests that the United States has at stake in the way we deal with China.

You understand very clearly, I know, probably more clearly than I do, that those interests are complicated. And the President obviously is not making that balance in the same way that you would make it. But I think this is a matter that is very worthy of continuing discussion.

I would be happy to come to your office and look at that tape, but I am not the person who is going to be whispering in the President's ear on what our stance toward China should be government to government except in the domain where I have the responsibility

for helping the President judge whether particular activities in science and technology are in our national interest or not.

Mr. WOLF. Mr. Fattah.

Mr. FATTAH. Thank you very much.

MAKING SUFFICIENT INCREASES IN SCIENCE SPENDING

And I join with you in your admiration for the chairman and his efforts in relationship to human rights.

Let me get to some of the issues at hand relative to science and technology.

Portugal is involved in a financial bailout due to some of the challenges that they are facing, but they also took a decision to provide laptops to every child in schools in Portugal.

And Singapore has invested over $5 billion in their National Science Foundation.

China made a decision a few years back to build 100 science only universities and some 200 math and science laboratories. And five years later, they were constructed and built.

I want to just go back a minute. Decades ago during the Cold War, we built national laboratories like Los Alamos and Lawrence Livermore and Sandia and on and on and on, made very significant investments. The country went into debt even to make commitments so that our country could be number one in the world in terms of our technological capabilities.

This Administration has called on the Nation again to make these investments even in difficult financial times. You do that in the context of a freeze on discretionary spending, but increases in the various accounts of agencies that were focused on in the report on the Gathering Storm, focused on in the America COMPETES Act.

So I just want you to kind of walk through this. You were chair of the PCAST during the Clinton administration, and there has been this proposal to create 1,000 STEM schools, 800 elementary, I believe, 200 high schools, and a number of other steps, and if you could just kind of walk through for the committee what you see as the critical investments that we need to make now.

If you get on a plane now and fly out to Sandia, you see an institution in which we have invested for 50 plus years, right? I mean, what are the investments we need to make now so that long after we are no longer in these roles America is number one, because we seem to be acting as if we are going to lead this world on the cheap? We have this notion that we are going to kind of cut our way to the front of the line.

And I want to be certain, since you are the lead science advisor to the President and you see what is going on across the globe in which countries smaller than us—I asked some of our officials how a country so much smaller than us could make such a significant investment in particular technologies. And I was told that their leadership had decided that even if they had to eat dirt, they were going to lead the world in that particular area.

I do not know that we remember the sacrifices that other generations have made to position our country in the lead. We benefitted by that. But I want to know what steps we need to take in responsibility to our stewardship of this country so that our children and

grandchildren will be in a circumstance in which we are number one.

Dr. HOLDREN. Well, thank you, Ranking Member Fattah. Let me answer as best I can a couple of parts of your question.

First of all, you referred to our national laboratories. We have by far the strongest national laboratory system in the world. Nobody else has capabilities close to the capabilities of our national labs and that is because we have continued to invest in those laboratories since the initial investments we made to set them up.

Second point, we have the strongest research universities in the world, again by far. Nobody is even close. There are a few universities in the UK, maybe one in Japan, maybe one in China that are even in the top 25. That list is completely dominated by U.S. universities.

Our task in both of those domains, the strength of our national laboratories and the strength of our research universities, is to maintain that strength, nourish it, and expand it. And that is the basis for the President's proposal to double the budgets of the basic research institutions in this country that provide so much of the support for those universities and for those national laboratories, the DoE Office of Science, the National Science Foundation in particular.

The other major component, there are two other major components which I have alluded to of our strength in science, technology, and innovation that we need to pay attention to. One is the private sector.

And what has happened in the private sector is some of the great research laboratories that the private sector used to maintain have been downsized, they have been fragmented and outsourced for a variety of reasons having to do with the structure of the economy and the incentives for the private sector. We have to increase the incentives, as I have already mentioned, for the private sector to invest more in research and development and innovation.

And we have to invest more in the mechanisms by which discovery is transferred out of the national laboratories and the great research universities into marketable and successful products in the economic marketplace.

One of the ways that is happening in the Obama administration is the energy hubs that the Department of Energy has stood up. Three of them have been stood up. We propose to stand up three more. And those hubs involve the interaction of national laboratories, research universities, and corporations to bring to bear their diverse comparative advantages on this challenge of translating discovery into jobs, into products, into new businesses in the marketplace.

As we get better at that, that will prove to be one of the crucial dimensions of maintaining our economic standing in the world, maintaining the jobs we need, and maintaining our competitive position against competitors like China.

The last element that we need to pay attention to is STEM education—science, technology, engineering, and math education. The President has said on a number of occasions that he believes the single most important thing we could do for the future of our coun-

try is to lift the level of our game in STEM education, particularly K through 12 STEM education.

You mentioned PCAST, the President's Council of Advisors on Science and Technology. We provided the President with a report on what needs to be done to improve K through 12 STEM education some months ago. And one of the things we argued in that report is we need equal measures of emphasis on inspiration and on preparation. We need to inspire more kids to go into science and engineering and math and innovation and we need to do a better job of preparing them and keeping them there and keeping them successful in those pursuits once they get there.

That is a large part of what the President's educate to innovate initiative is about which he announced originally in November of 2009 with at that time over half a billion dollars in private sector and philanthropic support for efforts in which national laboratories, corporations, and universities would provide real life scientists and engineers and mathematicians to go into classrooms and work with teachers to improve the curriculum, to develop more hands-on activities and experiments so kids could learn about science and engineering by doing it rather than just by being lectured about it.

And so they would have more role models of both genders of every ethnicity to establish in real human terms what exciting and interesting careers are available to kids who pursue science and engineering and math.

We have got to get better at that. That is probably, of the four pillars of continuing strength, the research universities and national laboratories, the private sector, the capacity to translate between discovery and applied innovation in the marketplace and STEM education, STEM education is I think the one and the President thinks is the one that requires the most additional effort to bring us up to speed. You see it in the international test scores. You see it in other measures and, yet, we also have fantastic examples of creativity and accomplishment in our young people.

If you go to the Intel science talent search finalists dinner and look at their displays as I have every year since coming into this position, if you meet with the middle school mathletes who have won national mathematics competitions, we have got some incredibly bright kids out there. We just have to do a better job of nurturing more of them, inspiring more of them, and preparing them when they get into these fields.

Mr. FATTAH. Thank you.

STEM EDUCATION AT THE TERMINAL DEGREE LEVEL

And you are absolutely right that we need help at every level. And I just commented in the congressional record and it is a very significant effort by ExxonMobil in terms of the national math and science initiative and a hundred plus million dollar commitment.

But let me talk to you not about K to 12 STEM education, but at the terminal degree level. We have a dearth of American citizens of any stripe pursuing terminal degrees in the hard sciences.

What can you tell us about why this is a continuing challenge and what are your recommendations as it relates to the President and his budget to address this issue? We have a number of entities

under the jurisdiction of the subcommittee that are involved in efforts in this regard, so I would be very interested in your thoughts.

When we look at people pursuing terminal degrees in nuclear physics or computer information science or any of the hard sciences, we are challenging ourselves in terms of the critical skills that are going to be necessary.

And just, for instance, in our federal agencies, there is going to be a major critical skills shortage just over the horizon unless we prepare more young people for these roles just in terms of, for instance, the nuclear stockpile, our non-proliferation work, I mean, just across a whole range of issues.

So I would be interested in your comments.

Dr. HOLDREN. Well, again, thank you for the very good question. I would say a couple of things about it.

Number one, the number of people who pursue and complete terminal degrees in science and engineering and math is deficient for a couple of reasons. One is too few people entering these programs. And the second reason is losing too many along the way.

And the reasons we have too few entering the programs are largely the reasons I just talked about, deficiencies in our inspiration and preparation and the combination of those at the K through 12 level. So too many kids who have the talent and potentially the curiosity and the excitement to excel in these fields decided to excel in something else.

But a further problem and a very important problem is too many people who enter college with the idea of majoring in math or engineering or science transfer into other fields along the way because they become bored, they become disenchanted. The way they are taught science and engineering and math at the university level is not what it needs to be to keep them inspired and engaged.

And on that particular topic, I have a couple of assurances to offer you. One is that my associate director for Science, the Nobel Laureate Carl Wieman, has focused most of his attention since getting the Nobel Prize not on doing more Nobel Prize–level physics but on understanding better what works and what does not work in college-level education in science and engineering and math.

And Wieman and his colleagues in that pursuit have developed some very important research findings that establish that it is quite practical to improve by a factor of two or more the success of college science, math, and engineering teaching both in terms of how much the students actually learn and in terms of how excited they stay about what they are doing.

And we are currently conducting a new PCAST study looking at the first two years of college education which is where you lose most of these folks to figure out how to apply these new research findings and specific programs which will cause them to spread.

And I have already spoken and Carl Wieman has spoken with the presidents of many of our research universities who are equally excited about the possibility of doing much better at this part of the effort, of keeping kids, young people engaged in science and engineering and math in college pursuing those goals in those fields, doing it more successfully, staying more excited, and addressing that particular problem.

Mr. FATTAH. Well, I am going to wrap up with just two more questions on this point. But one of the ways that we solved this problem in the past, because this problem has been with us for a while, is that we had foreign-born students to actually dominate many of these programs in the hard sciences at our great universities here in America and many of them would end up staying. And they would become citizens and they would have the terminal degrees. And our industry would have the intellectual genius necessary to go forward.

But now you have students who end up getting the degree who are going back to their native countries and being part of what is essentially the economic competition to our country long term.

So we have a number of challenges and we have to get more American-born students to pursue hard science degrees and we also need to keep talent that is coming to America for an education. We need to try to hold on to more of that talent to the degree that that is possible.

SCIENTIFIC AND TECHNOLOGICAL CHALLENGES

So I am interested, and I will end here, as you look at the broad spectrum of work, and your testimony touches on a number of issues, and we have obviously a range of challenges, but as the lead science and technology advisor to the President, if you could just comment in more general terms about what you see as the Nation's most pressing scientific and technological related challenges over the near-term horizon of the next 10 and 20 years that you believe we should be focusing on here in the Congress and in terms of our priorities relative to appropriations.

Dr. HOLDREN. Well, again, another good and rather sweeping question. Let me say a couple of things about it.

First of all, in terms of students from other countries who graduate in science and math and engineering from our universities, as you say correctly, some of them do go back to their home countries. That is not in itself entirely bad for the United States to have highly educated people going back who have experienced the advantages of the economic and political system of the United States.

It is one of the ways over the long run that we work to change the economic and political cultures in those countries because a lot of these students become leaders in their countries and their views about the United States and how we do things become very important.

But it is also important that we not make it too difficult for those who would like to stay to do so. And in some respects in our visa policies I am afraid we have done that. We are looking at our visa policies to see if there are modifications that would make it easier for those foreign born students who do want to stay in the United States and who have been educated in science and engineering and math in our universities, make it easier for them to pursue that choice to stay and apply their talents in this country because we have gotten great benefits from the talents of foreign-born students who have decided to stay.

You also asked me what the great challenges are. I mean, clearly a structural challenge is that part of the problem of inspiration and keeping students in these fields is having them confident that

there will be exciting and interesting jobs available for them to take up after they graduate.

And that again is a matter of ensuring that the private sector makes the investments that they should be making, that we make the investments and the private sector makes the investments in science and technology infrastructure. That includes information technology, high-speed computing. It includes infrastructure in space which we use for communications, for geopositioning, and for many other purposes. We have to continue making the investments if the jobs are going to be available for those students to engage in.

In terms of substantive challenges, what are the things that we really need to be getting right in science and technology going forward? I mean, clearly a huge substantive challenge is in the domain of how do we strengthen manufacturing again in this country? What can we do with nano-tech, with info-tech, with bio-tech, with the intersection of those to develop a much stronger manufacturing sector again in this country?

And that is something that we are spending a lot of time looking at jointly with the National Economic Council and in concert with many of the high-tech CEOs and leaders in this country and in the research universities and the national laboratories. How do we apply these rapidly advancing scientific developments in the domains I have mentioned to translate them into new industries, into new jobs?

In terms of another substantive focus that is going to be immensely important, it is what I would describe as the energy-economy-environment intersection. We need affordable and reliable energy to fuel our economy, but we need to get it in ways that do not imperil our national security in the way our very heavy dependence on imported oil from unstable regions does today. We need to get it in ways that do not imperil our environment.

There are tremendous technological challenges and opportunities at this intersection of energy, economy, and environment in which we need to be the leaders. We need to be the leaders in new battery technology. We need to be the leaders in fuel cell technology. We need to be the leaders in smart grid technology.

And, again, these are challenges, but they are also enormous opportunities that can constructively occupy a lot more graduates of science and engineering and mathematics from our great universities than we are generating now.

Mr. FATTAH. Thank you very much.

Thank you, Mr. Chairman.

Mr. WOLF. Thank you.

Mr. Culberson.

Mr. CULBERSON. Thank you, Mr. Chairman.

COMPLIANCE WITH CHINA LANGUAGE FROM FISCAL YEAR 2011, CONTINUED

Dr. Holdren, I noted in your response to Chairman Wolf's questions that the Administration has decided that any negotiations that the President conducts are an exemption to the policy adopted by Congress.

Dr. HOLDREN. I have to say first of all Congressman Culberson, I am not a lawyer.

Mr. CULBERSON. Right.

Dr. HOLDREN. But I have been advised by our counsel and consultation with the Department of Justice that we must take care not to infringe the President's constitutional authorities in relation to the conduct of foreign relations, and diplomacy in particular.

Mr. CULBERSON. I am always astonished in the time that I have been here that the number of administration officials who forget that the President's responsibilities under the Constitution are actually very narrow, and in fact are limited to: the President is the Commander-in-Chief of the Army, shall have the power to make treaties, and shall have power to fill up vacancies. That is it.

It will be the chief executive officer of the United States, and chief executive officer means to execute the laws enacted by Congress, and the Congress just enacted and the President just signed into statutory law an absolute, ironclad, unambiguous requirement that none of the funds made available by the Congress to the Administration may be used for NASA or your office to develop, design, plan, promulgate, implement, or execute a bilateral policy program, order, or contract of any kind to participate, collaborate, or coordinate bilaterally in any way with China or any Chinese-owned company unless that activity is specifically authorized by statute and enacted after the date of enactment of this law.

It is not ambiguous, it is not confusing, but you just stated to the chairman of this committee that you and the Administration have already embarked on a policy to evade and avoid this very specific and unambiguous requirement of law if, in your opinion, it is in furtherance of the negotiation of a treaty, right?

Dr. HOLDREN. Well, Congressman, I say again.

Mr. CULBERSON. It is exactly what you just said. I don't want to hear about you not being a lawyer. If you are——

Dr. HOLDREN. Okay, as long as that is——

Mr. FATTAH. Can we let the witness answer the question, please.

Dr. HOLDREN. What I have been informed is that a variety of opinions, previous signing statements and other legal documents have found that the President has exclusive constitutional authority to determine the time, the scope, and the objectives of international negotiations and discussions as well as the authority to determine the preferred agents who will represent the United States in those diplomatic exchanging.

Mr. CULBERSON. Okay.

Dr. HOLDREN. And I have been informed similarly——

Mr. CULBERSON. Okay.

Dr. HOLDREN [continuing]. And I am not qualified to dispute——

Mr. CULBERSON. You are just following orders.

Dr. HOLDREN [continuing]. Or argue with you about what I have been advised that as a result of those exclusive constitutional authorities that have been asserted to me by people who are lawyers and who work in this domain that the provision of the legislation, which you just read, should not be read to restrict activities that support those constitutional authorities.

Now you can argue that with me till the cows come home, but I will lose, I am not a lawyer, I don't know how to argue that point.

Mr. CULBERSON. Oh, no, I am not arguing about it legally, this is just common sense and it is plain English. And all of your money flows through this committee.

Dr. HOLDREN. I understand. I understand that.

Mr. CULBERSON. I just laid out for you they are now evading the law just enacted by Congress.

Essentially, obviously the White House's position is that any activity that your office engages in or any division of the executive branch engages in with China or any Chinese-owned company is obviously going to be classified as being in furtherance of negotiations involving treaty responsibilities of the President in the Constitution.

I mean you just laid out for us very clearly how you intend to evade the very explicit and unambiguous law enacted by Congress. It is very distressing and you are not likely to—I mean you need to remember that the Congress enacts these laws and it is the chief executive office's job to execute those laws, and this is unambiguous.

Your office cannot participate, nor can NASA in any way, in any type of policy, program, order, or contract of any kind with either China or any Chinese-owned company.

Now if any employee of yours, if you or anyone in your office or anyone at NASA participates, collaborates, or coordinates in any way with China or any Chinese-owned company you are in violation of the statute, and frankly not only are you endangering your funding, you are endangering—I mean this is not only—it is a direct violation of law and it is up to the chairman and this committee to decide how to enforce or frankly to—what remedies are available for what is obviously the—your intent to violate this—the Administration's intent to violate this law.

Dr. HOLDREN. Congressman Culberson, I——

Mr. CULBERSON. You have a huge problem on your hands.

Dr. HOLDREN. I hear——

Mr. CULBERSON. Huge.

Dr. HOLDREN. I hear you very clearly. It is not our intention to evade this law as you say, we intend to comply with it insofar as it does not infringe on the constitutional authorities that I have been advised exist.

Mr. CULBERSON. I understand.

Dr. HOLDREN. I said we would review on a case-by-case basis activities with China as to whether they are precluded by this legislation or not, and we will inform the committee, as the chairman has asked, of those considerations.

But I am very much aware that there are many activities that we would have carried out with China or might have carried out with China that will be precluded by this, that do not fall under the President's constitutional authorities with respect to diplomatic relations with other countries.

Mr. CULBERSON. The President's responsibilities for negotiating treaties with other countries are obviously set out. I mean he has got that responsibility set out in the Constitution, but the scope, the extent, the deal, the manner in which he conducts those negotiations are what officers of the executive branch are authorized to do.

Now, frankly, the existence of your office—you are a creature of statute. Every officer in the executive branch was created by a statute, by Congress, and funded through this committee, so the scope of the President's responsibilities again are all designed by statute. You have now got a statute that preempts every other statute on the books.

Now I am a good enough lawyer and practice enough in court to know that what you have just given us from the chief counsel's office is very revealing, Mr. Chairman, because obviously the White House is now going to engage in a—rather they have obviously identified a way to evade the intent of Congress, and are obviously going to try to classify anything you are doing with China as in pursuit of a treaty, but that is not going to fly.

It has been signed into law, and the limitation that the Congress enacted preempts every other statute of the books, it is a long standing rule, and this one again is just common sense, that a law that you pass today that is, for example, very specific in regard to a particular subject, not only does a law passed today preempt every other law passed before it, but number two, particularly if the law today that is very specific, it deals with a particular subject, that absolutely preempts every other law passed before it, and that is just a general rule.

In this case it is even more specific, and this is not legal, it is just common sense, Dr. Holdren, that you can't participate, collaborate, or coordinate in any way with China or any Chinese-owned company unless that activity is specifically authorized by a law enacted after the date of enactment of this division.

So you need to tell the lawyers, the General Counsel's Office what you just read to us now threatens their funding. I am a pretty good lawyer, and I can think of lots of ways to help the chairman of this committee and other subcommittees enforce the law. I mean it doesn't have to be just lawsuits, there are a thousand ways to enforce the law, all kinds of creative ways to enforce the law. I mean the law is essentially what—you know, the law is meaningless unless it is enforced, and it doesn't have to be just through a judge.

