

ENHANCING THE RELEVANCE OF SPACE TO ADDRESS NATIONAL NEEDS

HEARING BEFORE THE SUBCOMMITTEE ON SPACE AND AERONAUTICS COMMITTEE ON SCIENCE AND TECHNOLOGY HOUSE OF REPRESENTATIVES ONE HUNDRED ELEVENTH CONGRESS

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**ENHANCING THE RELEVANCE OF SPACE TO
ADDRESS NATIONAL NEEDS**

THURSDAY, JULY 16, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE AND AERONAUTICS,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 2:00 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Gabrielle Giffords [Chairwoman of the Subcommittee] presiding.

HEARING CHARTER

**SUBCOMMITTEE ON SPACE AND AERONAUTICS
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

**Enhancing the Relevance of
Space to Address National Needs**

THURSDAY, JULY 16, 2009
2:00 P.M.–4:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

I. Purpose

On Thursday, July 16, 2009 the Subcommittee on Space and Aeronautics will hold a hearing on enhancing the relevance of space activities to address national needs. The hearing will (1) examine how recent reports by the National Research Council and The Space Foundation characterize the relevance of space-related activities, particularly their role in improving the health, economic well-being, and the quality of life of all Americans; (2) review what should be done to maintain and enhance that relevance; and (3) analyze whether enhanced awareness of the contributions from space-related activities would result in inspiring future generations of Americans. The hearing will focus on the following questions and issues:

- *How relevant is space to addressing important national needs, and what noteworthy benefits have been achieved as a result of past space-related investments?*
- *What should be done to maximize the benefits to be realized from the Nation's space activities and the relevance of those space activities? How important is it for those activities to be aligned to national goals and objectives?*
- *How important is the inspirational component of the Nation's space activities, and what would be the most effective ways to use space activities to motivate emerging generations of Americans to pursue studies and careers in science and engineering?*
- *How well does the public understand the relevance of the Nation's space activities to meeting national needs and realizing societal benefits? Is there a need to "get the message out" on the relevance of those space activities and the benefits to be derived from our space-related investments? If so, how can that message be most effectively communicated?*
- *The Nation's space program generated considerable public excitement during the Apollo era. What will it take to get today's public interested and enthused about the Nation's space program?*
- *What challenges do communications media face in attempting to reach the broadest and largest possible audience while engaging and enlightening them about space? What tools and strategies are used to address those challenges?*

II. Witnesses:

General Lester L. Lyles [U.S. Air Force, retired], Chair of the Committee on the Rationale and Goals of the U.S. Civil Space Program, Aeronautics & Space Engineering Board, National Research Council

Ms. Patti Grace Smith, Board of Directors, The Space Foundation

Ms. Debbie Adler Myers, General Manager, Science Channel, Discovery Communications

Mr. Miles O'Brien, Journalist

III. Overview

Forty years after accomplishing the feat of landing humans on the Moon's surface, the U.S. civil space program, including its largest component, the programs of the National Aeronautics and Space Administration (NASA), finds itself at a critical

juncture. Key factors that will influence the future of the U.S. civil space program include:

- **Upcoming results from an independent review of U.S. human space flight.** The Obama Administration has initiated an independent review of “*ongoing U.S. human space flight plans and programs, as well as alternatives, to ensure that the Nation is pursuing the best trajectory for the future of human space flight—one that is safe, innovative, affordable, and sustainable.*” Led by Norman Augustine, the blue-ribbon committee held a public meeting in Washington last month and has several others planned in the weeks ahead. Results and supporting analysis are scheduled to be provided in August 2009, in time to support a decision on the way forward. Until then, NASA is continuing on a path to complete the International Space Station (ISS) and retire the Space Shuttle fleet in 2010, develop its next generation of human space transportation systems, and encourage the development of commercial space transportation systems capable of bringing cargo to the ISS.
- **Direction from a new NASA Administrator.** Charles Bolden, nominated to head NASA, said at his Senate confirmation hearing last week that he wanted to rekindle the pioneering spirit of the space agency’s early manned space program. His strategy for achieving that objective will have an impact on the future direction of the Agency.
- **Future NASA funding levels.** Many in Congress have argued that NASA’s budgets have not kept pace with the tasks it has been asked to carry out. How this mismatch is resolved will have a major impact on NASA’s future.
- **Competition and cooperation in space.** Other nations’ ambitions in space have resulted in significant progress and accomplishments. China has joined the United States and the former Soviet Union as the only countries to have launched humans into space. Europe is considering the feasibility of developing its own human space flight transportation system, as is India. The once dominant U.S. civil space program finds itself no longer the only game in town. Moreover, it is now commonplace for U.S. commercial space interests to find themselves in vigorous competition with other nations’ space companies in vying for business in a global environment. However, cooperation in space has long been a significant element of the U.S. civil space program. In establishing the National Aeronautics and Space Administration through the *National Aeronautics and Space Act of 1958* (P.L. 85–568, as amended), Congress made clear its intent that the space program provide benefits to people, that research be utilized, and that the United States cooperate with other nations in “*the peaceful application*” of its space activities. Many of today’s societal challenges including climate change, food security, and availability and access to natural resources and energy supplies are global in nature. Space assets and cooperation among nations in space activities are expected to be important in addressing these global societal issues. The future scope of international cooperation on space activities will likely shape the direction of the civil space program here in the U.S.
- **Relevance of space to the public.** While NASA remains generally popular with the public according to various polls, concern has been raised about public understanding of what the Agency is doing and how space research and developments help improve our lives. At present, Americans and society at large use multiple services and technologies that were developed, initially, within the context of the U.S. space program. For example, communications satellites, space-based weather monitoring and prediction, and precision navigation and timing emerged from the Nation’s investments in space; today these assets are critical to our basic infrastructure. Space technologies have also enabled improved medical imaging, telemedicine, and disease tracking, among multiple other applications. NASA has documented many of the technologies, products and services derived from investments in the space program in its annual NASA Spinoffs publications (<http://www.nasa.gov/offices/ipp/home/index.html>). In addition, the Agency has developed a tool called NASA City that allows users to trace the impact of space on their daily lives (www.nasa.gov/city). Yet, although the applications of space research and development are infused in the everyday life of Americans, there is a perception that the public lacks awareness of how space affects their lives, which can contribute to a lack of enthusiasm for space program investments.
- **Replenishing a skilled workforce for continued leadership in space activities.** The perceived lack of excitement may influence the maintenance of a skilled future civil space workforce. A February 2003 article by the *Wall Street Journal* stated:

"Many young people today with a technical bent are more entranced with the Internet or biotechnology than space exploration. Space travel, after all, was a fascination of their parents' generation."