Trust me, the chairman of this committee and the Appropriations Committee is charged with enforcing the law. What you just read to me endangers, frankly, your funding, and the Office of General Counsel's funding. I intend to go after all of them in every division of the White House.

You have just opened the door for me, and I think it is very revealing. You just gave us a peek behind the curtain. You are obviously not going to pay any attention to this law if the General Counsel's Office tells you that this activity that you are engaged in, Dr. Holdren, or your subordinate, is in furtherance of a treaty. You have just told us you can go right ahead and do it.

Dr. HOLDREN. What I have said, Congressman Culberson, it is not our intention to declare that every activity in which we do or might engage with China falls under the category that is within the President's exclusive constitutional authority. That is not our intention.

And I am sure that this provision, as long as it stays in force, and I must admit I am very hopeful that when the next round of

appropriations comes there will not be a similar restriction in it because it will be restricting. It will be restricting. There is no question about it.

Mr. CULBERSON. So not every activity.

Dr. HOLDREN. It will be restricting.

Mr. CULBERSON. Not every activity is going to be cut off. And so clearly you are already beginning to identify some.

I just think it is very distressing and disturbing. Not only does it ignore the intent of Congress, but you are also blindly ignoring the threat posed by China.

I heard you respond earlier to questions from the chairman that you took your BlackBerry to China. Do you know that Google executives, and frankly no executive of any company I know, will permit their employees to take their cell phones or iPads or whatever to China. Google actually requires that their employees—the only thing they can take is a stripped down notebook that has a web browser on it, and then when they return the machine is destroyed.

Dr. HOLDREN. Uh-huh.

Mr. CULBERSON. Do you know about that? You nodded your head. You are familiar with that.

Dr. HOLDREN. No, I do know about that, sir.

Mr. CULBERSON. Do you know about the National Security Agency and the policy of the United States military not to permit any U.S. military officer or any government official, and I think it is even true, Mr. Chairman, of the State Department, I think you serve on the committee with Kay Granger, I don't believe anybody from the State Department takes a PDA or a wireless computer device of any kind into China. You sync your BlackBerry at the White House don't you?

Dr. HOLDREN. Sir, I am not sure what the State Department does, but the policies of the White House in this regard have certainly been vetted with our security agencies, and I suspect the reason for a difference between what Google requires and what the White House requires is that we have greater confidence in the technical abilities of the people who are working for the Administration in the security domain to make these devices secure. If that judgment is misplaced and we learn about it clearly we will correct it.

But again, it is my understanding that the experts, including experts in the NSA and the FBI and the expertise available to our intelligence community in this domain, is that we can make these devices safe for us to use in China.

And again, you know, you are outside my domain of specific expertise. The advice I am getting on this from people who are experts is that we can safely do this, and so we do.

Mr. CULBERSON. Your BlackBerry syncs wirelessly or do you sync it at the White House with a hard plug in?

Dr. HOLDREN. No, it syncs wirelessly.

Mr. CULBERSON. Okay. Well, Mr. Chairman, I know you are going to help educate Dr. Holdren on what obviously everybody else in the government knows, and that is you don't take wireless devices into China. The extent of the espionage, the aggressive attempts by the Chinese to penetrate the U.S. government and private companies with cyber attacks is something you, as a science

advisor, ought to know better than anybody else, and I am frankly very disappointed, disturbed to hear that you already found a way, in your opinion, to evade the law enacted by Congress, and that you are also obviously indifferent to or unaware of the aggressive attempts by China to go after the United States in stealing our technology in cyber attacks. It is just very disturbing, Mr. Chairman, and you have been very gracious.

I will save my other questions for the next round.

Mr. WOLF. Mr. Schiff.

Mr. SCHIFF. Thank you, Mr. Chairman.

Thank you, Doctor, for being here. I just want to echo a couple comments you made earlier in terms of the situation with graduates of institutions of higher learning who can't stay in the country.

Caltech is in my district, as you know, and it is a cause of great concern for me that we have these very bright people come to Caltech from all over the world that get advanced degrees in math, science, and engineering, they want to stay, they want to start a business, they want to hire Americans, and we boot them out of the country. They then go elsewhere and compete with us.

And while I acknowledge there is certainly a benefit in having bright people educated in America in other countries, there is an even greater advantage in keeping them here to help grow our economy, and I have been working on legislation that would provide for those that graduate with advanced degrees in math, science, and engineering who want to start a business and hire five Americans we should give them a green card and encourage them to do that.

SUPPORTING LARGE RESEARCH FACILITIES AND INFRASTRUCTURE

I wanted to ask you a comment on something. Having access to cutting edge research facilities is increasingly important to our Nation's ability to make game changing discoveries. Given the increase in cost to build and operate these facilities around the globe we often now have to work with partners to keep costs down. Increasingly the construction of these large facilities, such as the 30-meter telescope in Hawaii, not only require non-federal contributions, but also sophisticated international collaboration. Important international partners need to understand U.S. plans are going forward to ensure that we get the most bang for our buck and that U.S. scientists are participating and having access to these cutting edge facilities.

In what ways are the White House and the Office of Science and Technology Policy leveraging international and non-federal funding commitments for large facilities sponsored by federal agencies such as NSF, NASA, and the Department of Energy?

Does OSTP actively work with federal research agencies to spur negotiations to ensure that proper planning, design, and development can occur?

Dr. HOLDREN. Well, thank you, Congressman Schiff. The answer is yes, on all counts. That is OSTP does have the lead responsibility in the White House for working with all of the science and technology rich agencies in what they do jointly with other counties and in international collaborations, including ITER, the Inter-

national Thermal Experimental Reactor, including international high energy physics experiments, includes the astronomical kinds of facilities you are talking about.

We have as one of our four divisions, the Division of National Security and International Affairs, which has within it the responsibility, and a number of people work in that domain very specifically to work with the DoE, with the NSF, with NOAA, with NASA on the development and implementation of cooperative efforts, which as you point out are enormously important.

Mr. SCHIFF. Let me ask you another question related to my first comment in terms of the visa situation.

INSPIRING INTEREST IN STEM EDUCATION

Over the years I have brought a great many astronauts to my district to meet with middle school students, and I brought an astronaut to a middle school in Pasadena, one of the lowest performing schools in my congressional district. He was particularly good with the kids. They all are very good, but he was particularly good.

He had a bunch of NASA patches in his trouser pocket that he offered to give the kids if they could get certain questions right. They had to earn the patches. And the first question he asked kind of bugged me because I got the math wrong. He said that——

Dr. HOLDREN. You didn't get a patch?

Mr. SCHIFF. I did not get a patch. I was lucky I didn't put my hand up.

The question was when he is on the shuttle he orbits the earth every hour and a half, how many sunrises and how many sunsets would he see in a 24–hour day?

I didn't think it was that difficult a math problem, but the students who are all middle school students, you know, guessed eight, guessed six, guessed twelve, and then one child put up his hand, and I think the correct answer was thirty-two, which was—when at the astronaut reached to take out a patch and give it to him I realized that the answer I had was wrong, I was off by four, and I spent I think the rest of the presentation figuring out——

Dr. HOLDREN. Trying to figure it out.

Mr. SCHIFF [continuing]. Why I got the math wrong. It really bugged me. I had to get him to explain it to me afterwards.

But I wondered when he gave this to this young child whether that middle school student knew he was gifted.

And you know my district is a suburban, largely middle income, but there are a lot of lower income families, particularly served by this school, and I wondered, you know, this kid who put up his hand among 300 other kids was clearly gifted to get it right, to get it right in front of 300 other classmates who were all guessing all over the boards, and I wondered whether he knew he was gifted, whether his teacher knew he was gifted, whether his parents knew he was gifted, and what the odds were that that child would make it in his lifetime the one mile from there to Caltech, and I thought the odds were probably not very good, and in some respects the odds of coming to Caltech from half way around the world were better and easier than coming from a mile away from Caltech.

And I wonder what your thoughts are and what we could do about that. How do we make sure that we identify talented young people like that? That we give them every opportunity to make their way what geographically is a short distance, but in terms of society and everything else may be an infinite distance. What can we do about that?

Dr. HOLDREN. Well, first of all I would say I would guess that the odds of that student making it the one mile to Caltech went up because astronaut came to that classroom, and they went up both because of the inspiration that that visit provided and because the nature of the interaction called attention to that kid's talent in a way that the teacher couldn't help but notice, and the kid probably noticed that he was able to do something that the other kids weren't.

Mr. SCHIFF. And this Congressman wasn't able to.

Dr. HOLDREN. I didn't want to mention that.

That is one of the ideas that is behind this educate to innovate initiative in trying to get more real world scientists and engineers and mathematicians into classrooms working with kids. It is not just for the inspiration, but it is for the nature of the interactions that reveal talented kids who might not have known themselves how talented they were until they have the opportunity to engage in these kinds of interactions with somebody who has succeeded in these domains.

And we have found by the way as you did in this instance that astronauts are enormously effective in this domain. They are very highly trained, they are very smart, they are very interesting in terms of the way they think about physical problems and the physical world and can relate them to kids.

I have got so many examples that are similar to yours of seeing astronauts interact with kids. We had five astronauts when we had Astronomy Night for Kids on the White House lawn in October of 2009. We had Sally Ride, the first American woman in space. We had Mae Jemison, the first African American woman in space. We had Buzz Aldrin, the second person to set foot on the moon. We had of course Charlie Bolden, the NASA administrator. And we had John Grunsfeld, the Hubble repairman, the guy who spent 55 hours walking in space, and we had 300 kids from middle school. Kids who either had done particularly well in science and math or who had been recently rapidly improving their performance. That was their reward is being able to come to this event. And the interactions were just mind boggling.

We had moon rocks and we had a portable planetarium, we had 16 telescopes, but the interactions between those five astronauts and those 300 kids I would bet changed a lot of lives. I mean this is one very important way that you get it done, but we have to do more as your question suggests to be able to reach into the communities that are less well off, that are less likely to have parents inspiring their kids and teaching their kids, and we have to figure out more ways to make this happen.

Mr. SCHIFF. Do we have a mechanism, you know, I know many areas have magnet schools, but do we have a mechanism to identify students at a very young age like this who have this talent and pull them into a special program?

Dr. HOLDREN. We try to do it in part with science fairs, and as you know the President has given a lot of prominence to the value of science fairs and robotics competitions and math competitions and so on, which start at a very early age. I have a grandson of ten who just competed in a science fair in a public elementary school in Falmouth, Massachusetts where he lives, and it was clear to me—I was not there, but my wife went, my wife is a scientist as well, and she went as one of the people sort of observing this whole thing—and it is apparent that these experiences that kids have in science fairs in developing their own experiments and explaining them to people are a way in which kids of exceptional talent do get identified early, and then the trick is—again, your question goes to this—what to you do once these kids are identified by their teachers? How can you provide the resources needed to ensure that that talent get develops, that that inspiration continues? And we are thinking about that. We are trying to think about what both the limitations and the opportunities are associated with these kinds of competitions, which have become immensely popular.

I don't know if you were able to go to the science and engineering fair on the mall last year, but the robotics displays were the ones that were most overwhelmed. The second most overwhelmed display—and I think 500,000 people came to this weekend event—but the second most overwhelmed display was the NASA display where they had real live astronauts meeting kids and talking with them.

But the first most overwhelmed display was the robotics where kids were dealing in hands on ways with robots and being able to modify them and make different kinds and so on and so forth, and that is just a wonderful mechanism for identifying particular kinds of talent, and we have to figure out what the next steps can be.

Mr. SCHIFF. Well, I would love to stay in touch with you on that. We have great robotic programs in my district as a result of Caltech. They work with a lot of our local high schools on robotics programs.

But it still seems a bit haphazard what you are describing. It requires a student to kind of self-initiate and gravitate towards a science fair.

I got the impression, although it may not be correct, that some of our competitor countries, they will identify these students through examination and then they are put in a certain program, track, et cetera, quite methodically to cultivate that talent.

I don't know that we want to go exactly down that route, but it seems we may be missing a lot of our native talent.

Thank you, Mr. Chairman.

Mr. WOLF. Thank you, Mr. Schiff. Have you seen Waiting For Superman?

Dr. HOLDREN. I have not seen it.

Mr. WOLF. I will get you a copy. If I do, will you watch it?

Dr. HOLDREN. Oh, absolutely I will. I think Carl Wieman has already been trying to get me to watch it.

Mr. WOLF. Have you seen it?

Mr. SCHIFF. No.

Mr. WOLF. I will get you a copy.

I think the answer is there, and it is a very powerful movie. At the end, some of the young people want to get in a school, and the decision as to whether they will be able to do it is based on whether they win the lottery. They follow the families, and those who win the lottery are cheering. It is almost like a hockey game or a basketball game where the parents cheer because their young child gets in. Then the two or three who never make it go home. One is from California, and I will get you a copy. I will try to get it for you certainly by the time to go home for the recess, and you should watch it.

Also, we are losing astronauts. I bumped into an astronaut the other day, and for the record we can check and make sure that what I am saying is accurate, but he told me the astronauts are leaving in droves based on the Administration's position with regard to NASA and space. We don't want to get to the point that we don't have any astronauts or where the astronauts are so rare.

Dr. HOLDREN. I agree.

Mr. WOLF. I took the NASA Administrator down to an intercity school in Washington, D.C., and I think every child deserves that opportunity ,and not just, you know, a handful.

NASA'S FISCAL YEAR 2012 BUDGET LOGISTICS

With regard to the NASA budget, science investments were supposed to be an area of particular emphasis in the 2012 budget request, but the emphasis seems to have been very unevenly applied. Agencies like NSF, NIST, and the Department of Energy Office of Science received significant increases, but NASA, the fourth largest R&D agency and one that we were all raving about, was held flat from 2010.

How does a flat NASA budget reflect the Administration's emphasis on scientific investment?

Dr. HOLDREN. Well, as you know, Mr. Chairman, NASA has a great many functions under its roughly $18.5 billion budget, and we have been trying in the Obama Administration to strengthen the science within that.

We think one of the things that happened over the prior administration when there was a grand vision for expanding our activities in human exploration, but the budgets for that were never provided, is that the science budget suffered, and we have been in the process of trying to build them back up, but we are living as you know in an extremely difficult budget time.

I mean if I were a king, NASA would have a bigger budget so that we would be about both to pursue a vision for advanced technologies to take us farther and faster in space so that we would be able to fund all of the earth observation that we really need NASA to be doing, so that we could fund all the looking outward that we need NASA to be doing.

Unfortunately at this particular juncture there is not enough money and some difficult choices have been made.

I said early on that while I agree with you that science and technology did much better in the 2010 Continuing Appropriations Act than nearly any other sector of government activity, that still doesn't mean that we are doing as well as those of us who are fo-

cused on the challenges and the opportunities in science would have liked.

Mr. WOLF. Well, I would agree with you. The Administration needs to step forward and deal with the entitlement issue, Medicare, Medicaid, and Social Security. We don't want to get off into that subject, but the President appointed the Bowles-Simpson Commission, and then he walked away from their recommendations two different times. If he had embraced it by dealing with the entitlement issue, you could plus up many of these accounts.

But the question was, the others had increases and NASA has a flat line, and that just doesn't make any sense.

Last year, you attempted to cancel NASA's exploration program and were soundly repudiated by Congress. It seems like the Administration didn't learn its lesson, though, because this year's NASA budget is also unacceptable.

You are once again proposing big increases in earth science, space technology, and commercial space flight, and paying for those increases by cutting the exploration program, which is budgeted at more than $1 billion below the authorized level.

Why does the Administration insist on using the exploration program as the bank to pay for the other priorities?

Dr. HOLDREN. Well, with respect, Mr. Chairman, I wouldn't have phrased it quite that way. I think first of all that the 2010 Authorization Act from NASA contained much of what the President wanted and it also contained much of what the Congress wanted. I thought it was a pretty good compromise between positions that initially seemed to be quite far apart. So I didn't consider it a resounding repudiation of what the President wanted to do.

With respect to the amounts of money in space exploration, the President's budget still funds at a very substantial level, the key ingredients of that, the heavy lift vehicle, the multiple purpose crew vehicle, but it was necessary.

And you referred to the astronauts. It is necessary if we want to maintain access for U.S. astronauts to the $100 billion International Space Station on U.S. rockets, if we want to minimize the gap during which we would be dependent entirely on the Russian Soyuz, we absolutely have to make investments in commercial crew development, and at the same time we need to invest in those technologies, the heavy lift and the multipurpose crew capsules to be ready for the next step, and there is a balancing act involved in doing that under a budget cap that is lower than what one would want to pursue all of those goals.

I think the President's budget made the best choices that NASA and the President's other advisors thought could be made under the circumstances, and taking into account that we were restrained until the recent passage of that 2011 Continuing Appropriations Act, we were restrained by the language in the 2010 Appropriation's Act which heavily restrained NASA from moving any resources around in the Constellation Program, and by the time we were relieved of that constraint you weren't in the same position that you would have been in if throughout fiscal year 2011 one had had more flexibility.

DEVELOPING NASA'S HEAVY LIFT LAUNCH CAPABILITIES

Mr. WOLF. The NASA Administrator has been quoted several times saying that NASA is not going to build a 130 metric ton launch vehicle, which is a requirement of the authorization and now the fiscal year 2011 appropriations bill also.

Between statements like that and a budget request that significantly underfunds the authorized exploration program it looks like the Administration has no regard for the legal requirements of the authorization.

Do you view the lift capability requirement as legally binding?

Dr. HOLDREN. Mr. Chairman, first of all I believe——

Mr. WOLF. It has got to be really difficult to pick what you want to like. This is not a cafeteria government, it is——

Dr. HOLDREN. Look, I understand that, and I believe that the administrator has clarified his views on that and has made clear subsequently. There was a statement he made in response to a question from a reporter that I think was at best less than a complete commitment to the 130 tons, but he has clarified that subsequently.

I was at a meeting with him, a public session with at the Goddard celebrating the anniversary of Goddard's birth out in Maryland in which the administrator made very clear that he is committed to 130 tons, and I think that is a fact.

Mr. WOLF. I don't want to put words in your mouth, but you do view the lift capability requirement as legally binding then?

Dr. HOLDREN. I regard it as something that we are legally obliged to pursue. I don't think we can necessarily legislate success. Ultimately we will get 130 tons. Whether we will get it by the date specified in the legislation that is something we are obliged to try to do and we will try to do it.

But I am concerned, I know the administrator is concerned that sometimes what is Congress wants, however admirable, is not necessarily achievable under the available budgets and in the time available.

So we are going to try, we are going to do everything we can to get this capability by the date specified, but it is going to be a challenge.

Mr. WOLF. The Administration advocates for the development and deployment of a smaller launch vehicle, such as one with 70 to 100 metric tons of lift. A vehicle of this size would be oversized for servicing the Space Station, but undersized for deep space exploration.

What would the mission be for a 70 to 100 metric ton launch vehicle, and why would the development of the smaller vehicle be a useful achievement?

Dr. HOLDREN. Well, I would say that is a question that goes beyond my expertise, and it is one that I would direct to our colleagues at NASA.

I could speculate as to the value of that intermediate step in terms of preparing the way for the larger capability that ultimately we will need, and I would speculate that there are a variety of kinds of payloads that would fall in that range that would still be extremely useful to be able to get up there, including the possi-

bility, should the 130 tons not be available by the specified date, to launch the components we need in pieces and put them together in orbit, but that would be speculation.

I know that NASA is engaged in a detailed study of how best to meet the goal that the Congress has specified, and my understanding is that that study will be ready by mid-summer and will be provided to the Congress, and I think it would not be terribly productive for me to try to second guess what it is going say.

Mr. WOLF. Well, maybe you have answered this, but I want to kind of lock it down so there is no misunderstanding. In addition to funding issues, NASA's work on the exploration system is being delayed by foot dragging within the Administration on the vehicle designs and acquisition strategies for the crew vehicle and the launch system.

NASA told us that they can have these decisions made and communicated to the Congress by June 20th, which you are referencing, but we are hearing reports that others in the Administration want to delay that.

Any further delay is, I believe, unacceptable and I assume you would agree. Will you commit to us right now that the exploration implementation plan will be done and submitted by June 20 as NASA has planned?

Dr. HOLDREN. Mr. Chairman, I cannot guarantee NASA's performance, but I have heard no reports that anybody is trying to slow them down, that anybody has suggested that it would be acceptable to deliver that report later.

It is my understanding that that is their goal, that that is their intention, and I expect they will meet it, but I can't guarantee you personally since I am not at NASA and not engaged directly in this process.

I will certainly convey to the administrator your view as expressed here that that deadline is firm and it is essential that it be met.

Mr. WOLF. Well, you are a very important person in this administration and in the space area, and we have been hearing that there has been some effort to urge NASA to go slowly, particularly since this appropriations process will then pass. But if you could check with the Administrator——

Dr. HOLDREN. I will do that.

Mr. WOLF [continuing]. And then get back to the Committee to let us know that that June 20th date will be met. I would appreciate it.

Dr. HOLDREN. I will do that, sir.

[The information follows:]

SUMMARY OF DR. HOLDREN'S DISCUSSION WITH NASA ADMINISTRATOR BOLDEN

At the House CJS Appropriations Subcommittee on May 4, 2011, Chairman Wolf requested that Dr. Holdren call Administrator Bolden about the June 20 deadline for NASA to submit its exploration implementation plan to Congress.

Response: On May 12, I talked to NASA Administrator Bolden about the exploration implementation plan. I stressed the importance of completing the exploration plan by the June 20 target date. Administrator Bolden confirmed that NASA is making every effort to meet that date.

Mr. WOLF. With the funding levels proposed in the President's budget, NASA will be unable to meet the 2016 target date for ini-

tial operation of the Space Launch System and the Multi Purpose Crew Vehicle, which will further prolong the gap in our national human exploration capability.

Aren't you concerned about the possibility of additional years without a NASA-owned system for getting Americans into space? And what do you see as the impact on our national prestige and security of a major delay in NASA's exploration program?

Dr. HOLDREN. Well, first of all I am concerned about it, Mr. Chairman, and I am doing everything I can within the constraints that we are all working under to see that NASA does meet that target and that we minimize, as I have said before, that we minimize the period in which we are dependent on the Russian Soyuzy for transport of our astronauts to the International Space Station.

I am concerned as you are by the possibility that the number of people interested in becoming astronauts and remaining astronauts will go down if we do not have assured means of providing access to the space station.

We think the space station, by the way which under the President's proposals, would continue to operate until at least 2020 is an enormous resource for science and for technology development and for the continuing inspiration of American young people seeing American astronauts going back and forth to and from the space station and operating and working and living there, and we want that to be a viable resource with U.S. astronauts getting there on U.S. rockets. That is our aim, that is my aim.

Mr. WOLF. Okay. We are going to go into STEM education. I don't want to keep others waiting, but I want to go into STEM, which I am a big supporter of.

A year or two ago, and I guess we can check the figures, 50 percent of the money that was available for STEM grants was left on the table, and it was not accessed by students. You might want to check and see if that is accurate and then get back to the Committee. I would appreciate that.

[The information follows:]

RESPONSE TO CHAIRMAN WOLF'S CONCERN THAT 50% OF STEM GRANTS GO UNSPENT

At the House CJS Appropriations Subcommittee hearing on May 4, Chairman Wolf expressed concern that 50% of STEM grants go unspent.

Response: Nearly all STEM programs are spending all their money, with these notable exceptions: The Higher Education Reconciliation Act of 2005 created two new need-based grant programs that complement funds awarded to Pell Grant recipients: Academic Competitiveness Grants (ACG) and National Science and Mathematics Access to Retain Talent (SMART) Grants. The former are awarded to Pell Grant recipients in their first and second years that completed a rigorous high school curriculum, while SMART Grants are given to Pell recipients in their third and fourth years that major in technical fields or languages vital to national security. Unfortunately, the number of students receiving the grants has been lower than estimated, resulting in the amount of funds available exceeding the value of grants awarded. Due to this unexpectedly low usage, the Department has rescinded $1.085 billion in total funds for the program since the 2008 fiscal year. This figure includes a recession of $560 million in fiscal year 2011. Both ACG and SMART Grants are scheduled to sunset after the end of the 2010–11 academic year and are not scheduled to receive any additional appropriations.

Secondly, you mentioned something that triggered the idea. We have asked the National Science Foundation to do an in-depth study, which they hope to have some time this summer, as to why

young people make a decision to go into math, science, physics, chemistry, biology, the sciences. There seems to be some sort of fifth or sixth grade deciding point there, and so the director of the NSF is working with a number of other people to look at that.

If you have any ideas for that I urge you to talk to him and cooperate. They hope to do a report, which we would then hope to get into the hands of all of the school systems. Because there may be somebody in some place that is doing something amazing, and if we could just let people know about it that may be kind of the silver bullet, if you will, for that issue. But if you could check on those two things, I would appreciate it.

Dr. HOLDREN. I will talk with him. Dr. Subra Suresh is a good friend and we spend a lot of time talking about these matters, and I too have seen the research that indicates that kids actually decide very early on their trajectory, and they either get excited about science and math and engineering early or they may not get excited at all, and you are absolutely right, we have to work harder to understand that and to make sure that for the kids with that inclination and those kinds of abilities that they get the inspiration to make those choices.

Mr. WOLF. Okay. With that I will just go to Mr. Aderholt.

Mr. ADERHOLT. Thank you, Dr. Holdren.

I want to follow up with chairman, just with the heavy lift, of course with the understanding, my understanding that the cost of developing a rocket with a lift of 70 tons, which was not fully integrated into a robust plan for completing a 130-ton rocket, would still be about 80 percent of the cost of a fully integrated plan.

The language in the CR bill for the heavy lift rocket indicates that it will be simultaneous development of the upper stage of that rocket.

The question would be how will your office help ensure that NASA manages contract modification and other options to ensure that the law is followed for simultaneous development?

Dr. HOLDREN. Congressman Aderholt, we will certainly be paying attention to that and working with Administrator Bolden and his staff to do everything we can to promote the successful achievement of the goals that the Congress has specified.

I think any interest in a 70-ton rocket would be in the context of a fully integrated plan to get to 130 tons, and again, I think the administrator has clarified his views on that subsequent to some initial expressions which were less clear, and OSTP is also committed to that goal and we will work with NASA to try to ensure its achievement.

Mr. ADERHOLT. Okay. Let me change into just another topic.

TORNADO DEVELOPMENT AND PREDICTION RESEARCH

Of course as you know the southeastern part of the United States was hit by the series of tornados, I guess it was a week ago today, and I think over the course of the southeastern states there were approximately, and I think we are hovering around 350 deaths right now, actually a third of those are in the district that I represent, and a lot of those is just north of Tuscaloosa, Birmingham, that area that I represent.

The question I have in relation to the tornados that hit. Do you believe that the tornado genesis, the process by which a tornado develops, is it the same in the humid southeastern United States as it is in the central plain areas of the United States? Go ahead.

Dr. HOLDREN. Well, first of all the amount of energy available to tornado formation is certainly affected by the amount of water in the atmosphere and by the temperature of the atmosphere, and both have been increasing. The temperature has been increasing, the amount of water has been increasing. There are a lot of other factors that govern the formation of tornados, including the interaction of weather fronts as you know, and so it is not a simple matter of saying simply if it is more humid and if it is hotter we are going to have more tornados, but all else being equal, that is given the other conditions that it takes to form tornados, if there is more moisture in the air or more heat in the air the potential for powerful tornados is larger.

Mr. ADERHOLT. I see. How does the budget request for your office or for NASA or NOAA reflect the need for research on these southeastern tornados, which you have indicated, you know, cause with more humidity and the more rain would cause? Does your request reflect research regarding that?

Dr. HOLDREN. There is certainly considerable research in NOAA on that question, the National Oceanic and Atmospheric Administration, and it is continuing.

The other relevant factor that I think is very important in this case is the capacity to forecast tornados and provide early warning, and NOAA's budget is very important in that domain as well. In fact we have a particular challenge in this domain because the Joint Polar Satellite System, which was not fully funded in the 2011 is budget is essential to maintaining continuity of the capacity to forecast tornados.

For all the tragedy that these tornados caused it would have been even larger. The loss of life could have been significantly larger had it not been for the amount of early warning that we had in large part due to the continuing availability and functionality of our polar-orbiting weather and climate satellites, and we could lose that. In fact we are now projecting a gap in that capability some time in the vicinity of 2015 because we have not made adequate investments to put the next polar-orbiting satellite up there.

So this is a very important matter where the safety of our citizens and the budget for NOAA come together.

Mr. ADERHOLT. No doubt, I mean the series of tornados that went through I know Alabama last Wednesday can only be compared to 1925, and when there were over 700 deaths, and of course I think a lot of that is due to the fact that the early warning was not there in 1925, and so, you know, the tornados that occurred last Wednesday could have been much worse than 700 had there not been that early detection, so I do understand and I do appreciate that.

So okay, thank you, Mr. Chairman.

Mr. WOLF. Thank you.

Mr. Fattah.

Mr. FATTAH. Thank you.

In this discussion about the tonnage for NASA, I am not sure that in the past the Congress has been so specific about the level of tonnage, and it is obviously challenging to think that as members we would be able to kind of project forward the science. But I think that the point is, is that where this requirement is in statute and if the science does not get us to the capacity to be able to do it then we run against a circumstances that would be challenging. So it will be interesting as we go forward.

But I think that the focus and the direction is in the right—the compass is correct. That is, that we want to produce a heavier lift as we go forward in terms of tonnage. I don't know that we have the wisdom, even though we obviously put it in statute, to say that somehow we are going to be able to do a certain tonnage. But notwithstanding that it has been done and we will see where we go.

NOAA SEVERE WEATHER PREDICTIONS AND WARNINGS

I want to shift gears a little bit to NOAA, and I note that you just commented on this, but in terms of the very severe weather that parts of our country have faced and it is very unfortunate about the deaths and injuries and the loss of property, but that whether or not given the NOAA budget submission in the 2012 budget whether there are issues inside of that budget that will be important for us to consider.

First is the severe weather issue. So we have the tsunami warnings, we have the severe weather warnings, we have—a large part of this request has to do with satellites, and if you could talk a little bit about this issue it would be helpful.

Dr. HOLDREN. Well, I would be happy to talk about that issue, although it is a vexing one.

When this administration came into office, we were faced with a situation in NPOESS, the National Polar-orbiting Operational Environmental Satellite System, in which the replacements for our polar-orbiting satellite suite, which satellites are of great importance to our military as well as to civilian weather forecasting and to climate monitoring, was over budget——

Mr. FATTAH. If you would yield for a second.

Dr. HOLDREN [continuing]. Behind schedule, and under performing.

Mr. FATTAH. If you will yield for a second, that is why the bin Laden raid was delayed for one day because of weather, right?

Dr. HOLDREN. It does illustrate that forecasting the weather is extremely important to military operations, but of course it is extremely important as well as we understand from this horrible experience in the southeast, it is extremely important for civilian purposes as well.

And in hurricane season our hurricane tracking capability is extremely important to the safety and welfare of our citizens, and we are very heavily dependent on this suite of polar-orbiting satellite for these purposes.

I understand from the NOAA administration, Dr. Lubchenco, that over 90 percent of the data that we use for forecasts beyond 48 hours comes from these polar-orbiting satellites, and if we lose that capability, if it is interrupted, and particularly if it was inter-

rupted for long, for that period the quality of our forecasts beyond 48 hours will be seriously degraded.

We are going to lose that capability now it appears for a period of time no matter what we do because the budgets for the last couple years have not been adequate to keep even the replacement program which we worked out with fewer instruments, fewer satellites, but still enough to do the basic job on track, and we need to get that back on track in 2012.

The President's 2012 budget makes a request that would get it back on track. I very much hope that we will have the support of the committee and the Congress as a whole in getting that done.

NATIONAL CAPABILITY GAPS IN HUMAN SPACE FLIGHT AND WEATHER DATA

Mr. FATTAH. Well, let me delve into this a little bit, because there have been a lot of comments about the fact that we have to depend on the Russians to take astronauts because we have a gap in a space vehicle and now we have a gap in satellite coverage for our severe weather forecasting that is going to appear. And I want to go back to the decision package that led to these gaps.

Now the ending of the shuttle flights was a planned activity well back more than a decade or so ago, and in 2004 the final timeline was put together for the end of these flights. There are people in our country who believe that the Obama Administration decided that we are going to stop flying shuttle flights.

I want you to comment on these gaps and how we got to this moment where we have hundreds of tornados, we have a tsunami that hit Japan, created a nuclear problem, but yet we are going to be without satellite coverage for some period of time in terms of checking the weather. So if you could help us understand how we got to this moment that would be important.

Dr. HOLDREN. Well, Ranking Member Fattah, it is a complicated story. I could send you a timeline and would be happy to do that.

[The information follows:]

Summary of Recent Past Events Leading to the End of the Shuttle Program

At a hearing before the House Appropriations Subcommittee for Commerce, Justice, and Science on May 4, 2011, Ranking Member Fattah requested that the Director of the Office of Science and Technology Policy, Dr. John P. Holdren, provide a timeline of events that led to the currently projected gap in US capacity to carry astronauts to low Earth orbit following the end of the Space Shuttle program (p. 84 of transcript).

- The Clinton Administration's 1994 National Space Transportation Policy directed NASA to "continue to maintain the capability to operate the Space Shuttle fleet" until a replacement was available. The Policy made clear that the "development of a new reusable launch system is anticipated," that NASA would lead "technology development and demonstration of next generation reusable space transportation systems," and that "no later than December 1996" a decision would be made on whether or not to "proceed with a sub-scale flight demonstration which would prove the concept of single-stage-to-orbit."
- Given this policy direction, in 1996 NASA began the X-33 program as a joint effort with Lockheed Martin. The X-33 was a development effort aimed at proving the concept of single-stage-to-orbit (along with the new technologies necessary to make the concept technologically feasible and affordable). The X-33 project was expected to lead to a new orbital vehicle called the "VentureStar," which was intended to replace the Shuttle for access to Earth's orbit by 2006 and produce significant advantages in terms of lower-cost operations.
- After a series of technical difficulties, X-33 was canceled in 2001.
- In 2002 NASA established an "Integrated Space Transportation Plan," which aimed to develop an "Orbital Space Plane" to complement Space Shuttle operations. The Orbital Space Plane, when completed, was to provide transportation for crew to Earth's orbit, while the Space Shuttle would focus on cargo transportation. At that time NASA was planning to operate the Space Shuttle through at least 2010, and would eventually have to decide whether or not to extend Space Shuttle operations through 2020.[1]
- Following the 2003 Space Shuttle *Columbia* tragedy and the report of the Columbia Accident Investigation Board, the Bush Administration released the "Vision for Space Exploration," or VSE, in 2004. The VSE directed NASA to "retire the Space Shuttle as soon as assembly of the International Space Station is completed," which was targeted for 2010. The VSE further directed that NASA was to end its plans for the Orbital Space Plane and instead develop a new Crew Exploration Vehicle, with a targeted operational availability of "not later than 2014" thus setting the stage for a four-year gap in human access to low-Earth orbit on US vehicles.
- In 2005 NASA established the Constellation Program as a means of implementing the VSE. The Constellation Program initially aimed to develop the Orion Crew Exploration Vehicle and the Ares I Crew Launch Vehicle not later than 2014, but as close to 2010 as possible. Ultimately NASA was not able to commit to an operational date for Ares I and Orion any earlier than March of 2015.

[1] A more detailed, but still concise discussion on these first four bullets is available in Chapter 5 of the final report of the Columbia Accident Investigation Board, and in wide variety of reference material used to produce that chapter.

- In 2009 the Obama Administration initiated an independent review of NASA's human spaceflight plans. The review committee, known as the Augustine Committee (after its Chairman, former Lockheed Martin executive Norman Augustine) concluded that the Ares I/Orion integrated system would likely not be operational until approximately 2017, and that other goals of the Constellation program were not achievable under any plausible scenario. The committee described several plausibly affordable options for the US human spaceflight program to and beyond low Earth orbit.
- After consideration of the options, the Obama Administration proposed a path forward with its FY2011 budget, released in February 2010. A number of elements of that plan survived the ensuing intense debate in Congress and became part of the 2010 NASA Authorization Act, signed into law in October. The Act lays out an ambitious program that includes a Space Launch System and Multi-purpose Crew Vehicle for exploration purposes, as well as a commercial crew services effort for transporting astronauts to Low Earth Orbit and supporting the operations of the International Space Station. It does not, however, eliminate the gap in US capacity to take astronauts to low Earth orbit following Shuttle retirement later this year. There was no feasible or affordable way to eliminate this gap starting from the program the Obama Administration inherited when it came into office.

Summary of Recent Past Events Leading to the NPOESS Decision

At a hearing before the House Appropriations Subcommittee for Commerce, Justice, and Science on May 4, 2011, Ranking Member Fattah requested that the Director of the Office of Science and Technology Policy, Dr. John P. Holdren, provide a timeline of events that led to the decision to restructure the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program.

- Initiated by PDD/NSTC-2 in 1994, the NPOESS program was intended to integrate the capabilities and infrastructure of the DoD and NOAA polar-orbiting weather satellite programs and NASA's expertise in technology development. As part of this convergence, DoD, NOAA and NASA created an NPOESS Executive Committee (EXCOM), which included senior officials from the three agencies, in order to provide oversight for the joint effort and to help ensure that the program as a whole met the needs of the three agencies. An Integrated Program Office (IPO) was also established to manage actual hardware development and related activities.
- During the latter part of the 1990s and early 2000s, the requirements for NPOESS expanded to include the continuity of many (if not most) of the climate data records from space that NASA had been collecting through their Earth Observing System (EOS) program as well as other satellites.
- In 2002, the NPOESS program was estimated to cost $7 billion (for development and operations through FY2018) to provide satellite development, satellite launch and operation, and integrated data processing. The plan was for six NPOESS platforms in 3 orbits, the first of which (C-1) was to be launched in early 2009 (see table below).
- The NPOESS Preparatory Program (NPP), a joint NASA/NPOESS IPO project consisting of an initial NASA satellite to test the new sensors, had initially been considered a bridge between the NASA Earth Observing System (EOS) and the NPOESS programs. NPP was intended to be launched in early 2006, but this launch date was delayed to October 2011 due to late delivery of instruments from the NPOESS IPO. (Because of delays in the NPOESS program, the role of NPP was also shifted to an operational mission for polar-orbiting weather capabilities.)
- The program encountered numerous technical and management challenges, which led to restructuring of the NPOESS program in 2006 due to cost over-runs that triggered a breach under the Nunn-McCurdy statute. (This statute requires DoD to recertify a program against established criteria if costs exceed baseline estimates by 25%. Without such a recertification a program would be terminated.) This recertification, which concluded in June 2006, assigned highest priority to preserving continuity of operational weather measurements and ultimately led to a decision to remove several climate and space weather capabilities from the NPOESS satellites. (Many of these climate monitoring capabilities were subsequently restored with funding from NOAA.) The restructured program reduced the scale of the program from six main satellites (in three sun-synchronous orbits) to four satellites (in two orbits). The U.S. would rely on European satellites for operational weather observations from the remaining orbit. After the 2006 restructuring, the new life-cycle cost estimate (through FY2024 due to delays) was $12.5 billion for the reduced capability, and the launch schedule had slipped further.