The National Research Council recently examined the relationship between the U.S. space program and societal and national needs and priorities and how U.S. leadership can be maintained. Key elements of that report are described in the following section. In addition, space advocacy groups have identified the benefits of space to society and have documented, for example, the contributions of space to the national and global economy. *The Space Report 2009*, published by the Space Foundation, which is summarized in this hearing charter, is one example. These and many other organizations have also emphasized the importance of space in inspiring the next generation to excel in science, technology, engineering and mathematics and in ushering in a steady pipeline of professionals to replenish an aging aerospace workforce. Communications and media organizations confront the challenge of how best to engage individuals by using science content related to space. Perspectives from such organizations and individuals can provide insight into some of the approaches that have been taken to effectively communicate the excitement of space to the public.

IV. Background

National Research Council's Report on America's Future In Space: Aligning the Civil Space Program with National Needs

The National Academies' National Research Council (NRC) recently released a report that recommended a series of measures to better align the civil space program with national needs. The report's overall conclusion is *"that a preeminent U.S. civil space program with strengths and capabilities aligned for tackling widely acknowledged national challenges—environmental, economic, and strategic—will continue to make major contributions to the Nation's welfare."* The impetus for the NRC's chartering a review was its recognition of a changing national and international context for space activities. The U.S. space program, initially driven by competition with the former Soviet Union, now finds that many nations have established, or are aspiring to develop, independent space capabilities. Developments over the past 50 years have led to an explosion of scientific and engineering knowledge and practical applications of space technology. Space activities now play critical roles in commerce, government, and science. Furthermore, the private sector has become a significant factor in the expansion of space-related products and services.

In light of this changing context, the NRC established the *Committee on the Rationale and Goals of the U.S. Civil Space Program* and charged it to prepare a report to advise the Nation on key goals and critical issues in 21st century U.S. civil space policy. The committee's report, prepared under the oversight of both the NRC's Space Studies Board and Aeronautics and Space Engineering Board, is entitled *"America's Future In Space: Aligning The Civil Space Program With National Needs."*

In its initial discussions, the committee concluded that debates about the direction of the civil space program often focused on addressing near-term problems and issues *"without first putting those issues in the context of how a disciplined space program can serve larger national imperatives. In the committee's view, characterizing the top-level goals of the civil space program and the connection between those goals and broad national priorities is necessary as a foundation on which the Nation (both now and in the future) can devise sustainable solutions to nearer-term issues."*

Consequently, the committee chose to focus on the long-term, strategic value of the U.S. civil space program. In responding to its charge, the committee *"sought to provide a long-term, strategic perspective that frames a vision for civil space activities that can endure for many years."* According to the report, the committee's thinking was informed by the following national priorities:

- *"Ensuring national security,*
- *Providing clean and affordable energy,*
- *Protecting the environment now and for future generations,*
- *Educating an engaged citizenry and a capable workforce for the 21st century,*
- *Sustaining global economic competitiveness, and*
- *Working internationally to build a safer, more sustainable world."*

The report added that *"A common element across all these urgent priorities is the significant part that research and development can play in solving problems and advancing the national enterprise in each area."* The importance of space-related activi-

ties to generating interest in science was not lost on the committee. The report noted:

“The high visibility of space activities attracts students’ attention to science, technology, and mathematics, and space activities are an exciting focus for teaching those subjects. Commercial space-related ventures now figure significantly in global economic competitiveness, and, while government investments to stimulate the Nation’s fragile economy will have short-term impacts, R&D investments can be counted on to make longer-term sustainable contributions to the Nation’s economic strength. As has countless times proved the case, research in and from space will continue to lead to important future, and not always currently predictable, benefits that hold the promise of progress toward realizing U.S. as well as shared international goals.”

The committee believed that to be a strategic leader in a globalized world, the United States needed *“a civil space program whose breadth, competence, and level of accomplishment ensures that U.S. leadership is demonstrated, accepted, and welcomed.”* Consequently, the committee identified six strategic goals that it regarded as basic for guiding program choices and resources planning for U.S. civil space activities. The goals identified in the committee’s report are:

- *“To re-establish leadership for the protection of Earth and its inhabitants through the use of space research and technology. The key global perspective enabled by space observations is critical to monitoring climate change and testing climate models, managing Earth resources, and mitigating risks associated with natural phenomena such as severe weather and asteroids.*
- *To sustain U.S. leadership in science by seeking knowledge of the universe and searching for life beyond Earth. Space offers a multitude of critical opportunities, unavailable in Earth-based laboratories, to extend our knowledge of the local and distant universe and to search for life beyond Earth.*
- *To expand the frontiers of human activities in space. Human space flight continues to challenge technology, utilize unique human capabilities, bring global prestige, and excite the public’s imagination. Space provides almost limitless opportunities for extending the human experience to new frontiers.*
- *To provide technological, economic, and societal benefits that contribute solutions to the Nation’s most pressing problems. Space activities provide economic opportunities, stimulate innovation, and support services that improve the quality of life. U.S. economic competitiveness is directly affected by our ability to perform in this sector and the many sectors enabled and supported by space activities.*
- *To inspire current and future generations. U.S. civil space activities, built on a legacy of spectacular achievements, should continue to inspire the public and also serve to attract future generations of scientists and engineers.*
- *To enhance U.S. global strategic leadership through leadership in civil space activities. Because of the growing strategic importance of space, all nations that aspire to global political and economic leadership in the 21st century are increasing their space-faring capabilities. Continued U.S. global leadership is tied to continued U.S. leadership in space.”*