- In early 2009, the EXCOM established an Independent Review Team (IRT) to review the program baseline and the management approach. The resulting IRT report stated that "the current NPOESS program has an extraordinary low probability of success," and that the program "is being managed with cost as the most important parameter and not mission success." The report continued by stating that "the NPOESS EXCOM process is ineffective and must be fixed," and that "the IPO [does] not have sufficient space systems acquisition expertise and process" necessary for a program of this size. The IRT suggested that "an established space acquisition center" would provide "the institutional knowledge, robust infrastructure support, and a cadre of seasoned space system acquisition experts" to ensure success of the program. Finding that the management reserve contained in the cost estimate of the program was unrealistic, the IRT noted that while a more conservative (i.e. 80% confidence) cost estimate would, in their opinion, be beyond what the DoD would find affordable, a program which would fit within a currently acceptable budget would perform at such a reduced level that it would be unacceptable for NOAA and NASA. Believing that the EXCOM would be unable to resolve this difference, the IRT report stated that "this will require the White House to define the NPOESS program that is in the national interest." (At a June 2009 hearing at the House Science and Technology Committee, both IRT Chair Tom Young and GAO agreed that the life-cycle cost of the program would rise by at least $1 billion, and possibly $2 billion).[1]
- In August 2009, the Executive Office of the President formed a Task Force led by OSTP Associate Director Shere Abbott, and included representation from OMB and NSC in order to facilitate a review of options going forward with regard to the NPOESS program.
- In December 2009, the CJS Appropriations final FY2010 Conference Report language (House Report 111-366) stated the following:
    - "...repeated schedule delays portend an unacceptably high risk of weather and climate satellite observation gaps." In addition to "recognizing that this satellite program is critical to forecasting the Nation's weather" the conferees noted that "the budget request does not reflect the true need and the program's long-term projections for success remain in doubt. In fact, to date this experiment in combining disparate elements has been a horrendous and costly failure."
    - "Delays or postponements of decisions ... have long-term consequences for both the sustained robustness of the operational observing system and for the Nation's industrial capacity. Nothing short of an immediate and out-of-the-box solution will do. The program needs a cooperative solution that will take advantage of the strengths of the three agencies involved, sustain the integrated operations of the various satellites, and should not be based on financial projections that have proven to be consistently and abysmally unreliable."
    - "NOAA is encouraged to request appropriate contingency funding to avoid delays and additional management and industrial policy challenges when programmatic funding is diverted to solve an imminent crisis. In addition, NOAA is encouraged to request funding for and to develop back up capabilities to ensure continuity of climatological observations. Accordingly, the conference agreement removes the

[1] House Science and Technology Committee hearing, June 17, 2009: "Continuing Independent Assessment of the National Polar-Orbiting Operational Environmental Satellite System." The hearing transcript and the text of the IRT report can be found at http://www.gpo.gov/fdsys/pkg/CHRG-111hhrg50173/pdf/CHRG-111hhrg50173.pdf

50/50 NOAA-DoD funding split requirement to allow for more creative funding decisions to avert the critical climate and weather gaps that are sure to occur if a management solution is not identified soon."

- "Changes to the overall management structure are also needed to bring the program back in line, which includes modifying existing relationships between NOAA, the Department of Defense, and the contractor and enlisting more help from an agency with real space acquisition experience, such as NASA."

- During the fall of 2009, while the EOP review was being conducted, DoD sponsored a separate review of the NPOESS program. The results of this review stated the following: C-1 and C-2 were executable; NPOESS big problems were in the past; success would require competent execution; executive management is impeding progress; state of program maturity in terms of design, build, test, and risk levels is consistent with current phase of the program; schedule and funding reserves inadequate for remaining work to be done.
- The Administration announced its decision to restructure NPOESS as part of the roll-out of the FY2011 budget on February 1, 2010. The restructure entailed NOAA/NASA taking responsibility for procurement for the afternoon orbit (as the Joint Polar Satellite System, or JPSS), and DoD taking responsibility for procurement for the early-morning orbit (as the Defense Weather Satellite System, or DWSS). This restructuring was accompanied by a significant increase in NOAA's FY2011 budget request (from $382 million in FY2010 to $1.06 billion) in order to expedite the polar-orbiting weather satellite launch schedule and reduce the risks of a gap in forecasting data.
- Tom Young, chairman for the IRT review, testified on the restructured program before the Senate Commerce Committee on February 24, 2010. In response to a question from Senator Nelson about his view of the EOP NPOESS decision, Young stated that "it's extraordinarily better than status quo," and that he "strongly recommends support for the restructured program."
- The restructuring of the program was endorsed in NASA Authorization Act of 2010 (PL 111-267) Section 707; "Sense of the Congress that ... the Congress supports the decision made by OSTP in February, 2010, to restructure the program..." (October 11, 2010.)
- In April 2011, the Department of Defense and Full-Year Continuing Appropriations Act, 2011, funded NOAA's polar-orbiting satellite programs at $382 million, the same level as NOAA's FY2010 budget for the NPOESS program. NOAA estimates that because the FY2011 appropriations allows for only a fraction of the funding necessary to continue work on the instruments and spacecraft for the first of NOAA's satellites (JPSS-1), work has been slowed down considerably. Under the current funding level, the JPSS-1 mission could be delayed a minimum of two years, thus forcing the weather forecasting community to rely solely on satellites that will be operating well past their planned mission life. Based on analysis conducted by the Aerospace Corporation on behalf of NOAA, this will result in a nearly 100% chance of a data gap by 2017.
- DoD is currently planning first launch of DWSS in 2018 to maintain coverage in the early-morning orbit.

History of cost and schedule estimates of the NPOESS program[2]

Date	Life-Cycle Cost Estimate (billions)	Number of NPOESS satellites	Launch date, NPOESS Preparatory Project (NPP) satellite	Launch date, final POES satellite (NOAA 19)[3]	Launch date, first NPOESS Satellite (C-1)
Aug. 2002	$7.0	6	May 2006	March 2008	April 2009
July 2003	$7.0	6	October 2006	March 2008	November 2009
Sep. 2004	$8.1	6	October 2006	March 2008	November 2009
Aug. 2005	$8.1	6	April 2008	December 2007	December 2010
June 2006	$12.5	4	January 2010		January 2013
Dec. 2008	$13.95	4	January 2010	February 2009	January 2013
June 2009	$14.95[4]	4	January 2011		March 2014

[2] Based on GAO Report 10-558, "Polar-orbiting Environmental Satellites: Agencies Must Act Quickly to Address Risks That Jeopardize The Continuity of Weather and Climate Data" (2010)
[3] House Science and Technology Committee hearing charter, June 17, 2009: "Continuing Independent Assessment of the National Polar-Orbiting Operational Environmental Satellite System"
[4] GAO estimate based on their analysis of contractor data.

Mr. FATTAH. I would like for you to do that.

Dr. HOLDREN. The essence of the matter is in part you are right that we have known since early in the previous administration that the shuttle program needed to come to an end. It needed to come to an end for a number of reasons, one of them being that this is basically 1970's technology which in some sense is so complicated and so fragile you see the results in the fraction of the time that we end up having to postpone launches for the safety of the astronauts, which obviously has to remain paramount. But it was also the case that the shuttle is so expensive to operate that while you are operating it you can't find the money in any plausible NASA budget to develop its replacement, and so it was recognized again already in the Bush Administration they made that decision that the shuttle would be phased out.

And the problem was that the successor program to the shuttle, the Constellation Program, was going to provide both access to lower earth orbit and the heavier capabilities for deeper space missions. It never got the budgets it needed to stay on track, and the result was by the time we came into office the Constellation Program was in danger of being three to four times over budget, that is over the originally anticipated cost for those vehicles.

And in addition, it was so far behind schedule that no amount of money poured into it at this point could erase the gap in the capacity to put American astronauts on the space station on U.S. rockets.

At the same time the attempt within NASA to find enough money to keep Constellation on track had sapped the resources available for many of NASA's other programs, but we had a further problem. We had a problem that the NPOESS program, the successor program for these polar-orbiting satellites was a joint venture of the Department of Defense, NASA, and NOAA, and for a whole variety of reasons those folks were proving not to be playing very well together, and that contributed to delays and cost overruns in the NPOESS program itself, which we were charged when we came into office with fixing.

I say we, I was charged in my confirmation hearing for fixing it and then I was charged by the President with fixing it because it is an interagency science and technology program that falls under the jurisdiction of OSTP, and we worked very hard with those three agencies to fix it and we figured out a way, we thought the best possible way to fix it in terms of dividing certain responsibilities more clearly between the Department of Defense on the one hand and NOAA and NASA on the other, but carrying out those responsibilities required an increase in NOAA's budget which they have not received.

That is the essence of the story. I will give you a longer time line following this hearing, sort of the step by step of who did what and to whom that led us to this predicament.

Mr. FATTAH. I want to thank you, that is very illuminating and unfortunate, but I want the time line.

Thank you, Mr. Chairman.

Mr. WOLF. Thank you.

Mr. Culberson.

Mr. CULBERSON. Thank you, Mr. Chairman.

CONTROL OF RARE EARTH ELEMENTS

Dr. Holdren, I know you have published repeatedly in the journal *Science* and other science publications so I know you are familiar with them and read the journal *Science* on a regular basis. I am confident.

Dr. HOLDREN. I am sometimes a little bit behind on my reading of *Science* because of my other responsibilities, but I do read it on a regular basis.

Mr. CULBERSON. I can certainly sympathize. You said you were not aware that the People's Liberation Army had any role in the—or you weren't sure of the role or how far their tentacles extended into NASA.

To what extent are you familiar with the role of either the People's Liberation Army or the Communist Party in Chinese universities in the way they are operated or governed?

Dr. HOLDREN. Well, first of all I am aware that the PLA has a substantial role in the Chinese space program. I don't want to be misunderstood about that.

Mr. CULBERSON. Okay.

Dr. HOLDREN. I said I am not clear on the details of the extent of that role and how it works.

Mr. CULBERSON. Fair enough.

Dr. HOLDREN. But there is no question that the PLA has a role in the Chinese space program, and similarly I would be very surprised if the PLA didn't have some interactions with the Chinese university system. I am not again familiar with the details of how that works.

Mr. CULBERSON. Or the Communist Party's involvement in either the space program or in their research at their universities.

Dr. HOLDREN. Well, the Communist Party governs that country, and so the involvement is obviously extensive.

Mr. CULBERSON. You mentioned earlier in your testimony that you are engaged in efforts to promote scientific and technological cooperation that you feel is in our best interests.

And I just want to make absolutely certain you were aware—and I was unaware until I had seen this in the April 8th edition of *Science*—that all mainland universities in China, Mr. Chairman, have two leaders, the president of the university and the Communist Party secretary. So it is not just the space program. It is pervasive.

And the reason the chairman and I keep circling back to this is that the Chinese have made it their national policy, it is their goal to make the 21st century the Chinese century, and they see their primary obstacle to be the United States.

And the chairman quoted an article I think that the—was it the IMF, Mr. Chairman, said that about 2016 the Chinese economy would surpass ours?

It is, I think, self-evident that by the—and this has, I think been out in the open that by 2015 the Chinese will be in a position militarily to announce, as I expect they would, their own Monroe doctrine of sorts, and that is my own personal supposition, Mr. Chairman, but I have run that past a number of folks and I think we can safely predict that some time within the next four to five years

we will see China announce a Monroe doctrine for the eastern hemisphere that they have a zone of influence within which the United States can't and shall not have any influence or interference. The Malacca Straits are the carotid artery to the Chinese in terms of their reliance on foreign oil.

The chairman also took testimony of the subcommittee from the Director of the National Science Foundation that in fact the Chinese—and I just saw an article more recently on this, Mr. Chairman—that the Chinese now control 97 percent of all rare earth elements on the planet.

And you were quoted in this same article, Dr. Holdren, this is from the journal *Science*, March 26, 2010, that the—or excuse me, I'm sorry—a group of scientists had sent you a letter: "last month magnet industry leaders in the United States sent a letter to John Holdren [. . .] calling on the Obama Administration to take prompt action to restore rare earth mining and processing in the United States and other western countries. The recommendations including establishing short-term stockpiles of rare earths critical for defense needs and having the U.S. Department of Energy set up a $2 billion loan guarantee program to help western mining companies build new mining and processing facilities."

What have you done in response to that letter and what have you done to protect the United States and help ensure that we have access to these strategically vital rare earth elements?

Dr. HOLDREN. Well, thank you for those good questions, Congressman Culberson.

Let me start by saying that we do understand that China wants to be number one. That is not surprising. We want to stay number one. And the things that we are recommending in the 2012 budget are intended to keep us number one, and we have talked already a bit about the ingredients that will be required for us to stay number one.

I have also already said I don't think any of us has a clear crystal ball as to when China might pass us and in what respects. I think China has some big internal problems, most of them of their own making, many of them resulting from the kinds of policies and practices that Chairman Wolf has been a leader in denouncing, and my hope is that we stay number one and that China does not pass us in important aspects of capability.

I also hope that China is not in a position militarily at any foreseeable time to make a unilateral declaration of the sort that you described that would impair United States' interest and the United States' freedom of action.

But with that said and turning to the rare earth element question, we have been aware of that issue for a long time. We have had in place under the leadership of the Office of Science and Technology Policy jointly with the National Security staff and the National Economic Council an interagency working group on the rare earth minerals that has provided briefing papers for the President, that has developed short-term and long-term strategy proposals for how to minimize this vulnerability.

Mr. CULBERSON. Which are?

Dr. HOLDREN. China has come to this position because they were able to undercut the price.

We have considerable rare earth mineral resources in the United States, in Alaska, and in other parts of the United States, but it is a matter of not just having the resources but of developing the whole supply chain of not just mining, but processing those materials into usable forms, and we are doing a number of things to make that happen.

Mr. CULBERSON. Such as?

Dr. HOLDREN. We have developed a review of domestic and global policies that effect that and are looking to strengthen the ones that will accelerate U.S. production.

We have been in conversation with companies and with the governors of the states that possess these resources on what they can do to accelerate the process of reviving rare earth mineral industries in their states.

Mr. CULBERSON. Reviews and conversations.

Dr. HOLDREN. Reviews and conversations. We have——

Mr. CULBERSON. Something specific.

Dr. HOLDREN. Well, we have the——

Mr. CULBERSON. Tangible.

Dr. HOLDREN. The DoE has ramped up its R&D, including developing a new hub on critical minerals, which as the other hubs have done will aim to reduce the time lag between discovery and innovation in universities and national laboratories——

Mr. CULBERSON. But that is utilization of the rare earth elements.

Dr. HOLDREN [continuing]. And getting things into the progress.

Mr. CULBERSON. That is utilization of rare earth elements.

Dr. HOLDREN. No, it is not just utilization. I'm sorry, sir, but it is also how we can mine them more cheaply, process them more efficiently, convert them into the forms that we need in our products more efficiently so that the Chinese will not be able to undercut us economically and maintain that very large market share that they now enjoy. It is not just a process focused on using them.

Mr. CULBERSON. Okay. What specific tangible things have you done—because this is in your shop, this is your responsibility—to protect the United States against what is obviously now a monopoly of the Chinese on rare earth elements, which they have used already to their strategic advantage when one of the Chinese captains of a Chinese ship t-boned a Japanese ship some time last year I think, and the Japanese arrested the Chinese captain, who deliberately hit them, you remember that, and then all of a sudden the Japanese had to release the captain.

Well, it turns out the Chinese had, you know, these reports out there that you can read them and find them, and the open source is that the Chinese used their monopoly on rare earth elements to strangle the Japanese and force them to release this captain.

I mean this is a strategic threat to the United States, and we are really looking for what—you got this letter from the industry leaders last March and you have known about this for a long time, what specific tangible steps have you taken to ensure that the United States has access to rare earth elements from sources other than China? I am looking for some other nation.

Dr. HOLDREN. Well, we are always talking to the Australians, have been talking to the Australians who have considerable resources of these.

The problem, Congressman, as I mentioned, is not the existence of resources of these minerals in many countries other than China, the problem is that it is a matter of two or three years to develop the supply chain, and we are working with companies and governments to develop those supply chains and to do it with technologies that will enable us to compete with or undercut the Chinese.

Now that is not something you can do overnight and it requires initially understanding the character of the problem. We have gotten started. We got started. We got started a year ago March on that effort.

I would be happy to provide you following the hearing with a more detailed report on that.

[The information follows:}

***Response to Rep. Culberson's question about what the Administration is doing about rare earth element supply* (p. 94 of transcript).**

The supply of rare earth elements (REE) is one aspect of the broader concern over the reliability of critical and strategic mineral supply chains. For any mineral deemed critical a thorough analysis must consider what form (raw oxides, metals, alloys, components, etc.) is in short supply and, in the case of REE, a shortage of which of the seventeen REE at greatest risk for being in short supply would be most damaging to U.S. industry. Since March of 2010, the Administration has been actively assessing the impact on and risks to U.S. industry associated with supply disruptions of REE.

In the short term (1-2 years), a wide range of options for the diversification of REE supply chains are being considered, from the development of domestic sources to engagement with interested foreign trade partners; and we believe the use of diplomacy with our trading partners to be the most effective short-term activity because it allows for maximum flexibility as conditions change in both the market and the geopolitical landscape. In the short term it would appear that both domestic and foreign (non-Chinese) interests are active in the necessary diversification of supply. Additional supplies of REE are expected to be available on the global market over the next two years, from Australia (developed by Lynas Corp.) and the U.S. (developed by Molycorp), that are projected to alleviate supply shortfalls for several REEs (*e.g.*, lanthanum and cerium). Furthermore, industry is pursuing targeted recycling that could ease the supply picture for other REEs (*e.g.*, terbium and europium).

In the long term, we continue to have significant concerns with U.S. dependence on supply chains of REE and finished components that may be vulnerable to disruptions in the five- to twenty-year timeframe. What follows is a list highlighting key Administration activities initiated in the last year to mitigate the medium- and long-term risks associated with REE and other critical and strategic mineral supply chains.

- **DOE Energy Innovation Hub.** The President's FY 2012 funding request includes the creation of a DOE Energy Innovation Hub ($20M) on critical materials that will focus on reducing U.S. reliance on materials such as REE. The Hub activity will focus on the following three challenges: (1) finding ways to reduce the content of such critical materials in existing components; (2) identifying new chemical compositions, material designs and approaches that are not reliant on critical materials; and (3) pursuing technologies that increase yields and decrease the cost of separating critical elements from recycle streams and ores.

- **OSTP Interagency Working Group.** Since March 2010, in coordination with the National Economic Council and the National Security Staff, the Office of Science and Technology Policy has been hosting an interagency working group on critical and strategic mineral supply chains, which includes the topic of supply constraints on REE. The initial focus of this group is in four areas: (1) critical mineral prioritization and establishing an early warning mechanism for potential shortfalls in supply, (2) federal R&D prioritization, (3) review of domestic and global policies that affect the supply of critical and strategic minerals (*e.g.*, permitting, export restrictions, recycling, stockpiling, etc.) and consideration of methods to mitigate risks through industrial or diplomatic processes, and (4) transparency of information (both geologic and market). The Department of Energy (DOE), the Department of Defense (DOD), United States Geological Survey (USGS), Department of Commerce, Environmental Protection Agency, Department of Justice, Department of State and the Office of the United States Trade Representative (USTR) participate in the group.

- **USGS Mineral Resource Assessments.** The USGS has examined lands that might have occurrences of REE or other mineral resources as part of national or regional mineral-resource assessments. The objective of USGS mineral-resource assessments is to estimate quantities, qualities, and areas of undiscovered mineral resources in a form that conveys both economic viability and uncertainty associated with the resources. The assessments include compilation of information about identified resources, both as a component of the total resource assessment and as a key input for the deposit models needed as part of the process of assessing undiscovered resources. In November 2010, USGS issued a report detailing domestic REE reserves and resources. It concluded that proven domestic sources could contribute ~1.5 MM tons of REE oxide supply (global demand is currently ~200,000 tons per year).

- **USTR Trade Activity.** In October 2010, the Office of the United States Trade Representative (USTR) initiated an investigation into a variety of Chinese government policies in the green technology sector, including allegations concerning China's export restraints on REE, pursuant to a petition brought by the United Steelworkers under Section 301 of the Trade Act of 1974, as amended. Although no formal action was taken by USTR under Section 301 on the REE allegations when the formal Section 301 investigation concluded in December 2010 with the initiation of a WTO dispute challenging Chinese government subsidies to wind power manufacturers, USTR stated that it would continue to work closely with stakeholders on other allegations made in the United Steelworkers' petition, and if sufficient evidence could be developed to support those

allegations and they could be effectively addressed through WTO litigation, the U.S. would pursue the enforcement of its rights at the WTO. Moreover, through our bilateral economic and trade dialogues, we continue to press China to remove its export restraints on REEs and other materials. We are also working with the European Union, Japan and others using WTO meetings, G-20 discussions, Organization for Economic Cooperation and Development meetings, and bilateral dialogues to raise the profile of problematic export restraints on raw materials by China and other countries.

- **DOE Critical Materials Strategy.** DOE's *Critical Materials Strategy*, released in December 2010, concluded that a number of clean-energy technologies rely on mineral raw materials subject to supply disruptions, including wind turbines, electric vehicles, photovoltaic solar cells, and fluorescent lighting. The report finds that five rare-earth elements (dysprosium, neodymium, terbium, europium, and yttrium) and indium are important to clean energy and subject to the greatest supply risks in the short term. It identifies three strategic priorities to address material criticality: diversifying the global supply chain for critical materials, seeking substitute elements and materials, and fostering increased recycling, resource efficiency, and re-use. The report discussed eight policy options, ranging from R&D to diplomacy. Following the issuance of the report, DOE has taken steps to invest in relevant research. Additional follow-on work this year includes an updated Critical Materials Strategy and an R&D plan.

- **DOD Assessment.** The Department of Defense is in the process of conducting a congressionally-mandated assessment of individual REE demand from defense applications (due in July 2011), and based on the findings will recommend measures to ensure adequate supply of REE.

Mr. CULBERSON. Okay, please do, I know the chairman would be very interested.

By the way, in your office does anyone in your office, anyone working with your office have any Chinese nationals working directly or indirectly for them or with them?

Dr. HOLDREN. We of course don't have any Chinese nationals working in our office. To work in the Office of Science and Technology Policy you have to be an American citizen and you have to be eligible for a top secret clearance.

Mr. CULBERSON. Directly or indirectly——

Dr. HOLDREN. No.

Mr. CULBERSON [continuing].Would anyone working with or that has access to your office have any Chinese nationals working with them directly or indirectly?

Dr. HOLDREN. I am not sure, Congressman, what you mean by indirectly, but as the chairman has mentioned, I myself have traveled to China numerous times over the last several years and have had Chinese visitors here in connection with my responsibilities for conducting the Joint Commission on Science and Technology Cooperation with China, but we have nobody in our office who is a Chinese national or who is consulting for our office who is a Chinese national.

Mr. CULBERSON. Super.

ADDRESSING SOCIAL ISSUES THROUGH SCIENCE

I also wanted to ask about, if I could, I notice that when you were president of the AAAS that you asked that scientists tithe 10 percent of their time to working on your number one priority as AAAS president: fighting world poverty. Do you recall all that?

Dr. HOLDREN. I recall my presidential speech in which I listed a number of important priorities, including fighting world poverty and disease, mastering the energy-economy-environment challenge and more.

Mr. CULBERSON. Right. Did your number one priority you laid out for AAAS was to—and I am looking at your speech here on the *Science* website that how can science and technology help, what is your obligation to scientists? Number one, meeting the basic needs of the poor, right?

Dr. HOLDREN. I believe, Congressman, I would have to revisit that text myself, but I listed five or six items, and I think I said they were not in order of importance.

Mr. CULBERSON. Okay.

Dr. HOLDREN. They were all important and they included avoiding the use of weapons of mass destruction.

Mr. CULBERSON. Sure, and that——

Dr. HOLDREN. They included maintaining the productivity of the oceans and so on.

Mr. CULBERSON. Right, right.

Dr. HOLDREN. And I suggested that not all scientists tithe 10 percent of their time to reducing world poverty, but that they tithe 10 percent of their time to these large public interest questions across the board.

Mr. CULBERSON. Noble worthwhile effort, but what I am driving at is another issue. You have said, and it is clear that your office

since NASA doesn't report to the—the NASA administrator is not a cabinet-level official and doesn't report directly to the President, the NASA administrator reports to you, so essentially your responsibilities are very broad for the President to encompass essentially a supervisory role or as sort of the administration official responsible for NASA.

Dr. HOLDREN. It would be I think more accurate to say, Congressman, that the NASA administrator reports to me on matters of science and technology, to OMB on matters of budget, and to Cabinet Affairs on matters of interaction with the rest of the administration.

Mr. CULBERSON. So to what extent since you have a long history of publications of, you know, guiding the AAAS and focus on that number one—maybe not in priority order—but one of the top five goals of scientists, you know, tithing 10 percent of their time and focusing on the fighting of global poverty, to what extent were you involved in and how and what way did you help guide Lori Garver and her remarks to Goddard last year in which she said NASA's number one goal was fighting world poverty?

Dr. HOLDREN. I had no influence on those remarks at all and was not aware of them until after they came out, and I don't really understand the context. I had no interaction with Lori Garver.

Mr. CULBERSON. That makes no sense, I agree.

ATMOSPHERIC EMISSIONS AND ENVIRONMENTAL CONTROLS

A couple of other quick areas, Mr. Chairman, that I just find particularly fascinating and revealing.

Back in 2001, you published a paper in *Science* in which you argued we have a—essentially an environmental Hippocratic Oath to do no harm to the environment, that the—you had argued that the atmosphere is essentially a commons that we all have an equal right to, and when you had published a paper with Paul Baer, John Harte, Barbara Haya, Antonia V. Herzog, Nathan E. Hultman, Daniel M. Kammen, Richard B. Norgaard, and Leigh Raymond, which I know you are familiar with, and I will be as brief as I can, Mr. Chairman, but this is particularly interesting and I know will be of interest to the chairman as well, that you were attacked in a letter of February 2nd, which I am confident you remember.

A gentleman by the name of Arthur Westing wrote and said hey, this idea proposed by John Holdren and others that recommends apportioning the use of the atmospheric commons as a gaseous and aerosol waste dump sounds superficially attractive and that you suggested that emissions were allocated based on equal rights to the atmospheric commons for every individual.

And he says the idea of an equal per capita allocation of greenhouse gases is flawed, because he said, it implicitly condones global overpopulation and rewards countries in proportion to their level of transgression of human carrying capacity of their portion of the global biosphere.

And you wrote a response to him saying that, you know, we see no evidence that an equal per capita allocation would provide an incentive to significantly alter national population growth. Climate demographic interaction would help reduce population growth rates through increased investments, and in any case we suggest in our

policy form possible solutions to any appearance of incentives for governments to adversely alter their population policies in response to per capita permit allocations.

This can be achieved, for example, by choosing a fixed base-year population by determining for each country a population baseline, incorporating reasonable declines in population growth, or by allocating permits to population based on some previous time point.

Would you explain this? I am just not sure I understand the concept of an atmospheric commons, and I don't notice the Chinese respecting that. I mean they dump more pollution into in atmosphere along with the Indians than any other country on the face of the earth. And what right would any international body have to impose population limits on any country?

I mean that essentially is what you are advocating here. It is just sort of bizarre. I am not sure I understand what you are——

Dr. HOLDREN. You are not correctly understanding it. We are not proposing there to impose population limits on anybody. The idea of a population baseline was simply a reference point against which entitlements to add pollutants to the atmosphere would be based. Precisely the problem that you mention with China making very large emissions into the atmosphere under which we all live.

Mr. CULBERSON. And India.

Dr. HOLDREN. And India as well. Is one of the reasons that in selected domains we think it is in our interest to continue to cooperate with them, to move them more rapidly toward reducing those emissions, which is in our interest because we all live under one atmosphere.

The only significant point about the concept of an atmospheric commons is the atmosphere is common to everybody. We live under one atmosphere. Things added to it in one place that stay there influence the conditions and the quality of life for others elsewhere.

Mr. CULBERSON. Uh-huh.

Dr. HOLDREN. And therefore ultimately society has to figure out, and that can only be done by negotiations and agreement ultimately, has to figure out how to limit what every country adds to that commons to the detriment of all the others.

Mr. CULBERSON. Okay.

Dr. HOLDREN. There is nothing more sinister or sophisticated than that behind this interaction.

Mr. CULBERSON. Okay. One final question.

Why, then, should the United States continue to unilaterally, under your guidance and the Administration's guidance, continue to impose aggressive and stringent restrictions on access to domestic sources, oil and gas, restrictions on atmospheric emissions, carbon dioxide, unilaterally, when the Chinese and Indians are ignoring it? That is a cannon ball around the ankle.

Dr. HOLDREN. Again, with all respect, Congressman Culberson, you phrased that a little differently than I would phrase it.

We are not imposing stringent restrictions on carbon dioxide emissions in this country at this point. And the Congress has not agreed to do that and it is not happening.

Mr. CULBERSON. But you were trying to do it by rule through the EPA. Aren't you helping in that effort?

Dr. HOLDREN. The EPA has some authority in this domain, and——

Mr. CULBERSON. And you are advising them on it and helping them on it.

Dr. HOLDREN. I am not advising the EPA, I advise the President, let me be clear about that.

But in my view it is important and valuable and necessary that the United States reduce its emissions of greenhouse gases because, we along with China and India, are major contributors to the additions of greenhouse gases that are implicated in global climate change that is not good for any of us.

And it is also I think highly likely that if we are to succeed in persuading China and India to take more stringent steps to reduce their emissions—and by the way, China has already done quite a lot to reduce their emissions below what they would otherwise be, they are still enormous, but they have made large investments in energy efficiency and particularly in automotive efficiency, they have imposed stringent standards on automotive efficiency, they are building more advanced coal plants to try to reduce the emissions from that sector, they are studying carbon capture and sequestration.

I think we should continue to urge the Chinese to make progress in that direction and we should continue to make progress in that direction ourselves.

Mr. CULBERSON. On our own.

Dr. HOLDREN. On our own and in negotiation and cooperation with others. It is in our interest to persuade China to reduce their emissions, and it is in our interest to reduce our own.

Mr. CULBERSON. The chairman has been very gracious, thank you, sir, for the extra time.

Mr. WOLF. Thank you.

POPULATION CONTROL

Well, I didn't know Mr. Culberson's line of questioning, and let me just say I am not going to ask you a question. But I do want to, based on what he said, put this in the record.

In anticipation of the hearing, I got your book out of the Library of Congress. Your book, "Ecoscience: Population, Resources, Environment," coauthored with population control advocates Paul and Anne Ehrlich. There is no question to ask, and many views that people had in 1977 they have discontinued. I want to put that out there, but it was troubling when I went through it.

On page 837 it said, "indeed it has been concluded that compulsory population control laws, even including requiring compulsory abortion could be sustained under the existing Constitution if the population crisis becomes sufficiently severe to engage the society." Page 837.

You also went on to say on page 838, "neither the Declaration of Independence nor the Constitution mentions a right to reproduce."

It says in the Declaration that all men are created equal and are endowed by their creator with the rights to life and liberty and the pursuit of happiness. Those words were drafted by Thomas Jeffer-

son in Independence Hall in the City of Philadelphia, which I used to walk through and see the Liberty Bell almost every day.

Lastly, you went on to say on page 787, "the development of a long-term sterilization capsule that could be implanted under the skin and removed when pregnancy is desired opens additional possibilities for coercive fertility control. The capsule could be implanted at puberty and might be removable with official permission for a number of births. No capsule that would last that long, 30 years or more has yet been developed. But is technically within the realm of probability."

Dr. HOLDREN. Mr. Chairman, if I may.

Mr. WOLF. Sure.

Dr. HOLDREN. You didn't ask a question.

Mr. WOLF. No, I didn't.

Dr. HOLDREN. But the chapter—I want to comment.

Mr. WOLF. Sure.

Dr. HOLDREN. The chapter from which you read was a compilation of ideas and concepts that had been discussed in the literature, it was identified as such, and the author statement at the end says we do not advocate these measures.

I think it is not fair to assert that I held the view that compulsory measures to limit population were appropriate, justified, warranted, or moral. That was a summary of views that appeared in the literature in a large comprehensive book in which I was mainly responsible for the chapters on geochemical cycles, on energy, on materials, and so on.

Mr. WOLF. Well, I appreciate that.

COORDINATION OF STEM EDUCATION PROGRAMS

On STEM education in a report on duplication in government programs that came out a few weeks ago, GAO identified five different agencies—NSF, NASA, Department of Energy, Defense, and Education—who fund programs to improve STEM education.

We know this is not a complete list because other agencies fund it. NOAA also has STEM education programs.

Do you believe that the benefits of having so many different agencies involved outweigh the costs of inefficiency and program fragmentation?

The other question that we can kind of marry to that is, the GAO review concluded we need better cross agency coordination to reduce duplication and ensure a balanced portfolio of STEM education programs.

This is not a new finding. In fact, it seems that this finding is made pretty much every year by both internal and external reviewers.

Since we have known that STEM education coordination is a problem, why haven't we fixed it and what can we do working with you to fix it?

Now again, I am talking about trying to have more, not talking about cutting back. We are talking about encouraging more. So those two questions together.

Dr. HOLDREN. Chairman Wolf, I agree with you, and that is why we have stood up this National Science and Technology Council committee chaired by Carl Wieman, Carl Wieman agrees with you

as well, we want to look at all those programs across all the agencies that are engaged in STEM education, we want to figure out which ones are duplicative, which ones are effective, and which ones are ineffective. We want to eliminate the duplicative and ineffective ones and we want to end up with a package that is more potent that spends the resources we have available in a more effective way to lift our game in STEM education in this country. I think you are exactly right, that has been begging for review and we have gotten it under way.

Mr. WOLF. Well, I want to help you on that. If we can do something in this committee in the mark up, I hope you will come to it.

So the question sort of continues. Last year's America COMPETES Act, which I voted for and I commend Bart Gordon very, very much for the work that he did, assigned responsibility for the coordination of federal STEM education programs to a committee, which we have been discussing, under the auspices of your office.

What is the status of the committee? Can you tell us who is on it? How many meetings they have had? When can we expect to see concrete steps taken?

And then to connect that, the COMPETES Act also required you to submit a report with each year's budget request outlining what is in the budget for STEM education, discussing potential duplication and providing progress and implementation updates on ongoing activities.

Will there be a report for 2012?

Again, this is nothing you should be fearful of. We are not looking to throw this out. It is so we can have a more effective effect.

So, who is on the panel, the committee that you referenced?

Dr. HOLDREN. I can't tell you off the top of my head who is on the panel. I can tell you who chairs it, and that is my associate director for science, Dr. Carl Wieman.

Mr. WOLF. And that is very impressive, but can you tell us——

Dr. HOLDREN. I will happily provide that. I don't have the list of the panel members with me, but all the agencies that have these programs are represented on the panel.

[The information follows:]

REQUEST FOR DETAILS ON THE NSTC STEM ED COMMITTEE

At the House CJS Appropriations Subcommittee hearing on May 4, Chairman Wolf requested details about the newly-formed STEM Ed Committee under the NSTC: who sits on the committee; action plan, etc.

Response: The National Science and Technology Council (NSTC) Committee on STEM held its first meeting on March 4, 2011. The Committee is co-chaired by Dr. Carl Wieman, Associate Director for Science at OSTP, and Dr. Subra Suresh, Director of the National Science Foundation. Agencies represented on the committee include: Departments of Agriculture, Commerce, Defense, Education, Energy, Health & Human Services, Interior, Transportation, as well as NASA and the EPA. There are two working groups under the committee: Federal Inventory of STEM Education Fast Track Action Committee and Federal Coordination in STEM Education Task Force. The Committee's charter is also included.

CHARTER of the COMMITTEE ON
SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EDUCATION

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

A. Official Designation

Pursuant to the requirements of Sec. 101 of the *America COMPETES Reauthorization Act of 2010* (the Act), [1] the Committee on Science, Technology, Engineering and Math (STEM) Education (CoSTEM) is hereby established by action of the National Science and Technology Council (NSTC) (Executive Order 12881 of November 23, 1993, as amended).

The CoSTEM serves as part of the internal deliberative process of the NSTC and provides overall guidance and direction. The NSTC, a Cabinet-level council, is the principal means for the President to coordinate science and technology policies across the Federal Government.

B. Purpose and Scope

The purpose of the CoSTEM is to coordinate Federal programs and activities in support of STEM education pursuant to the requirements of Sec. 101(a) of the Act.

C. Functions

The CoSTEM, in accordance with the Act, will:

1. Review STEM education activities and programs, and the respective assessments of each, throughout Federal agencies to ensure effectiveness;
2. Coordinate, with the Office of Management and Budget, STEM education activities and programs throughout Federal agencies; and
3. Develop and implement through the participating agencies a 5-year STEM education strategic plan, to be updated every 5 years.

D. Membership

The following departments and agencies are represented on the CoSTEM:

Department of Agriculture;
Department of Commerce;
Department of Defense;
Department of Education;
Department of Energy;
Department of Health and Human Services;
Department of the Interior;
Department of Transportation;

Environmental Protection Agency;
National Aeronautics and Space Administration; and
National Science Foundation.

The following organizations in the Executive Office of the President are also represented on the CoSTEM:

Domestic Policy Council;
National Economic Council;
Office of Management and Budget; and
Office of Science and Technology Policy.

Cooperating departments and agencies shall include such other Executive organizations, departments and agencies as the Co-Chairs may designate.

E. Private Sector Interface

The CoSTEM may seek advice from members of the President's Council of Advisors on Science and Technology and will recommend to the Director of the Office of Science and Technology Policy the nature of additional private sector advice needed to accomplish its mission. The CoSTEM may also interact with and receive *ad hoc* advice from various private-sector groups as consistent with the Federal Advisory Committee Act.

F. Termination Date

This charter shall terminate no later than March 31, 2015 unless renewed by the Director of the Office of Science and Technology Policy.

G. Determination

I hereby determine that the establishment of the Committee on STEM Education is in the public interest in connection with the performance of duties imposed on the Executive Branch by law, and that such duties can best be performed through the advice and counsel of such a group.