To contribute to realizing these national objectives, the committee identified four foundational elements it viewed as *“critical to a purposeful, effective, strategic U.S. space program, without which U.S. space efforts will lack robustness, realism, sustainability, and affordability.”* These are:

1. *“Coordinated national strategies—implementing national space policy coherently across all civilian agencies in support of national needs and priorities and aligning attention to shared interests of civil and national security space activities.*
2. *A competent technical workforce—sufficient in size, talent, and experience to address difficult and pressing challenges.*
3. *An effectively sized and structured infrastructure—realizing synergy from the public and private sectors and from international partnerships.*
4. *A priority investment in technology and innovation—strengthening and sustaining the U.S. capacity to meet national needs through transformational advances.”*

“The committee found that, in spite of their promise and utility, components of the civil space program are not always aligned to fully capitalize on opportunities to serve the larger national interest. Decisions about civil space priorities, strategies, and programs, and the resources to achieve them are not always made with a con-

scious view toward their linkages to broader national interests." The committee made seven recommendations:

1. "Addressing national imperatives. Emphasis should be placed on aligning space program capabilities with current high-priority national imperatives, including those where space is not traditionally considered. The U.S. civil space program has long demonstrated a capacity to effectively serve U.S. national interests."
2. "Climate and environmental monitoring. NASA and NOAA should lead the formation of an international satellite-observing architecture capable of monitoring global climate change and its consequences and support the research needed to interpret and understand the data in time for meaningful policy decisions."
3. "Scientific inquiry. NASA, in cooperation with other agencies and international partners, should continue to lead a program of scientific exploration and discovery."
4. "Advanced space technology. NASA should revitalize its advanced technology development program by establishing a DARPA-like organization within NASA as a priority mission area to support preeminent civil, national security (if dual-use), and commercial space programs."
5. "International cooperation. The government, under White House leadership, should pursue international cooperation in space proactively as a means to advance U.S. strategic leadership and meet national and mutual international goals."
6. "Human space flight. NASA should be on the leading edge of actively pursuing human space flight, to extend the human experience into new frontiers, challenge technology, bring global prestige, and excite the public's imagination."
7. "Organizing to meet national challenges. The President of the United States should task senior executive-branch officials to align agency and department strategies; identify gaps or shortfalls in policy coverage, policy implementation, and in resource allocation; and identify new opportunities for space-based endeavors that will help to address critical issues now confronting the United States and, to a considerable extent, the world as well."

In the course of this report, several points were made that are relevant to the work of the Subcommittee:

- **There is no single rationale for a U.S. civil space program:** "The committee's view is that there is no single rationale for the U.S. civil space program, but rather that, as a significant component of the Nation's R&D enterprise, the U.S. civil space program should be structured and supported to fulfill multiple responsibilities to assist the Nation in achieving its goals of exerting strategic leadership and improving the well-being of people. The U.S. civil space program should be preeminent in the sense that it can influence, by example, how nations take advantage of the opportunities afforded by space. For the United States to be a strategic leader, its civil space program must demonstrate breadth, competence, and a record of accomplishment so that U.S. leadership is accepted and welcomed."
- **There is unavoidable risk in human activity in space:** "Humans have proven effective in carrying out a variety of important roles as engineers and scientists in space. It is reasonable to expect that, in this century, humans will again surpass previous limits and will visit asteroids, travel to the moons of Mars, and establish a martian base similar in scale to those in Antarctica. In the committee's view, the leadership and inspiration achieved by expanding the frontiers of human space flight are worth the dangers faced in such exploration; lesser objectives may not be worth the same risk."
- **By pursuing the goal of inspiring, the space program will create other benefits.** Through pursuit of such a goal, the report said that the space program will:
 - "Instill a sense of interest, excitement, and optimism about opportunities for scientific and technological advancements to enhance the well-being of the Nation,
 - Attract and encourage members of the next generation of the Nation's technical workforce, and
 - Create a new generation who can draw on the advantages offered by space to help solve problems on Earth, and ensure U.S. leadership, building on the solid achievements of the past 50 years of U.S. investments in space."
- **Civil space activities provide an important stimulus for the next generation to pursue careers in science, technology, engineering, and mathe-**

mathematics. *"The NASA Authorization Act of 2008 states that "NASA, through its pursuit of challenging and relevant activities, can provide an important stimulus to the next generation to pursue careers in science, technology, engineering, and mathematics." While specific to NASA, this statement applies to all aspects of the U.S. civil space program. Furthermore, a reputation for competence in executing space missions that advance the frontier is likely to help attract talented foreign nationals to study and work in the United States as well as to inspire our own students to enter technical fields."*

- **A vigorous space program generates optimism.** *"Civil space activities also can exert an influence in building citizens' confidence in a brighter future. We live in a world with many immediate concerns—notably including a weakened world economy, regional conflicts and global terrorism, and threats of the consequences of climate change and limitations in energy sources. It is a time when people can be fearful that our tomorrows will be less promising than our past; that our children will have fewer opportunities than we enjoyed."*

Surely, a vigorous civil space program will be a strong signal that our future as a nation is promising, that life can be better, that our prospects are boundless. Civil space assets, with their global perspective on the changing Earth, can provide knowledge to enable wise stewardship of our planet's bounty. We can become a true space-faring society with new opportunities for our economy. Civil space activities will add to knowledge of our place in the cosmos and thereby expand the cultural richness of our nation."

The United States, leading by example and in cooperation with others in the exploration and utilization of space, can be a strategic leader in the world, not to be feared or despised, but rather to be valued for its concerted attention to basic challenges facing people worldwide."

- **Matching responsibilities to resources does not currently exist today.** *"A coordinated, sustainable set of strategies should ensure that responsibilities are realistically matched to available resources. Such a match does not exist today. For example, NASA has a central role in civil space, yet by any reasonable measure it is inadequately funded to pursue its many responsibilities. NASA now follows the U.S. space exploration policy established in 2004 by then President George W. Bush but must implement that policy within the budget constraints imposed by the Administration and Congress. The committee concurs with the primary conclusion of a 2006 NRC report, which summarized the situation by saying, "NASA is being asked to accomplish too much with too little. The agency does not have the necessary resources to carry out the tasks of completing the International Space Station, returning humans to the Moon, maintaining vigorous space and Earth science and microgravity life and physical sciences programs, and sustaining capabilities in aeronautical research." Rather than requiring that a broad and ambitious program be fit into an arbitrarily constrained budget as has been the case in recent years, a sustainable strategy would first define the program that the Nation is committed to undertake and then realistically define the resources that are required to accomplish that program."*

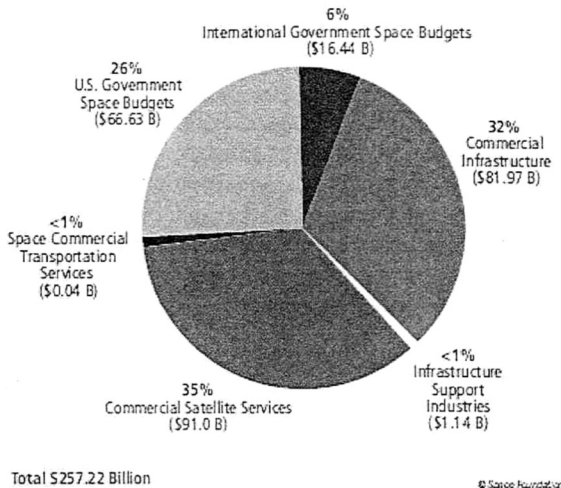
- **Budget levels need to recognize space programs' connection to the Nation's most prominent problems.** *"The budgetary situations faced by NASA and NOAA [National Oceanic and Atmospheric Administration] are a consequence of a trend in recent administrations to view the space program as an isolated stovepipe, with little or no connection to the Nation's most prominent problems. Civil space programs have largely been assigned budget levels that are incrementally based on previous years' budgets, with only tenuous connections to the evolution of the programs or their capabilities. An effective process would connect space policy to broader national needs, and then consider the necessary resources and implementation, improve efficiency by considering interdependencies and broad system effects, enhance productivity by providing focus and a longer-term view, and encourage a culture of collaboration among government agencies, the private sector (including both industry and academia), and international partners. This process would then provide a necessary foundation for continuing U.S. space leadership."*

General Lester Lyles, Chair of the Committee on the Rationale and Goals of the U.S. Civil Space Program, will be a witness at the hearing and can provide further details on the committee's work. The Executive Summary of the committee's report is included in Attachment I.

The Space Foundation's "The Space Report 2009"

In chronicling the previous year in space along with an outlook on what lies ahead, the Space Foundation's *The Space Report 2009*, released in April 2009, estab-

lishes the relevance of space by detailing the overall space economy; space products and services; space infrastructure; and economic impacts, workforce, and education. The report states that, “in a troubled financial environment, the space industry managed to maintain and increase its revenues in 2008, with estimated budgets and revenues from public and private sources of \$257 billion. Total revenue for space products and services in 2008 reached an estimated \$91 billion, 10.4 percent more than the \$82.4 billion total in 2007.”



(Source: The Space Report 2009)

Of particular interest to this hearing is how *The Space Report 2009* treats space products and services. The report notes that:

“The space industry has passed the point where all the ways in which space products and services are used can be described within the covers of a single publication. The examples in this report represent a small sampling to illustrate the breadth and ingenuity of the space industry in creating new ways to serve governments and the private sector. From private space travel to mobile Internet services to high-tech swimsuits, the space industry is fully engaged in finding new applications for existing technology and in developing new technologies to solve persistent problems. Common themes around some of these products and services involve making life easier and more interesting. In 2008, ICO Global Communications began testing a mobile TV service using a satellite over the United States designed to deliver up to 15 television channels for entertainment starting in 2010. Fishermen around the world are using satellite maps that report sea surface data to help guide them to profitable fishing grounds. The world watched U.S. Olympian Michael Phelps swim into the record books at the Beijing games. Less well known is the fact that Phelps and other Olympic swimmers were breaking records with the help of swim wear developed as a result of a technology spinoff from atmospheric drag research conducted for the Space Shuttle program.”

In comments regarding how pervasive and integral space products, services, and spinoffs have become, the report states:

“Space products and services and their related space technology spinoffs have become part of the fabric of daily life in ways that people increasingly take for granted, and often in ways that do not even bring space to mind.” The report provides a table listing examples of such technology spinoffs:

NASA Spinoffs, 2008

3-D immersive photography 3-D mapping & imagery software Advanced image analysis Aeroponic gardening system Automated panoramic photography Automotive lithium battery Clean energy-storing battery Deformation-resistant welding Dental water purification technology Drag-reducing Airtabs Electromagnetic biological cell separator Electron beam analyzer Faster prototyping software Fiber-optic sensing instruments	Friction-reducing swimwear Highly-durable polymer fabric High-speed, space-qualified circuit chip Improved space camera Industrial process monitoring system LED-based heat therapy Lockable knee brace Memory module for harsh environments Mid-power maximizer for outboard motors Non-invasive periodontal probe Nutrition fortification system Polymer coating for implantable medical devices	Polymer with high-temperature performance Portable rock and mineral analyzing device Pressure sensor for jet engine testing Protective suit for deep-sea divers Racetrack testing system Rehabilitative robotic joints for horses Robotic arm for complex surgeries Robotic technology for harsh environments Robust, flexible thermal insulation Satellite development and testing technology Schedule management software	Software to identify scrap tire piles Stability augmentation for helicopters Stemless valve that reduces emissions Vehicle health manager Virtual reality software Vision screening technology Water filtration for disaster relief Water-based coating for circuit boards Web-based mapping system Weld-strengthening system Wireless fluid-level measurement for boats Wireless sensor network technology
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(Source: The Space Report 2009)

The report also provides examples of how space products and services have contributed to improving health care. In describing one such example, the report stated:

"A collaborative effort between NASA and the University of Alabama at Birmingham (UAB) involves using satellite imagery to study and combat disease. Although this type of collaboration has occurred before, the new effort aims to formalize a training program. In 2008 a laboratory was set up to train public health students to use remote sensing for medical and public health applications. The students take courses both from NASA remote sensing scientists and UAB professors. Studies in the lab have been conducted on fighting malaria and the West Nile virus. Using infrared imagery from satellites, scientists can locate warm standing water, a breeding ground for disease-carrying mosquitoes. Satellites also collect data on pollution levels and other environmental factors in areas with high populations of asthma sufferers to determine the factors that might be causing asthma attacks."