Approved:

John P. Holdren

2-1-2011

John P. Holdren
Assistant to the President for Science and Technology and
Director of the Office of Science and Technology Policy

Date

[1] Relevant Language from the America COMPETES Act (Pub. L. No. 111-358):

SEC. 101. COORDINATION OF FEDERAL STEM EDUCATION.

(a) Establishment- The Director shall establish a committee under the National Science and Technology Council, including the Office of Management and Budget, with the responsibility to coordinate Federal programs and activities in support of STEM education, including at the National Science Foundation, the Department of Energy, the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the Department of Education, and all other Federal agencies that have programs and activities in support of STEM education.

(b) Responsibilities- The committee established under subsection (a) shall--

(1) coordinate the STEM education activities and programs of the Federal agencies;

(2) coordinate STEM education activities and programs with the Office of Management and Budget;

(3) encourage the teaching of innovation and entrepreneurship as part of STEM education activities;

(4) review STEM education activities and programs to ensure they are not duplicative of similar efforts within the Federal government;

(5) develop, implement through the participating agencies, and update once every 5 years a 5-year STEM education strategic plan, which shall--

(A) specify and prioritize annual and long-term objectives;

(B) specify the common metrics that will be used to assess progress toward achieving the objectives;

(C) describe the approaches that will be taken by each participating agency to assess the effectiveness of its STEM education programs and activities; and

(D) with respect to subparagraph (A), describe the role of each agency in supporting programs and activities designed to achieve the objectives; and

(6) establish, periodically update, and maintain an inventory of federally sponsored STEM education programs and activities, including documentation of assessments of the effectiveness of such programs and activities and rates of participation by women, underrepresented minorities, and persons in rural areas in such programs and activities.

Dr. HOLDREN. And I have to tell you that Dr. Wieman is not only a very smart guy, but he is a very determined guy, and he——

Mr. WOLF. Oh, I'm sure, I——

Dr. HOLDREN [continuing]. Wants to get to the bottom of this.

Mr. WOLF. I think it is a great appointment.

Now, when were they set up? What day were they set up?

Dr. HOLDREN. I believe they had their first meeting in March, last month, that's right.

Mr. WOLF. Okay. Do you know when they plan on—and this is not fair to put you——

Dr. HOLDREN. I don't know that off the top of my head, but I would be delighted to provide you the answers to those questions, who is on the committee, when they are planning on reporting, and what that report will cover.

Mr. WOLF. Will there be a report for the 2012 budget?

Dr. HOLDREN. I believe there will.

Mr. WOLF. Good, good.

Dr. HOLDREN. All right.

Mr. WOLF. Well, let us know if there is something that we can do here in this bill that helps you with regard to that. Again, I know it may be viewed in a different way by some that think we are looking to strip something out, we are looking to change. But I agree with you that we should give you more resources and have more young people involved.

Do you know if my figures are accurate with regard to last year or two years ago, with 50 percent of the——

Dr. HOLDREN. I must say that took me back, and I have made a note to look into it. I don't understand where that number comes from, but I will sure find out.

Mr. WOLF. If you can.

STEM EDUCATION BEST PRACTICES

Do you believe the 2012 budget reflects an appropriate balance between K through 12 STEM programs and those focused on higher education? Should we be more aggressively focused on the youngest kids to ensure that they become engaged in science? How are you balancing that out?

You mentioned earlier that you don't think it is being taught appropriately at some colleges, and you are right. I very seldom have heard of somebody who goes to the University of Virginia and majors in business administration or political science and then in their sophomore year transfers into physics. It is usually they go——

Dr. HOLDREN. Other way.

Mr. WOLF. It is the other way.

So do we have the right balance here? Is all the necessary original research out there and it is just a question for your office to pull this all together? Maybe you can participate in the conference the National Science Foundation is going to have showing what works for fifth grade and sixth grade, but also maybe have a separate session about how do you then tell the University of Virginia, Virginia Tech and MIT, how they can make it relevant so that the people who come into physics stay in physics rather than go into political science?

Dr. HOLDREN. The answers are all basically yes or maybe.

The maybe is do we have the balance right? I think we have taken a good cut at the balance in this budget, but we are constantly looking at it and we are constantly learning about additional opportunities to do things in different domains, that is one of the things that Dr. Wieman is looking at, and we will obviously be proposing to adjust balances over time as we learn more and discover things that we should be doing and aren't doing, or as we discover things that we have been doing that aren't working well.

In terms of the conference you mentioned we will absolutely be participating in that conference.

Mr. WOLF. You all are smart people, you have a lot of information. Is there something down there that you know now about it but you are so busy—and I respect that—but we are not getting it out to those people who need to know, like the deans of engineering across the country?

I saw a figure, I think it is in the "Gathering Storm," but don't quote me. It could have been in Norm Augustine's update, but it said, and I believe I made a comment on it, that we graduated more Ph.D.s in physics in 1956 than we graduated last year. Is that a fact?

Dr. HOLDREN. I don't know whether that is a fact.

Mr. WOLF. Do you think it could be?

Dr. HOLDREN. It is certainly conceivable, yes.

Mr. WOLF. If you have some information, Mr. Fattah and I could do a letter to all of the deans of engineering or we could put together a conference. You could call a conference, we could use the Capitol Visitor Center here whereby you could bring your best minds to say, "we now know this is successful at the university level, and this has worked whereby all you deans ought to be looking at this." But the point is you may have something there that we want to sort of get out.

Dr. HOLDREN. Let me tell you, Mr. Chairman, this is cutting edge stuff.

Carl Wieman is one of the leading researchers in the world, probably the leading researcher in the world and practitioner who at a number of major universities has put these new approaches into practice and achieved spectacular results, but this is such new stuff that it is not yet very propagated very widely.

We recruited Dr. Wieman to be the associate director for science at OSTP because—not because he is a Nobel Prize winner in physics, that it is wonderful to have a Nobel laureate as your associate director for science—but we recruited him because of his extraordinary leading edge work on this subject, and we are trying to use the fact that he is now in OSTP in the White House and talking with the President about this and talking with other university leaders. We are trying to use that to propagate these ideas, and we will continue to do that, and I think we will see these ideas and these approaches spread, and I think they will be helpful with the phenomenon you identify, that we have——

Mr. WOLF. Well, could you have the doctor come up and——

Dr. HOLDREN. Oh, absolutely.

Mr. WOLF. And maybe we should——

Dr. HOLDREN. He would love to, I assure you.

Mr. WOLF. Maybe we should have a conference this fall where we bring all the deans together here.

Dr. HOLDREN. He has been talking to a lot of them, but a conference could be a good idea.

Mr. WOLF. Well, why don't you have him come on up.

Dr. HOLDREN. No, I will do that.

Mr. WOLF. And we can just talk.

Dr. HOLDREN. Absolutely.

TSUNAMIS AND DISASTER PLANNING

Mr. WOLF. We had asked NOAA several weeks ago if they would hold a conference here, and I appreciate the NOAA Administrator saying yes. We are going to bring all of the governors up and down the east coast, the Caribbean and all the FEMA people together to see if all the economies are ready for a tsunami, are they ready for an earthquake? We hope to do the same thing maybe out at Caltech out there.

I don't know if you were going to be participating in that. You may talk to the head of NOAA to see. We are also bringing the U.S. Geological Survey.

Dr. HOLDREN. Good.

Mr. WOLF. That way if something is coming, we know that they should be prepared and we know that everyone has a plan. This Committee six years ago plused up the buoy systems around the world to make sure that we were ready, and so I think you should see if there is some role that you can play. We are not looking to fill your time up, but I would like to do something.

Dr. HOLDREN. This is important stuff and I am engaged in this domain of planning and preparedness and understanding how our facilities may be vulnerable to tsunami and earthquakes and making sure with the other agencies that are involved.

This is another one of these cross-cutting agency issues, and I am involved in it, and I agree with you about its importance.

Mr. WOLF. Well, the conference will be in June here at the Congress. The Congress is out that week.

Dr. HOLDREN. I can't tell you at this moment whether it is on my calendar, but it might well be, and I am scheduled to have a conversation with Under Secretary Lubchenco at the end of the afternoon.

Mr. WOLF. Well, she has been very good. She is really——

Dr. HOLDREN. She is great.

DUPLICATION OF EARTH SCIENCE PROGRAMS

Mr. WOLF. I have a question on NOAA duplication. We are just going to get it to you for the record.

There is some concern with regard to the duplication of NOAA and NASA on certain research topics like atmospheric composition, climate and other things, so please take a look at that.

OSTP FISCAL YEAR 2012 BUDGET REQUEST

The only new item in your 2012 budget request is a $350,000 decrease that would be achieved by limiting the activities of the President's Council of Advisors on Science and Technology.

What work did you have planned for the PCAST that might be deferred under the budget request?

Dr. HOLDREN. I have to say in all honesty, Mr. Chairman, that I didn't volunteer for that reduction. This comes under the heading of sharing the sacrifice, and the—what PCAST does depends in part on what studies the President asks us to conduct for him, and how we will deal with that decrease going forward will depend in part on what studies the President requests from us, and we may find ourselves having more meetings by teleconference and fewer meetings face to face, which has both advantages and disadvantages.

We may handle it by saying we are going to have to prioritize among the different requests the President has made of us and ask him what he wants the most, because we don't have enough money to do it all.

Mr. WOLF. Could that decrease impact the schedule for PCAST's planned report on higher education STEM programs?

Dr. HOLDREN. I do not think it will because that study is already well under way and I don't think its completion is going to be imperiled by that reduction. It would be studies later in the pipeline that would be impacted.

MEETING GOALS FOR BASIC RESEARCH SPENDING

Mr. WOLF. Between the American Competitiveness Initiative, two versions of the American COMPETES Act, and the "Rising Above the Gathering Storm" report, we have had a variety of calls for increases in basic research over the last few years.

ACI and the COMPETES Act proposed doubling the budgets of NSF, NIST, and Energy Office of Science over either seven or ten years, and "Gathering Storm" called for an annual 10 percent increase in basic research funding for physical science and math and engineering. Including the proposed 2012 budget, but excluding one time stimulus funding, how close are we to being on track to these goals?

Dr. HOLDREN. We are certainly not there in the Continuing Appropriations Act for 2011, and the only way we could get back on track on those projectories would be if the President's 2012 budget were approved by the Congress, but that would get us—if the 2012 budget were approved that would get us back on this sort of trajectory that you are describing and that American COMPETES called for.

Mr. WOLF. Well, I don't know what our allocation is going to be. I certainly will do everything I can, and I think Mr. Fattah feels the same way. I think you are back to that issue of hopefully—and I know this is not your responsibility, the President will deal with this whole entitlement issue—tieing the entitlement issue onto the debt limit, and then I think it would free up a lot of additional revenue.

Dr. HOLDREN. Uh-huh.

Mr. WOLF. If you looked at the tax package that passed, the White House said this was an example of Republicans and Democrats working together. I voted against the tax package. There was a cut in the payroll tax which will cost $112 billion for one year. Can you imagine what $112 billion spent wisely could have done?

Instead we give a break to Jimmy Buffett, a break to Warren Buffett, and we basically hit these programs really hard. So I don't know what the allocations will be.

The "Gathering Storm" report also calls for OSTP to set up an office to oversee improvements to the Nation's research infrastructure. Have you established this office? And what kind of strategy are you pursuing to ensure the aging research facilities get the upgrades needed to keep them functional and relevant?

Dr. HOLDREN. Well, that is both a function of the science committee and the National Science and Technology Council, which is also chaired by Dr. Wieman and it is always the focus of studying PCAST as initiated.

Mr. WOLF. So would the PCAST cut have any impact on this?

Dr. HOLDREN. I hope not.

Mr. WOLF. So maybe. Maybe?

Dr. HOLDREN. We have to look at how we are going to accommodate that cut. But again——

Mr. WOLF. You would really be upset if we put that money back.

Dr. HOLDREN. I am not sure I am allowed to answer that question.

Mr. WOLF. I think there are other questions that we will just submit for the record. I will go back to Mr. Fattah and Mr. Culberson at the end.

Mr. FATTAH. I am prepared to conclude, Mr. Chairman, unless we are going to go back around.

Mr. WOLF. No, we won't.

CYBERSECURITY AT OSTP

Two weeks ago we had a conversation with the NSF director about balancing the desire to promote public access to research findings with needs to protect scientific intellectual property and data critical to American economic and national security interests.

Do you believe we are currently striking the right balance? Or can you take a look at this?

Dr. HOLDREN. We are taking a look at it, that is another issue that is in our domain. There is a tension there that will never be entirely resolved between those two goods. The good of the need to protect intellectual property and national security information on the one hand and the need and the value of openness on the other.

I wouldn't swear to you, sir, that we have the balance exactly right now, but we are looking at it.

Mr. WOLF. Well, the Chinese are stealing us blind.

Dr. HOLDREN. I hear you on that.

Mr. WOLF. And if we can chat after you go out to the Cyber Center, the staff will get in touch with you. I was out there last Thursday and they are stealing us blind.

And keep in mind, a secretary in the Bush Administration had his computer stripped. They took the same equipment, I believe, to Beijing that you may have taken.

So we will also ask the bureau to talk to you about that too, but I think Mr. Culberson is right. There may be a problem.

Dr. HOLDREN. I would be happy to talk to the bureau.

Mr. WOLF. The Chinese stripped my computer here. Have you had any cyber attacks against your computer?

Dr. HOLDREN. Not that I am aware of, sir.

Mr. WOLF. You may be one of the only agencies in the government that has not.

Dr. HOLDREN. I mean I am not saying there have been no cyber attacks against OSTP, my understanding is that cyber attacks are directed all the time at virtually every U.S. agency. I am sure in that sense there have been attacks against OSTP as well.

I am not aware of any successful ones, and I am not aware of any cyber attack other than the usual things that come in every day on my own personal computer.

Mr. WOLF. Well, can you look and see if you believe, since you are the science advisor, that we have every necessary policy in place so that agencies such as NASA and NSF and others are doing everything that they need to do? We would even work it out here that you look at this in-depth government wide. Obviously the law enforcement agencies are looking at it, but almost from a different level than you might look at it. So if you would look at that, I would appreciate it.

Dr. HOLDREN. I will certainly do it, Mr. Chairman. I do want to assure you that OSTP is a full participant in the interagency working group on cyber security at every level from the working level to the deputy's level to the principals level in which I participate, and we do participate with the Director of National Intelligence and the head of the FBI and all the folks that you were talking about we are with them all the time talking about the cyber security issue, what we can do to increase the protection of U.S. assets and the protection of U.S. intellectual properties. So this is not a new issue for me.

Mr. WOLF. I understand.

Okay, do you have anything, Mr. Culberson?

Mr. CULBERSON. I will submit anything else in writing, but just to say, if I could that just to reiterate, that the scientific community has no better friends in Congress than Chairman Wolf and this committee, and all of us work arm in arm. Mr. Fattah, all of us. Adam Schiff, my dear good friend who has a daughter about the same age as ours, in support of the sciences, in support of NASA, in support of planetary exploration. We have philosophical disagreements in certain areas, obviously, but we are arm in arm in our commitment to support, to firewall our investment in the basic sciences and to preserve and protect America's leadership, and the world requires a very strong investment by the federal government in fundamental scientific research, sir, and you can expect strong support from this committee in that effort.

Dr. HOLDREN. Well, I thank you very much for that, Congressman Culberson, I appreciate it, I know it has been true in the past, and I see that it is going to be true going forward and it is greatly appreciated by me and by the Administration.

Mr. WOLF. In closing to follow up with what Mr. Culberson said, I had an event a while back that Norm Augustine attended—you know Norm Augustine. He made a comment that the 16th century was the Spanish century. Spain is a great country, but it is no longer the dominant power. He said the 17th century was the French century, and we used the French to help us at Yorktown. They are no longer the dominant power. He said the 19th century

was the British century. The 20th century, he said, was the American century. And then he left a question out there—will the 21st century be the American century or the Chinese century?

Not a question, but following up on what Norm Augustine said, I want the 21st century to be the American century, and we want to work with you to make sure that it is.

And also on the whole issue of China, I am going to take you at your word. We are not swearing people in under oath here, but if there is any activity that you are doing with China where you may think you are okay, I may not. Please call the Committee and tell us. Do I have your word?

Dr. HOLDREN. Yes.

Mr. WOLF. Okay, good, the stenographer can't pick up a nod of the head.

Dr. HOLDREN. Yes, Mr. Chairman.

Mr. WOLF. Okay. Then the meeting is adjourned.

Dr. HOLDREN. And thank you.

Mr. WOLF. Thank you very much. Thanks.

Chairman Frank R. Wolf
Questions for the Record
Office of Science and Technology Policy
Hearing on May 4, 2011

STEM Education

1. Please list each Federal agency involved in STEM education activities and describe that agency's unique role in the government-wide effort.

Answer:

Federal funding for STEM education is provided by the following agencies:

- **Department of Education**
- **National Science Foundation**
- **Department of Agriculture**
- **Department of Commerce**
- **Department of Defense**
- **Department of Energy**
- **Department of Health and Human Services**
- **Department of Homeland Security**
- **Department of the Interior**
- **Department of Transportation**
- **Environmental Protection Agency**
- **NASA**

Since the assets of each agency are different, their roles are also slightly different. The role of each agency in STEM education is tightly aligned to the agencies' overarching mission. The mission agencies (all but NSF and Department of Education) have two educational roles. First is to attract and train the specialized workforce necessary for carrying out the specific mission of the agency, either as agency employees or in private or public entities that carry out work of direct relevance to the agency mission. The second role of mission agencies is to utilize their unique assets, such as scientific findings, STEM expertise, technology, and research facilities to support formal and informal educational systems that can prepare a diverse, internationally competitive, and innovative STEM workforce and a STEM-literate society.

The Department of Education (ED) and the National Science Foundation (NSF) provide the majority of support for STEM education and have different roles from the mission agencies. NSF has leading roles in basic research and small-scale testing and dissemination, as well as incorporating the advances from the NSF science and engineering research directorates into educational materials and dissemination activities.

Much of the STEM effort in ED is in programs that target education generally, and thus they touch on STEM, but their primary focus is not STEM specific. They do provide substantial financial aid for undergraduate students both in STEM and in K-12 STEM teacher programs, they collect and disseminate data on U.S. STEM education, and they play the leading role in supporting large scale implementation by working with the States and multiple school districts.

The NSTC Committee on STEM Education is developing a five-year Federal STEM education plan that will better identify and coordinate the STEM education assets and roles of each agency.

2.The America COMPETES Act requires the Director of OSTP to submit a report with each year's budget request outlining what's in the budget for STEM education, discussing potential areas of duplication and providing progress and implementation updates on ongoing activities. Is there such a report for the fiscal year 2012 budget? If not, why, and when will we see the first report?

Answer:
OSTP will submit to Congress the first STEM education report with the 2013 Budget, and annually thereafter. Section 101 of the America COMPETES Reauthorization Act of 2010, enacted in January 2011, requires the establishment of an NSTC Committee on STEM Education to develop a 5-year STEM education strategic plan. In March, I established the Committee, and it is currently developing a strategic plan for delivery to Congress by the end of 2011. Subsection c of Section 101 requires OSTP to transmit a report annually to Congress at the time of the President's budget request describing the plan above and describing how the budget makes progress toward implementing the plan. Because the Committee had not been established nor the strategic plan delivered at the time of the release of the 2012 Budget, there is no STEM education budget report for the 2012 Budget.