In examining workforce issues, the report notes that:

"The highly visible rockets, satellites, telescopes, and other hardware that embody space exploration obscure the fact that these endeavors ultimately depend on skilled people. Scientists, engineers, astronomers, technicians, and administrators represent the true backbone of the space industry and are its most precious resource. The Space Report 2009 explores the talent pool needed to keep the space industry thriving. It describes the positive economic impact of space industry activity in states and metropolitan areas, and identifies a critical area of concern in the need to educate and train the next generation of U.S. space professionals. According to the U.S. Bureau of Labor Statistics, the U.S. space industry employs more than 262,000 men and women in 41 states including the District of Columbia. Between 2003 and 2007, the U.S. space industry sector added approximately 12,000 jobs at pay scales far above national averages. In just the commercial space transportation sector, the direct valuation according to the U.S. Federal Aviation Administration is \$23 billion, and \$139 billion when secondary and tertiary industries are included. This value exceeds one percent of the country's gross domestic product."

But keeping a flow of trained workers in the future will be a challenge. The report states:

"It is axiomatic that securing a skilled and technically trained workforce is critical to sustaining and growing the U.S. space industrial base. There is deepening concern that the young people who will make up the workforce required for the U.S. space industry to prosper into the future are not receiving the basic education they need in science, technology, engineering, and mathematics (STEM) fields. A long educational pipeline is required to develop these skills, beginning in elementary school and continuing through secondary and higher education. Science and technology levels in the United States, from kindergarten through the 12th grade (K-12) and at the post-secondary level, place the Nation at a disadvantage relative to other countries. The most recent data shows that American students are slipping behind their international counterparts in math and science education. This situation is exacerbated as other nations such as China have become more aggressive in developing their indigenous technical talent base. These worrisome indicators point to a need for the U.S. space industry to intensify its advocacy for the highly educated and technically trained workforce that enables it to thrive."

The success of space-related activity depends upon workers with great technical expertise, from astronauts and aerospace engineers to space scientists. The U.S. Bureau of Labor Statistics (BLS) occupational outlook projections show that demand will be high during the next ten years for workers in key space occupations as the needs and demands of the space industry grow. For instance, the BLS projections confirm that total employment levels for aerospace engineers will be 10 percent greater in 2016 than the 2006 employment level. The number of advanced degrees awarded in the United States for space-related fields of study has been on the rise for years. However, virtually all of this growth can be attributed to an increasing percentage of foreign graduate students in these subjects."

In examining the state of science, technology, engineering, and mathematics education in the United States, the report provides some sobering and worrisome statistics about the Nation's ability to address future workforce challenges:

"The results of this examination confirm prevailing concerns about shortages in the ranks of aerospace engineers as the scientists and technicians who began their careers during the era of the Mercury, Gemini, and Apollo programs reach retirement. According to U.S. Government estimates, the employment levels for aerospace engineers needed to sustain anticipated activity will be 10 percent greater in 2016 than a decade earlier.

Meanwhile, results of proficiency testing in science and mathematics show reason for serious concern about low achievement levels in U.S. elementary and secondary schools, as the report details. Only 29 percent of the Nation's 4th graders rated proficient in science; 39 percent in math. In a comparison of 36 nations, U.S. 4th graders ranked 11th in math achievement and 8th in science achievement. The nations outperforming the United States in these subjects include several that are pursuing ambitious space programs. Among 12th graders, only 18 percent achieved proficiency in science; 23 percent in math. In the physical sciences, more than 93 percent of middle school students are taught by teachers who are not certified or did not major in those fields.

The worrisome trends in U.S. science and math education extend to the college level. Between 1986 and 2006, Bachelor's degrees awarded in Earth and atmospheric sciences, engineering, math, and computer science fell eight percent. Graduate level degrees have increased significantly at both the Master's and doctoral levels, but that is due in part to the large number of foreign students studying in the United States. Immigration policies are making it harder for such students to come to the United States and study, and to stay once they graduate.

Engineering Bachelor's degrees have declined by 11 percent in the United States over the past two decades. The percentage of undergraduate degrees in science and engineering has also dropped considerably in the past 20 years. Engineering degrees comprised only five percent of all Bachelor's degrees awarded in 2006, down from eight percent two decades earlier.

In addition to improving the quality of math and science education in secondary schools, the space profession has recognized the need to recruit more women into the field. While women represent a majority of the students who received Bachelor's degrees in 2006, only one in five of the degrees in engineering were awarded to women that year. Female representation in the aeronautical and astronautical engineering fields has increased, but has a long way to go to reach parity.

Unless the current declining trend of space-critical degrees is reversed, many of these new jobs may go unfilled, opening the door to increasing competition from other countries for a field the United States has dominated for two generations."

In projecting its outlook for the future, *The Space Report 2009* states:

"The picture of space activity that emerges in The Space Report 2009 is one of continued innovation and risk-taking in the private sector, and ambitious exploration and international cooperation in the public sector. So far, the clearest visible impact of the global economic downturn on the space industry is in the equity markets, where space industries collectively sustained deeper valuation losses than broader market indexes. The raw numbers concerning space activity in 2008—employment, payroll, output, manufacturing, and launches—generally showed continued steady growth. There may be a lag time before a downturn in some of these measures of the space industry becomes apparent. If historic trends are indicative, the full impact of the economic slowdown on the commercial space industry may not be visible until 2009 or 2010 due to the numerous corporate growth program commitments and the consistently strong cash flows produced by the industry."

"Space activity has integrated itself so thoroughly into broader business activity, with an array of services vital to communication, travel, broadcast, and other industries, that the space industry is now part of the mainstream economy. It continues to demonstrate the potential for growth, expanding its breadth and volume of activity, and growing new business arenas in which the space industry is, or has become, a key player."

Ms. Patti Grace Smith, a Member of the Board of Directors of The Space Foundation, will be a witness at the hearing and can provide further details on the Foundation's report.

Surveys and Polls of Public Views on Space

The National Academies and Space Foundation reports documented the importance of space to our national needs and the myriad ways in which space benefits our lives and society at large. However, the extent to which the public is aware of those benefits appears to be limited. In recent years, NASA and other non-governmental entities have sponsored national surveys and public opinion polls to acquire feedback on how the public views NASA and the Nation's space program. One of those surveys, which was conducted for a NASA Strategic Communications Implementation Framework, showed that public perception about the relevance of space changed after individuals were informed of examples of how space affects their lives.

• Gallup Polls

Since 1990, Gallup has conducted polls to ascertain public attitudes about the job NASA is doing and public spending on space. According to Gallup, *"the public has generally rated NASA positively."* The two most recent Gallup polls were conducted in 2006 and 2007. The 2007 poll results were based on telephone interviews with 1010 adults (18 years of age or older).

An October 31, 2007 article on Gallup's web site, "Americans Continue to Rate NASA Positively," on the results of the Gallup poll states: *"According to the Sept. 14-16 poll [2007], 56 percent of Americans rate the job NASA is doing in positive terms, with 16 percent saying it is doing an 'excellent' job and 40 percent a 'good' job. Meanwhile, just eight percent say it is doing a poor job, with most of the rest describing NASA's performance as 'only fair'."*

Gallup has asked the same question—*"How would you rate the job being done by NASA—the U.S. space agency? Would you say it is doing an excellent, good, only fair, or poor job?"* since 1990. According to the 2007 article, *"NASA has had less-than-majority positive evaluations just twice since 1990, when Gallup first asked this question. The initial 46 percent rating in July 1990 came shortly after a flaw in the Hubble telescope was discovered. Gallup measured the historical low rating of 43 percent in September 1993 after a series of mishaps, which included the loss of contact with the Mars Orbiter and a couple of last-second decisions to scrub planned Space Shuttle missions."* In addition, the 2007 article notes that *"The high point in NASA's ratings came in November 1998, shortly after Sen. John Glenn—one of the earliest U.S. astronauts—made a much-heralded return trip to space."*

• Public Views of Space Exploration: An Independent National Survey

In February 2009, The Everett Group, conducted an independent national survey to:

- *"Gauge Americans' impressions of the space program relative to other national institutions*
- *Determine what the public perceives to be the greatest benefits of the space program*
- *Gauge the level of public support for an increase in funding for the space program*
- *Identify future missions that the public would support."*

The survey included a random sample of 360 U.S. adults.

In response to the question, *"How would you describe your overall interest in the U.S. space program?"*, the participants answered: *very interested (15 percent), somewhat interested (44 percent), not too interested (22 percent), and not at all interested (19 percent)."*

In response to the question, *"Can you think of any ways that your life has been improved directly by the U.S. space program?"*, *"Half of the public says 'Yes' and can name one or more ways the space program improved their life."* *"The other half says 'No' and believes that the program has not improved their life in any way."* Of those that answered that space improved their lives and provided an example, *"satellites, knowledge about the universe, and new technology"* were the three most common ex-

amples cited. Other responses included “computers, Velcro, foods, cell phones, plastics, knowledge about weather/environment, microwaves, medical advances, communications, clothes/fabrics, educating young scientists, and entertainment/pictures.”

The write-up of the survey lists “Key Take-Aways” as:

- “Most Americans are interested in the space program (60 percent) but an alarming number have no interest at all (19 percent). Interest is particularly soft among women.
- On the positive side, large majorities feel that the space program is important to national security (71 percent), contributes to national pride (79 percent), and inspires young people to study math and science (82 percent).
- Half of the public feel that the space program has not directly improved their lives in any way. Those who do, however, cite technological developments and knowledge about the universe.
- Most believe that the U.S. continues to explore space in order to maintain our status as an international leader or because it is human nature to explore.
- The majority of Americans (60 percent) reject the idea that the space program is a waste of taxpayer money. They are not convinced, however, that more funding is needed.
- A plurality feel that a manned mission to Mars should be the next major mission, but there is some sentiment that this should not be pursued during the current economic recession.
- Many Americans would prefer to see the space program’s resources used to help solve terrestrial problems rather than extraterrestrial ones for the time being.”

NASA Strategic Communications Framework Implementation Plan

In 2007, NASA’s Office of Strategic Communications developed an Implementation Plan with the purpose of putting “forward specific messages and initiatives based on the Strategic Communications Framework and recent round of market research and analysis.” According to the Plan, the overall Agency communications goals were:

1. “Build greater public support for NASA’s mission and activities. Authority for effort based in:
 - Space Act of 1958
 - 2005 NASA Authorization Act
2. Make Agency communications more participatory
 - Increase users of MyNASA, Inside NASA, and communications.nasa.gov
3. Change communications behavior within the Agency
 - Reach out to new audiences
 - Demonstrate relevancy and benefits to key audiences.”

The report states that “Messages and outreach activities are informed by relevant policy guidance: Vision for Space Exploration, National Space Policy, National Aeronautics Research and Development Policy.”