3.To wha t extent are our national struggles in STEM education due a lack of effective implementation of known methods of instruction as opposed to a lack of knowledge about how to effectively teach STEM material? If there are already many examples of effective STEM programs, should we be shifting more of our resources from programs that do theoretical research on STEM education to those that identify and disseminate proven ideas?

Answer:
The answer to this question depends on the gradc lcvel. At the undergraduate level, while there remain things to be learned, there is a large amount of evidence demonstrating how to greatly improve the teaching of STEM subjects, and the main problem is getting implementation of these improved teaching methods. That would also benefit the training of K-12 STEM teachers by exposing them to more effective ways to teach and learn STEM.

At the K-12 level much less is known about how to teach STEM effectively and how to train teachers to be effective. Advances in learning and education research over the past 1-2 decades have yielded a greater understanding of how people learn. The current state of research in science education is summarized in the NRC report *Taking Science to School*, and offers hope for great improvements. While there are new and emerging insights about the general principles of effective STEM-education pedagogy and curriculum, such as encouraging discourse, integrating the teaching of content and skills, and putting STEM into meaningful contexts, there is still much work to be done to develop an understanding of how such principles can be translated into effective K-12 STEM education programs, particularly given the diverse range of school settings and demographics represented in the United States, and the lack of teacher-preparation programs that are designed around these principles and ensure their graduates have mastered them. We know that teachers have a profound effect on the learning of students, but surprisingly little is known as to exactly what characteristics make a teacher highly effective. This is a very active area of current research. There is even less known about how to train a teacher so his/her students achieve greater learning. Answering these questions is a research priority at NSF, as reflected in the FY12 budget request. We also need to know more about classroom pedagogy and curricular materials, particularly on the influence of the surrounding social contexts on the effectiveness and reproducibility of various approaches, before we will be able to replicate successful programs. Far too many educational programs that appear to be highly successful, such as math and science magnet schools, look very different when one adjusts for the bias in the data due to selection of the particular students and teachers involved. So when one tries to replicate such programs with a more typical set of students and teachers, many, if not all, of the apparent benefits vanish. Research on instructional practices, curricula, and assessments for use in K-12 math and science classrooms has been an ongoing focus of research at ED through the research programs and R&D centers in the Institute of Education Sciences (IES). In these research programs, researchers are required to test the impact of these interventions in typical schools and under conditions of routine practice to better ensure they are applicable to a broad range of schools.

NASA Exploration

4. NASA is fina lizing an implementation plan for the newly authorized exploration program. This plan will include a final decision on vehicle designs and acquisition options. If NASA decides to dramatically change the reference vehicle design or the acquisition strategy for the crew vehicle and the launch system, what will be the impacts on NASA's ability to deploy a new system in a timely manner? What will be the impacts on the industrial base that has been involved in the exploration program to date?

Answer:
NASA is currently conducting an in-depth analysis of options for how best to implement the newly authorized exploration program, using as its reference design a launch vehicle and crew capsule configuration described to the Congress in an interim report this past January. That reference design assumes the use of Ares I and Shuttle-derived technology for a heavy lift launch vehicle and the Orion capsule as the Multi-Purpose Crew Vehicle, consistent with the provisions of the 2010 NASA Authorization Act. NASA continues to examine alternative designs to validate and/or challenge those concepts. Such due diligence aims to ensure that the final vehicle choices will be the best value for the taxpayer with respect to cost, risk, schedule, performance and impacts to critical NASA and industrial skills and capabilities. Further details about NASA's analysis and final decisions about a path forward for SLS and MPCV will be provided to Congress in a report to Congress in the late spring/summer time frame.

Duplication Between NASA and NOAA Earth Science Missions

5.Do y ou believe there is any programmatic duplication between NASA and NOAA in the area of earth science?

Answer:
No. As called for by the National Aeronautics and Space Administration Authorization Act of 2008 (P.L. 110-422), GAO examined whether NASA programs duplicated those of other agencies. In their 2009 report (GAO 10-87R), the conclusion for Earth Science was that there was "no duplication found in areas we reviewed." The report went on to state that "NASA provides a unique role in Earth Science that is leveraged by other federal agencies."

6.Eve n if any specific activities aren't being duplicated, NASA and NOAA have a number of shared research interests, including atmospheric composition, climate and weather variability and water cycles. If both agencies are doing work in these areas, do you believe that they have the work divided between them in a way that maximizes efficiency and effectiveness?

Answer:
Yes. In order to maximize efficiency and effectiveness, NASA and NOAA coordinate their weather and climate activities via:

- **regular meetings between NASA's Earth Science Division and NOAA's National Environmental Satellite Data and Information Services (NESDIS) office, including research to operations transition plans;**
- **the U.S. Global Change Research Program (NASA and NOAA are two of the 13 agencies involved, and both hold leadership positions on the USGCRP Executive);**
- **NASA's Joint Agency Satellite Division oversees NASA efforts to develop and launch NOAA's satellites on a reimbursable basis.**

In addition to the GAO report mentioned in the response to question 5, we can have confidence that NASA's science efforts are not duplicative with the efforts of other agencies for at least a few other reasons.

- **First, NASA Administrator Bolden and his personnel are continually engaged with NOAA and other agencies, communicating their plans and coordinating their activities. OSTP, and other parts of the Executive Office of the President, are equally engaged to make sure we are not duplicating our efforts.**
- **Second, a recent NRC report on interagency collaborations in the Space and Earth sciences noted that, while there are always difficulties, the NASA-NOAA relationship is one where there are "distinct, but complementary" roles. The 2010 report is titled "*Assessment of Impediments to Interagency Collaboration on Space and Earth Science Missions*."**
- **Third, several formal Executive and Congressionally mandated organizations and forums coordinate among the agencies and serve to avoid duplication. In the case of NASA and NOAA, these include:**
  - **the Office of the Federal Coordinator for Meteorological Services and Supporting Research;**
  - **the NASA-NOAA Joint Working Group (formally the NASA-NOAA Quarterly Roundtable from section 306 of the 2005 NASA Authorization Act);**
  - **the Joint Center for Satellite Data Assimilation;**
  - **the Interagency Working Group for Airborne Data and Telecommunication Systems; and**
  - **the U.S. Weather Research Program.**

7.What do you see as the major implications of devolving some of NASA's earth science programs to NOAA? How would this impact budget planning, staffing or relationships with the research community?

Answer:
Design, development, and implementation of precision, cutting-edge scientific space systems is a complex activity requiring effective, efficient collaboration among many highly skilled and experienced experts. NASA has the best space technology engineers in the Nation, and arguably, in the world. This NASA know-how is essential for conducting Earth Science from space. Though NOAA and USGS have built strong capabilities to operate satellites after they are launched into orbit and activated, NASA remains very much in the lead for space systems development and for advancing the broad sweep of Earth Science activities from space. If NASA loses its Earth Science mission, the Nation would lose its ability to observe the Earth from space.

There are many commonalities among the skills and processes needed for the design and development of scientific spacecraft to serve different disciplines. Our nation's space-based scientific research activities span the disciplines of astrophysics planetary

science, heliophysics, and Earth science. NASA's major satellite-mission development centers work in all four of these science areas, allowing efficient synergies, communications of "lessons learned" and common procedures, and rapid cross-discipline deployment of expert personnel.

Managing Through the End of the Stimulus Bill

8.The Administration strongly supported the inclusion of significant science funding in the stimulus bill, but the expiration of those temporary funds has researchers facing a feast-or-famine situation as stimulus-funded activities come to a close. What is the Administration doing to help agencies manage this stimulus-caused funding cliff?
Answer:

The Administration is taking a number of actions to help Federal agencies and the science community adjust to the expiration of Recovery Act funding. From enactment of the Recovery Act in February 2009, OSTP and other White House offices have helped agencies to design their Recovery Act spending plans to maximize immediate economic payoffs while still managing for long-term stability. We have helped NSF and other agencies, for example, construct a mix of 2, 3, 4, and in some cases 5-year research grants so that Recovery Act-funded research projects do not all end at the same time. We have helped Federal science agencies invest in research infrastructure and instrumentation to build research capabilities and to provide immediate economic benefit without incurring long-term research funding obligations. We have helped Federal science agencies invest in targeted graduate research fellowships, first-time investigator grants, traineeships, and enhanced postdoc support to sustain economically vulnerable members of the U.S. science and engineering community during difficult times. These measures have all helped to make the transition to the post-Recovery Act era more manageable for research institutions and researchers. To manage better the transition still looming before the U.S. research community, the 2012 Budget proposes a robust, fiscally responsible Federal investment in research. If enacted, targeted increases in funding for key science agencies including NSF, NIH, DOD, and DOE will help to increase the competitive opportunities for researchers transitioning from Recovery Act research projects to regular research projects.

9.W hat do you believe is the impact on the American scientific community of these major up and down swings in available research funding?

Answer:

With over $787 billion in funding, the American Recovery and Reinvestment Act is one of the single boldest and largest investments in the U.S. economy in the nation's history. The Recovery Act's design was three-fold: to *rescue* a rapidly deteriorating economy; put the country on a path to *recovery* by putting Americans back to work quickly; and *reinvest* in the country's long-term economic future, building a foundation for a new, more robust, and more competitive American economy. Within the reinvestment

spending of the Recovery Act, over $100 billion has been invested in innovative and transformative programs, including more than $18 billion for research and development (R&D). The American scientific community responded heroically with groundbreaking research proposals for projects that are now pushing forward the frontiers of our knowledge. To give just one example, because of Recovery Act funding the number of complete human genomes anticipated to be sequenced in the next few years is expected to dwarf, by 50 times or so, the number of complete human genomes that have been sequenced to date.

Of course, in more ideal economic conditions it would be better for Federal research funding to be smooth and predictable rather than up and down. But in response to the greatest economic crisis since the Great Depression, the Recovery Act was a one-time stimulus in which the scientific community played its part. Recovery Act investments, from the beginning, were understood by the scientific community as one-time investments to respond to an economic downturn that affected universities and other research institutions, the employment prospects of science and engineering graduate students, and the local economies surrounding major research institutions. Recovery Act research funding advanced the state of our knowledge, aided in the economic recovery, and ameliorated difficult short-term conditions. With the economic recovery fragile but nevertheless well under way, the U.S. scientific community and Federal science agencies are transitioning to a more normal environment in which sustained, predictable Federal investments in research are needed. The 2012 Budget is consistent with a long-term vision for Federal investments in research as articulated by the President in his April 2009 National Academy of Sciences speech, his President's Plan for Science and Innovation of a long-term doubling path for key science agencies, and the America COMPETES Reauthorization Act of 2010.

Dissemination of Research Data

10. Under section 103 of the America COMPETES Act, OSTP is supposed to be leading an interagency committee tasked with coordinating agency policies on the dissemination and maintenance of research data. What is OSTP's plan for implementing this section, including dates by which OSTP will report conclusions or recommendations to the Congress?

Answer:

The Interagency Working Group on Digital Data of the National Science and Technology Council's Committee on Science is addressing the scientific data preservation, dissemination, and interoperability issues raised in section 103 of the America COMPETES Reauthorization Act. A report to Congress will be provided within the 12 month timeline specified in the Act.

11. Do you expect this committee to produce a single, uniform, government-wide policy on access to data?

Answer:

The membership of the Interagency Working Group on Digital Data, with participants from more than 20 Federal departments and offices, is designed to ensure the full spectrum of agency, science, technology, community of practice, and other needs are represented in designing comprehensive solutions. The Working Group is tasked with developing fundamental policy principles that can be applied government-wide while supporting the legitimate need for interoperable standards appropriate to varying science contexts and differing data types and uses.

Wireless Innovation Fund

12. The fiscal year 2012 budget includes proposed mandatory spending for wireless technology research and development at Federal science and technology agencies. This spending is funded by a reallocation of Federal and commercial spectrum bands over the next 10 years, but that reallocation (and, therefore, the revenue) is dependent on future statutory authority. When does the Administration anticipate sending such a legislative proposal to the Congress?

Answer:

There are currently a number of bills pending in Congress that support aspects of the President's Wireless Initiative. We look forward to working with Congress as legislation proceeds in order to address the Administration's priorities.

13. The wireless R&D portion of the spectrum revenue totals $3 billion. Who decided how this $3 billion would be distributed between various Federal programs?

Answer:

A world-leading wireless network will be a critical platform for driving future American economic growth and the competitiveness of American businesses and workers. Substantial innovation is required to achieve this vision and overcome key challenges. The President's Council of Advisors on Science and Technology (PCAST) recently identified key enabling technologies that are likely to form the direction of "5G" networks, including security, reliability, interoperability, analytic, and spectrum-sharing technologies, and recommended an additional $1 billion investment a year in networking and & IT R&D, more broadly. These R&D investments envisioned are an important input to enabling the nationwide, interoperable wireless broadband network for public safety to achieve its desired attributes of safety, security, and resiliency.

In addition, wireless R&D is important for advances for the efficient use of spectrum in the commercial and public sectors as outlined in the Presidential Memorandum on Unleashing the Wireless Broadband Revolution. That document emphasized the

importance of agency collaboration in research and development for emerging wireless technologies to explore innovative approaches to spectrum-sharing. It is also important to develop technologies to test and demonstrate authentication and strategies for enabling trusted infrastructure, such as those called for in the President's Cybersecurity Review. With these priorities and the current state of technological development in mind, the Administration identified agencies and programs that would be best suited for promoting the development and use of such technologies and requested funding for these programs as part of the Wireless Innovation (WIN) Fund in the FY 2012 Budget.

International Coordination and Cooperation

You testified that a legal determination was made within the Administration that language from section 1340 of the fiscal year 2011 appropriations bill prohibiting bilateral coordination and cooperation between OSTP and China or a Chinese owned company could not be read to inhibit the President's constitutional authority to conduct foreign relations. Please submit a copy of this legal opinion.

14. **Answer**:

After careful consideration, including consultation with the Department of Justice, it has been determined that, with respect to OSTP, certain applications of Section 1340 of the Department of Defense and Full-Year Continuing Appropriations Act of 2011, Pub. L. No. 112-10, would infringe upon the President's constitutional authority to conduct foreign diplomacy. Attached is a copy of the recent letter that formally notified the Congress of this determination.

15. You appeared before the subcommittee on May 4. On May 5, you submitted a notification that you would be participating in a series of meetings with Chinese officials on May 6-10 pursuant to the U.S.-China Strategic and Economic Dialogue and the U.S.-China Innovation Policy Dialogue. When did you first know that you would be participating in these meetings? If you were planning to participate at the time of the subcommittee's hearing, why didn't you inform the subcommittee when you were specifically asked about compliance with section 1340?

Answer:

I have been planning to participate in these meetings since 2010, though I did not know the exact date of the meetings at that time. This is one in a long series of meetings with Chinese officials that have been ongoing. President Barack Obama and President Hu Jintao established a Strategic and Economic Dialogue during their first meeting in April 2009. I was prepared to discuss these meetings with the members of the subcommittee at the hearing, but I was not asked at that time whether any relevant

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20502

May 16, 2011

The Honorable John A. Boehner
Speaker
U.S. House of Representatives
Washington, DC 20515

Re: Section 1340 of the Department of Defense and Full-Year Continuing Appropriations Act of 2011

Dear Mr. Speaker:

After careful consideration, including consultation with the Department of Justice, it has been determined that, with respect to OSTP, certain applications of Section 1340 of the Department of Defense and Full-Year Continuing Appropriations Act of 2011, 112 P.L. 10, infringe upon the President's exclusive constitutional authority over diplomatic relations. In particular, Section 1340 interferes with the exercise of authority delegated to OSTP by the President to carry out the President's objectives in international diplomatic negotiations and discussions. OSTP will therefore refrain from applying the restrictions of Section 1340 when those restrictions impermissibly constrain the President's exercise of his constitutional authority over diplomatic relations. Consistent with the requirements of 28 U.S.C. § 530D, I am writing to advise you of this determination and to inform you of the steps OSTP will take to implement that determination.

In OSTP's organic statute, Congress specified that the OSTP Director shall assess and advise on policies for international cooperation in science and technology and identify areas in which science and technology can be used effectively in addressing national and international problems. Science and technology cooperation provides a powerful lever with which the United States can work to achieve important U.S. goals, including opening China to U.S. exports and improving Chinese respect for international intellectual property laws. The constraints that Section 1340 places on OSTP would impair US coordination with China on science and technology matters of critical importance, including preventing pandemics, the development of clean energy, reducing reliance on foreign oil and its impact on gas prices, and nuclear reactor safety.

The President designated OSTP as his agent to conduct certain diplomatic negotiations and discussions with China, including negotiations and discussions in support of the U.S.-China Agreement on Cooperation in Science and Technology. The President may also designate OSTP to represent him in other diplomatic discussions with China in the future. To the extent that Section 1340 restricts such activities, it impermissibly interferes with the President's exclusive constitutional authority to determine the time, place, manner, and content of diplomatic

communications and to select the agents who will represent the President in diplomatic interactions with foreign nations.[1] Congress cannot use its appropriations power to infringe upon the President's exclusive constitutional authority in this area.[2] Accordingly, and consistent with past Executive Branch practice, OSTP will not apply this provision where doing so would encroach upon the President's exclusive constitutional authority over international diplomacy. OSTP began implementing this determination on April 15, 2011. As OSTP Director, I am the officer responsible for implementing this determination. Please do not hesitate to contact me if you have any questions.

Sincerely yours,

John P. Holdren

John P. Holdren
Assistant to the President for Science and Technology
and Director, Office of Science and Technology Policy

cc: The Honorable Harry Reid, Senate Majority Leader
The Honorable Mitch McConnell, Senate Minority Leader
The Honorable Eric Cantor, Majority Leader
The Honorable Nancy Pelosi, Minority Leader
The Honorable Lamar Smith, Chairman, Committee on the Judiciary
The Honorable John Conyers, Jr., Ranking Minority Member, Committee on the Judiciary
The Honorable Patrick Leahy, Chairman, Senate Committee on the Judiciary
The Honorable Frank Wolf, Chairman, House Appropriations Subcommittee on Commerce, Science and Justice
The Honorable Chaka Fattah, Ranking Member, House Appropriations Subcommittee on Commerce, Science and Justice
Kerry Kircher, House General Counsel
Morgan J. Frankel, Senate Legal Counsel

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[1] *See, e.g.*, Memorandum Opinion for the Acting Legal Adviser, Department of State, from David J. Barron, Acting Assistant Attorney General, Office of Legal Counsel, *Re: Constitutionality of Section 7054 of the Fiscal Year 2009 Foreign Appropriations Act* (June 1, 2009) ("Section 7054 Opinion"), *available at* www.justice.gov/olc/opinions.htm; *Statement on Signing Legislation to Locate and Secure the Return of Zachary Baumel, a United States Citizen, and Other Israeli Soldiers Missing in Action*, 35 Weekly Comp. Pres. Doc. 2305 (Nov. 8, 1999); *Issues Raised by Provisions Directing Issuance of Official or Diplomatic Passports*, 16 Op. O.L.C. 18, 21 (1992) ("*Diplomatic Passports*").

[2] *See, e.g.*, Section 7054 Opinion at 10-12; *Diplomatic Passports*, 16 Op. O.L.C. at 29.

activities were scheduled. The subcommittee did ask me to keep it informed when I was doing anything with regard to China.