On the analysis of market research, the report provides a NASA Brand Balance Sheet:

“Strengths

1. Near Universal Awareness
2. Enormous Public Appreciation
3. High Support
4. Wide Appeal

Challenges

1. Little Specific Knowledge
2. Lack of Relevance
3. Low Excitement
4. Disconnect from Activities
5. Lack of Current Context”

The report recommends that NASA communications should:

- *“Demonstrate NASA’s role using message components:*
 - *Science*
 - *Economic*
 - *Security*
 - *Leadership*
- *Illustrate NASA’s relevance by highlighting*
 - *The importance of space to America’s economy*
 - *The benefits to people that exist because of technology developed by NASA*
- *Engage and inspire audiences about the future benefits of NASA and its leadership in space exploration, aeronautics research, science, and education.”*

In developing the 2007 Strategic Communications Framework Implementation Plan, NASA commissioned independent entities to conduct market research (focus groups and a survey) to:

- *“Set benchmarks in areas of knowledge, relevance, and excitement*
- *Testing of key words and messages*
 - *Development of messages around Space Exploration including Moon/Mars missions*
- *Effects of specific benefits in terms of illustrating relevance*
- *Gain insight into demographic differences.”*

The summary of market research results is as follows:

- *“NASA’s overall public image remains high and a large number of Americans believe continuing space exploration is important*
- *However, fewer Americans rate NASA as relevant to their daily lives and perceptions of NASA’s economic contribution vary*
- *Telling people about specific NASA-related technologies has a tremendous impact on both relevance and economic measures*
- *Among messages tested, there were no “weak” reasons for continuing space exploration, though some reasons were stronger than others*
- *When talking about NASA programs and activities, framing NASA communications in terms of relevance and benefits is most effective.”*

The report identifies outreach strategies [as of 2007] including the 50th Anniversary of NASA, NASA Future Forums (conferences to discuss how innovation helps promote and sustain economic development), NASA Lecture Series, the use of Shuttle launches to engage State and local leaders, public service announcements, strategic alliances, and the use of new media that takes advantage of customized and personalized web pages and opportunities for online interaction (MyNASA), as well as an upgrade of the NASA web site and an online catalog of NASA benefits and stories provided by individuals on how space affects their lives.

Social Networking and Other Forms of Communications and Outreach

As noted in the above sections on public awareness and strategic communications, many Americans are unaware of how space affects and benefits their lives. Enhancing the public’s awareness involves communication and information dissemination, including by means of new communication modes and tools that are widely used by younger generations. As stated in a March 2009 article in *Discovery News*, *“Ask most folks around NASA what lured them into the space business and they’ll tell you about how shivers ran down their spines watching Neil Armstrong step onto the moon in 1969. That’s a problem for an agency that exists to inspire the young and explore the unknown.”*

One of the ways that NASA is attempting to address this issue is through the use of social networking. According to the *Webcontent.gov* information on Social Networks and Government, social networking tools are *“web sites that connect people”* and involve *“online communities”* that people can join without cost and create a web page with their profile. These sites *“allow users to find people they know among the members, or look for other members with similar interests or affiliations.”* NASA is employing these tools as another means of communicating with the interested public, especially with younger people who are active users of social networking sites. The Mars Phoenix Lander mission has tens of thousands of Twitter followers. NASA astronaut Jose Hernandez used Twitter to relay insights in both English and Span-

ish on his Shuttle mission training. NASA is on Facebook and also disseminates video using YouTube.

NASA is also using naming and voting contests as another means to engage the public in its programs. A contest on what to name a new node of the International Space Station attracted considerable attention when participants voted to name it after comedian Stephen Colbert. (NASA elected to name the new ISS node, "Tranquility," but named a new treadmill, the Combined Operational Load Bearing External Resistance Treadmill (COLBERT) after the comedian.) Another contest allowed participants to vote, for example, on an observing target for the Hubble Space Telescope.

In addition, NASA has upgraded its web site to incorporate other tools that invite public participation in NASA activities. One example is a web page entitled "Collaborate and Connect with NASA" that provides links to Twitter, Facebook, USTREAMTV, myspace, YouTube, and flickr and provides multiple links that provide opportunities to collaborate with NASA. The Collaborate and Connect with NASA web page also provides links that outline how readers can help identify landforms in satellite images of Mars, one that has offered contests for artwork on the lunar environment, and a site that provides teacher lesson plans, access to Earth science data, and opportunities to participate in citizen science projects relevant to Earth science, among other means to engage with NASA activities.

ATTACHMENT I

Executive Summary of the Report

America's Future In Space: Aligning the Civil Space Program with National Needs

From its inception in 1958, much of the U.S. space program was driven by opportunities to serve national interests in a geopolitical environment heavily colored by Cold War threats and fears. Originally, the true potential of space activities was largely speculative. In the ensuing decades, however, early expectations for discovery and technological accomplishment have been richly exceeded. Without a doubt, the first 50 years of the space age have been transformative. Astronauts have stood on Earth's Moon while millions watched. Commercial communications and remote sensing satellites have become part of the basic infrastructure of the world. Satellites support worldwide communications, providing a critical backbone for daily commerce—carrying billions of global financial transactions daily, for example. Direct broadcasting beams television signals into homes globally, delivering images that bring unprecedented awareness of events occurring throughout the world. Military global positioning satellites provide ubiquitous signals that support a stunning variety of services, from assisting in the navigation of civilian airplanes, shipping, and automobiles to transmitting timing signals that enable cell phone and power grid switching. Remote sensing satellites obtain high-resolution images of Earth's surface, available now on the Internet for people worldwide to view and use, and provide critical information to monitor changes in our climate and their effects.

Our understanding of every aspect of the cosmos has been profoundly altered, and in the view of many, we stand once again at the brink of a new era. Space observations have mapped the remnant radiation from the Big Bang that began our universe. We have discovered that the expansion of the universe continues to accelerate, driven by a force that we do not yet understand, and that there are large amounts of matter in the universe that we cannot yet observe. We have seen galaxies forming at the beginning of the universe and stars forming in our own galaxy. We have explored the wonders that abound in our solar system and have found locations where life might have occurred or might even now be present. We have discovered planets around other stars, so many that it is ever more likely that there are other Earths comparable to our own.

What will the next 50 years bring? Today we live in a globalized world of societies and nations characterized by intertwined economies, trade commitments, and international security agreements. Mutual dependencies are much more pervasive and important than ever before. Many of the pressing problems that now require our best efforts to understand and resolve—from terrorism to climate change to demand for energy—are also global in nature and must be addressed through mutual worldwide action. In the judgment of the Committee on the Rationale and Goals of the U.S. Civil Space Program, the ability to operate from, through, and in space will be a key component of potential solutions to 21st century challenges. As it has be-

fore, with the necessary alignment to achieve clearly articulated national priorities, the U.S. civil space¹ program can serve the Nation effectively in this new and demanding environment.