In response to that request and to show good faith, I immediately submitted a written notice to the committee Chair and the Ranking Member the day after the hearing. I explained that, under the auspices of the U.S.-China Strategic and Economic Dialogue and the US-China Innovation Policy Dialogue that I co-chair within it, I would lead and participate in a series of meetings with Chinese officials. These meetings were aimed at ensuring that American companies competing in China's market have the same rights as Chinese companies. I would also participate in discussions with the lead Chinese climate-change negotiator aimed at improving the Chinese stance in international climate negotiations. Finally, I would serve as the US lead in discussions about whether to expand US-Chinese cooperation on avoiding and mitigating nuclear-reactor accidents. I explained that I was undertaking these activities pursuant to the President's constitutional authority to conduct foreign diplomacy. Consistent with section 1340 of the Department of Defense and Full-Year Continuing Appropriations Act, 2011, Pub. L. No. 112-10, 125 Stat. 38, I explained that I would not engage in any activity that went beyond the President's constitutional authority to conduct foreign diplomacy.

16. Please provide an estimate of OSTP's costs to participate in the May 6-10 meetings. This estimate should include staff time, space and any other categories of relevant expenses.
Answer:

OSTP's estimated incremental and allocated costs to participate in the May 6-10 meetings total approximately $3,500. The total incremental cost of the meeting was $1,000, expended for a dinner honoring foreign dignitaries who were involved in activities related to the Executive Office of the President's mission, specifically my work in support of the Strategic and Economic Dialogue. Allocated staff costs for these meetings, including planning and attending these events, is estimated at approximately $2,500.

17. What "foreign diplomacy" activities did you engage in during the May 6-10 meetings that could not have been conducted effectively by the Department of State or other agencies not operating under the section 1340 restrictions?

Answer:

OSTP is the agent assigned to conduct diplomatic negotiations and discussions with China in support of the U.S.-China Agreement on Cooperation in Science and Technology. Science and technology cooperation provides a powerful lever with which the United States can work to achieve important U.S. goals, including opening China to U.S. exports and improving Chinese respect for international intellectual property laws. The constraints that Section 1340 places on OSTP would impair US coordination and

negotiation with China on science and technology matters of critical importance, including preventing pandemics, the development of clean energy, reducing reliance on foreign oil and its impact on gas prices, and nuclear reactor safety. To the extent that section 1340 restricts such activities, it interferes with the President's exclusive authority to determine the time, place, manner, and content of diplomatic communications and to select the agents who will represent the President in diplomatic interactions with foreign nations.

18. What is the current status of the Administration's consideration of the European Union Code of Conduct for Outer Space Activities?

Answer:

Safe, responsible, and peaceful behavior is a cornerstone of U.S. activities in space and is clearly noted as a priority in the President's National Space Policy (released in June 2010). The United States is continuing to consult with the European Union on its proposal for an international "Code of Conduct for Outer Space Activities," which is one approach to promoting responsible and peaceful behavior. The Administration is committed to keeping the Congress informed as it considers the EU Code.

Ranking Member Chaka Fattah

Questions for the Record
Office of Science and Technology Policy
Hearing on May 4, 2011

1.The PCAST report on K-12 STEM education focuses on the need for a strategic approach to improving Federal STEM education activities, and on the importance of improved coordination among Federal agencies, particularly the Department of Education and the National Science Foundation. In what ways are NSF and the Department of Education taking steps to improve their coordination on federal STEM education activities?

Answer:

With encouragement from OSTP and OMB, NSF and the Department of Education are currently engaged in discussions on how to better align program criteria, proposal-solicitation language, and other elements to ensure better coordination of efforts. This is related to the larger effort to produce a strategic plan for STEM education across the federal government that will better coordinate all federal STEM education programs, as called for in the America COMPETES Reauthorization Act of 2010.

The new Committee on STEM Education is in the process of formulating this 5-year strategic plan. The cochairs for the NSTC strategic planning task force are from NSF and Department of Education respectively, and they are deeply involved in working through the issue of how their two agencies can work together most effectively, as well as how best to coordinate and support the STEM education work being carried out in the other agencies.

2.W hat should be the respective roles of NSF and the Department of Education to make sure they complement one another but do not overlap?

Answer:

While many specifics will emerge from the current strategic planning process, it is anticipated that NSF will take the leading role in basic research and small scale testing and dissemination, as well as incorporating the advances from the NSF science and engineering research directorates into educational materials. The Department of Education will play the leading role in supporting large-scale implementation by working with the States and multiple school districts. To work effectively, this division of effort will require coordination as to the "hand-off process", with NSF programs making sure they have suitable development and evidence standards so that successful interventions meet the criteria for ED large-

scale implementation. There are currently joint discussions underway to work out suitable consistent criteria that will achieve these goals.

In addition, ED provides substantial financial aid for undergraduate students both in STEM and in K-12 STEM teacher programs and they collect and disseminate data on U.S. STEM education.

3.W hat kind of assessments and performance metrics should NSF and the Department of Education have in place so that we can see whether the Administration's STEM education strategy is really working?

Answer:

Coming up with metrics that are both useful for evaluating and guiding strategy and practical to implement is difficult but very important. Deciding on suitable performance metrics and ensuring they are used is a high priority of the NSTC strategic planning process that is currently underway. One metric that is already agreed upon is that all the various federal STEM education activities should have rigorous evaluation of their individual outcomes.

4.How long will it take before we know if we are on the right track?

Answer:

In a system as large and complex as STEM education, there are no quick or easy fixes. The strategic plan will not be completed in time to have much impact on the FY13 budget, but should be reflected in the FY14 President's budget. In terms of improved coordination and evaluation of current federal STEM education programs there should be changes evident by the middle of 2012, with a few years after that needed before we start seeing improvements in the outcomes of particular concern, student learning in STEM, and the number of students going into STEM fields.

5.Reg arding the NOAA budget for Procurement, Acquisition, and Construction, the fiscal year 2011 budget requested $2,184,091,000, an increase of $825.7 million over fiscal year 2010. The vast majority of the fiscal year 2011 request was geared toward NOAA's weather satellite program. However, the final enacted appropriation for this account was $23 million below the fiscal year 2010 level. If NOAA were to be provided a similar level of funding for fiscal year 2012, rather than the $717.4 million increase that is being requested, how would this affect NOAA's weather forecasting capabilities and the public at large?

Answer:

The President's FY2012 Budget request contains $1.070 billion for NOAA to continue to acquire the Joint Polar Satellite System (JPSS). At this funding level, NOAA and NASA will continue JPSS development as outlined in the Administration's February 1, 2010 decision to restructure the National Polar-orbiting Operational Satellite System (NPOESS).

If NOAA is kept at the 2010 funding level of $382.2 million for FY2011 and FY2012, the launch date of JPSS-1 would be significantly delayed, and the U.S. would experience a gap in the critical data needed in the afternoon orbit to support national weather forecasting needs. Dr. Lubchenco at NOAA and Administrator Bolden at NASA have reiterated the importance of implementing the restructured JPSS program and have said that the JPSS program could not be developed in time to provide uninterrupted data continuity at level funding of $382.2 million.

Any gap would cause the degradation of all weather forecasts later this decade, resulting in forecasts that will incorrectly predict the magnitude of storms compared to current capability. According to NOAA, over 90% of the data the National Weather Service (NWS) uses in weather forecast models for 2 to 10 day forecasts comes from polar-orbiting satellites.

If no polar-orbiting data had been available for the February 2010 East Coast "Snowmageddon" storm, the weather models would have under-forecasted the snowfall accumulation in the Mid-Atlantic by at least 10 inches, and the 5 to 7 day maximum snow forecast would have been displaced by 200-300 miles or not predicted at all. The resulting prediction errors (up to 50%) would have had enormous consequences. In the recent Mid-west severe storm and flood events, the early warning provided days in advance would not have been possible without this critical data.

During the April 25 to April 28, 2011 storms in Alabama and the southern U.S., the National Weather Service forecast offices and the Storm Prediction Center used data from polar-orbiting satellites and other weather forecasting tools to provide specific forecast outlooks that warned of the potential for hazardous weather up to four days in advance of these deadly storms. While ground-based Doppler radar assists in detecting and tracking individual tornadoes, the weather forecast models that utilize polar satellite data provide advance notice of conditions capable of spawning severe tornadic activity. This advance warning allowed local officials to ensure staffing was in place and that storm damage mitigation measures (*e.g.*, shelters, sand bags, etc.) were prepared; these measures likely prevented an even greater loss of life.

6.NASA ha s partnered with NOAA for many years on the weather satellite program, with NASA providing particular expertise in the areas of satellite acquisitions and procurement management. Are there segments of that program currently handled by NOAA that could perhaps be done more efficiently by NASA?

Answer:

The NOAA/NASA partnership is successful because it integrates the strengths of each agency. NOAA does not attempt to duplicate NASA's expertise. Rather, NOAA partners with NASA to capitalize on NASA's strength in space systems acquisition. NOAA commits its efforts to satellite operations and the development of weather, climate, oceans and coastal products and services to meet the needs of the operational communities it serves.

Together, NOAA and NASA have, for over 40 years, successfully partnered to develop NOAA's legacy polar and geostationary satellite series to accomplish this endeavor. Non-duplication of effort was recently confirmed by GAO in its October 2009 report. GAO's in-depth review of NASA's Earth Science projects related to climate and weather research found no duplication of effort with other federal agencies (GAO-10-87R).

7.Could NASA help m ake the overall weather satellite effort more effective by taking a greater role on the operations side?

Answer:

The current synergy within NOAA's National Environmental Satellite and Information Service (NESDIS), as the satellite data provider to meet the weather forecasting requirements of the NWS, works well.

The relationship between NOAA and its users of weather products and services is well suited to meet the diverse user needs from other Federal, State, and local governments, the private sector and the public. The level of interaction between the operational weather provider and user requires significant attention which the NWS has developed over its 140 year history, and NESDIS' nearly 50 years of developing and managing the Nation's operational weather satellite program.

As the President's Science Advisor, I am in frequent discussion with NOAA and NASA, urging them to continue to build on the cooperative partnership that these two important agencies share. By having NASA work closely with NOAA to identify and devote resources to address some of the Earth-observing needs that could improve NOAA's operational readiness, it will also build and enhance the Nation's scientific leadership in the area of Earth observations.

8.Ar e there any opportunities to achieve savings and efficiencies in the weather satellite program by eliminating areas of duplication?

Answer:

The Administration's decision to restructure the NPOESS program was intended to take maximum advantage of the relative strengths of each of the agencies involved as well as minimizing redundancy. The future NOAA and DoD satellite systems will retain the common ground operations and data, thus making most efficient use of the hardware and operations being developed.

9.The f inal fiscal year 2011 Appropriations Act includes a provision prohibiting funds in the Act from being used to implement, establish, or create a Climate Service at NOAA. How would the activities carried out by a Climate Service differ from NOAA's current activities and what are the benefits of establishing a Climate Service?

Answer:

The Climate Service is a proposal to reorganize NOAA's existing work to make it better, more efficient, and more capable of responding to constituent needs for information on climate. As NOAA has stated in its 2012 Budget, it is a budget-neutral reorganization proposal that does not create new programs or new authorities and is consistent with the recommendations of the National Academy of Public Administration study requested by this subcommittee on how NOAA should be better organized to deliver reliable, well-organized, and timely information on climate to a variety of stakeholders.

10. The NASA Authorization Act of 2010 directs NASA to develop a space-launch system and crew vehicle for missions to near-Earth orbit and regions of space beyond low-Earth orbit utilizing existing contracts, investments, workforce, industrial base, and capabilities from the Space Shuttle, Orion, and Ares 1 projects to the extent practicable. Are there any proscriptive requirements of the Authorization Act that could result in additional costs or delays to NASA's deep space efforts?

Answer:

The Act presents NASA with the challenge of developing the next-generation Space Launch System and exploration Multi-Purpose Crew Vehicle that meets the funding, schedule and other goals outlined in the Act. NASA is conducting its analysis of design and acquisition approaches for implementing these programs, and NASA is working to develop the data to address how the Act's guidance will impact cost and schedule. Regardless of this point, NASA has made clear that it is committed to performing this task and meeting the challenge to the best of its abilities, given available budgets and the many other needs the agency is facing in human spaceflight.

11. Are there any requirements of the Authorization Act that, from an engineering point of view, are counterproductive to the overall effort to transport astronauts beyond low-Earth orbit?

Answer:

To my knowledge the performance targets and mission objectives reflected in the 2010 NASA Authorization Act are reasonable and appropriate for human space exploration beyond low-Earth orbit. However, for a more detailed response, I must refer you to Administrator Bolden and his team at NASA, who are examining various design and acquisition options for implementing the program described in the Act.

12. The Administration's fiscal year 2012 budget request includes just over $1 billion for NASA Space Technology, an increase of nearly $700 million above the comparable fiscal year 2010 amount. In a time of tight budgets, how and when will the public see the benefits of this large funding increase, particularly since human travel to deep space is still a great many years away?

Answer:

For several decades NASA—and a variety of external advisory bodies to NASA—have studied concepts and methods for human space exploration beyond Earth's orbit. These studies have led to a clear consensus opinion in the space community, expressed most recently by the Augustine Committee in 2009, that in order for future human spaceflight programs to be affordable and sustainable, our space program must reverse course from decades of under investment in advanced space technologies. This is why Space Technology was proposed by the President in his FY 2011 budget request for NASA, and why the program was authorized by the Congress in the 2010 NASA Authorization Act. We know that never making the investments to advance technology means we can never evolve past our current technological boundaries or make meaningful progress in attaining our beyond-LEO exploration goals.

In FY 2010, the fiscal year you reference as a comparison to the President's FY 2012 budget request, NASA had mission-specific technology development efforts spread through multiple accounts. It is important to note that through the FY2012 Space Technology budget request, NASA essentially is consolidating two of these congressionally authorized technology development programs into one Space Technology theme, while requesting certain additional funds to support a range of technology needs and priorities. The President's FY 2012 budget represents the path forward for NASA as broadly outlined by the 2010 NASA Authorization Act. I believe when one compares the FY 2012 request for Space Technology, and all of its

constituent projects and programs, to the 2010 NASA Authorization Act, one will see that the two resonate closely.

13. To what extent might the additional funding requested for Space Technology help to accelerate the date by which NASA will be able to travel beyond low-earth orbit?

Answer:

I would refer you to NASA about the specific plans it has for technology investments, how those investments return new capabilities over time, and how those new capabilities will make our exploration efforts more affordable, sustainable, and effective over the long term. However, it has been well-understood for some time that certain capabilities, such as in-orbit refueling and improved in-space propulsion, would greatly facilitate our efforts to explore other destinations in the Solar System, and make these missions more affordable. For example, development of better methods to store cryogenic propellants while in space could dramatically reduce both the mass required in low-Earth orbit and the cost of long duration space missions compared to today's technologies. As such, I believe that our nation is long overdue in making the investments necessary to develop such capabilities if we are to conduct serious exploration beyond Low Earth Orbit. Moreover, we can be virtually guaranteed that there will be no benefits of this nature in the foreseeable future if we continue to ignore such technology investments.

14. To what extent will the Space Launch System and Multi-purpose Crew Vehicle development activities directly benefit from these additional technological development efforts?

Answer:

I once again must refer you to NASA for information regarding its plans for using the output of the projects in the Space Technology program to meet the needs of other priorities, like the Space Launch System and Multi-Purpose Crew Vehicle.

Rep. John Culberson
Questions for the Record
Office of Science and Technology Policy
Hearing on May 4, 2011

1.P.L . 112-10 instructs NASA to build the Orion Multipurpose Crew Vehicle and the heavy lift Space Launch System. For Orion, it provides "not less than $1.2B to continue existing vehicle development." To date, we have not seen any evidence that NASA is moving forward with modifying the Orion contract. What is the status of the Orion contract? Please provide a timeline for the contract moving forward.

Answer:

It is my understanding that the Orion vehicle development program is considered applicable to the requirements of the Multi-Purpose Crew Vehicle called for in the 2010 NASA Authorization Act. However, I can only refer you to NASA for questions regarding the details of any one contract, or how and under what schedule NASA plans to work with any of its existing contracts to accomplish the goals of the Act.

Rep. Tom Graves
Questions for the Record
Office of Science and Technology Policy
Hearing on May 4, 2011

1.On May 4, 2011, I wrote the attached letter asking you to represent in detail how your agency would operate with a 25 percent reduction in funds, a 20 percent reduction in funds and a 10 percent reduction in funds. Will you provide the Committee with a copy of the reply for the record?

Answer:

Yes. Attached is the reply to your letter.

COMMITTEE ON APPROPRIATIONS
SUBCOMMITTEES:
AGRICULTURE, RURAL DEVELOPMENT, FOOD AND DRUG ADMINISTRATION AND RELATED AGENCIES
COMMERCE, JUSTICE, SCIENCE AND RELATED AGENCIES
FINANCIAL SERVICES AND GENERAL GOVERNMENT

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May 4, 2011

Hon. John P. Holdren
Office of Science and Technology Policy
Executive Office of the President
725 17th Street NW
Room 5228
Washington D.C. 20502

Dear Dr. Holdren:

I am writing today to request that your agency submit budgets to the Sub-Committee on Commerce, Justice, Science, and Related Agencies within the Committee on Appropriations that represent in detail how your agency would operate with a 25 percent reduction in funds, a 20 percent reduction in funds and a 10 percent reduction in funds.

As you know, as of this writing, we are months away from reaching our debt ceiling of $14.29 trillion. The Congressional Budget Office (CBO) projects that the gross federal debt will increase every year of the 2011-2020 period, reaching $23.1 trillion in 2020 and costing Americans over $1 trillion in interest payments alone by 2020.

According to CBO, at the end of the fiscal year of 2008, the debt held by the public was $5.8 trillion. Since then the public debt has shot to $9 trillion by the end of fiscal year 2010. While the government experienced lower tax revenues due to the economic recession, the response by the Administration and Congress to jolt the economy with higher federal spending coupled with the past imbalance between spending and revenues has led to an unsustainable debt.

Our fiscal situation is unacceptable. The responsibility for our debt is shared jointly by Democrat and Republican Administrations and Congresses of the past and finding solutions must be a bipartisan endeavor. That is why I am writing to you today to ask that your agency work with Republicans to begin reigning in spending and start our nation on a fiscally responsible course.

Thank you in advance for your willingness to work with the Sub-Committee on Commerce, Justice, Science, and Related Agencies on this important issue.

Sincerely,

Tom

Tom Graves
Member of Congress

PRINTED ON RECYCLED PAPER

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20502

May 25, 2011

The Honorable Tom Graves
House of Representatives
1113 Longworth HOB
Washington, DC 20515

Dear Congressman Graves:

Thank you for your recent letter requesting information on how the Office of Science and Technology Policy (OSTP) would operate under various possible budget-reduction scenarios. OSTP shares your interest in managing costs wisely and is constantly looking for ways to improve efficiencies and reduce costs.

Budget reductions on the scale of those you ask about would adversely impact OSTP's ability to ensure that the best science and technology are brought to bear to help solve the many serious challenges facing America today in areas such as health, sustainable energy, advanced manufacturing, information technology, science and engineering education, and national security. Further, given the important coordinating role that OSTP plays with regard to public and private investments in science, technology, and innovation (ST&I) and the amplifying impact of ST&I on the American economy, reductions in OSTP's budget can be expected to adversely affect our Nation's ongoing efforts to create new industries and build a national economy for the 21st century.

I look forward to working with Congress on how we can together address our country's fiscal situation in a way that maintains a robust science and technology enterprise, generates jobs, and strengthens our Nation.

Sincerely,

John P. Holdren

John P. Holdren
Director

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White House Office of Science and Technology Policy

Dr. John P. Holdren, Director

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