In its initial discussions, the committee concluded that debates about the direction of the civil space program have too often focused on addressing near-term problems and issues without first putting those issues in the context of how a disciplined space program can serve larger national imperatives. In the committee's view, characterizing the top-level goals of the civil space program and the connection between those goals and broad national priorities is necessary as a foundation on which the Nation (both now and in the future) can devise sustainable solutions to nearer-term issues. Therefore, the committee focused on the long-term, strategic value of the U.S. civil space program, and its report does not address nearer-term issues that affect the conduct of U.S. space activities other than to provide a context in which more tactical decisions might be made.

The national priorities that informed the committee's thinking include ensuring national security, providing clean and affordable energy, protecting the environment now and for future generations, educating an engaged citizenry and a capable workforce for the 21st century, sustaining global economic competitiveness, and working internationally to build a safer, more sustainable world. A common element across all these urgent priorities is the significant part that research and development can play in solving problems and advancing the national enterprise in each area. Instruments in space have documented an accelerating decline in arctic sea ice, mapped the circulation of the world's oceans, enabled the creation of quantitative three-dimensional data sets to improve the quality of hurricane forecasting, and created new tools to address a host of agricultural, coastal, and urban resource management problems, to cite only a few examples. Such capabilities demonstrate what can be achieved when technologically challenging space problems stimulate innovation that leads to long-term advances with applications beyond the space sector. Civil space activities are central to the R&D enterprise of the Nation, often in a transformational way, and thus present powerful opportunities to help address major national objectives.

Observations from space offering unique capabilities for global environmental and land-use monitoring are essential to informed decision-making about energy production and climate change policies, and they help provide the understanding required for wise management. The high visibility of space activities attracts students' attention to science, technology, and mathematics, and space activities are an exciting focus for teaching those subjects. Commercial space-related ventures now figure significantly in global economic competitiveness, and, while government investments to stimulate the Nation's fragile economy will have short-term impacts, R&D investments can be counted on to make longer-term sustainable contributions to the Nation's economic strength. As has countless times proved the case, research in and from space will continue to lead to important future, and not always currently predictable, benefits that hold the promise of progress toward realizing U.S. as well as shared international goals.

The committee's overall conclusion is that a preeminent U.S. civil space program with strengths and capabilities aligned for tackling widely acknowledged national challenges—environmental, economic, and strategic—will continue to make major contributions to the Nation's welfare.

GOALS FOR THE CIVIL SPACE PROGRAM

Structured and supported to match multiple responsibilities in serving key national objectives, the U.S. civil space program should be preeminent in the sense that it can influence, by example, nations' use of space. To be a strategic leader in a globalized world requires that the United States have a civil space program whose breadth, competence, and level of accomplishment ensures that U.S. leadership is demonstrated, accepted, and welcomed.

The committee identified six strategic goals that it regards as basic for guiding program choices and resources planning for U.S. civil space activities. The goals all serve the national interest, and steady progress in achieving each of them is necessary.

- *To re-establish leadership for the protection of Earth and its inhabitants through the use of space research and technology.* The key global perspective enabled by space observations is critical to monitoring climate change and

¹The committee considered "civil space" to include all government, commercial, academic, and private space activities not directly intended for military or intelligence use.

testing climate models, managing Earth resources, and mitigating risks associated with natural phenomena such as severe weather and asteroids.

- *To sustain U.S. leadership in science by seeking knowledge of the universe and searching for life beyond Earth.* Space offers a multitude of critical opportunities, unavailable in Earth-based laboratories, to extend our knowledge of the local and distant universe and to search for life beyond Earth.
- *To expand the frontiers of human activities in space.* Human space flight continues to challenge technology, utilize unique human capabilities, bring global prestige, and excite the public's imagination. Space provides almost limitless opportunities for extending the human experience to new frontiers.
- *To provide technological, economic, and societal benefits that contribute solutions to the Nation's most pressing problems.* Space activities provide economic opportunities, stimulate innovation, and support services that improve the quality of life. U.S. economic competitiveness is directly affected by our ability to perform in this sector and the many sectors enabled and supported by space activities.
- *To inspire current and future generations.* U.S. civil space activities, built on a legacy of spectacular achievements, should continue to inspire the public and also serve to attract future generations of scientists and engineers.
- *To enhance U.S. global strategic leadership through leadership in civil space activities.* Because of the growing strategic importance of space, all nations that aspire to global political and economic leadership in the 21st century are increasing their space-faring capabilities. Continued U.S. global leadership is tied to continued U.S. leadership in space.

FOUNDATIONAL ELEMENTS

To contribute to realizing critical national objectives including those listed above, the U.S. space program, both the civil and national security components, must have a strong foundation and adequate resources. While the breadth of the civil space program has grown, there is also a sense that the program has been unfocused, with corresponding impacts on the organizations and institutions that support it. The United States can no longer pursue space activities on the assumption of its unchallengeable dominance—as evidenced by the view of other nations that the United States is not the only, or in some cases even the best, option for space partnerships. U.S. leadership in space activities and their capacity to serve urgent national needs must be based on preeminent technical capabilities; ingenuity, entrepreneurialism, and a willingness to take risk; and recognition of mutual interdependencies. The time has come to reassess, and in some cases reinvent, the institutions, workforce, infrastructure, and technology base for U.S. space activities.

The committee identified four foundational elements critical to a purposeful, effective, strategic U.S. space program, without which U.S. space efforts will lack robustness, realism, sustainability, and affordability:

1. *Coordinated national strategies*—implementing national space policy coherently across all civilian agencies in support of national needs and priorities and aligning attention to shared interests of civil and national security space activities,
2. *A competent technical workforce*—sufficient in size, talent, and experience to address difficult and pressing challenges,
3. *An effectively sized and structured infrastructure*—realizing synergy from the public and private sectors and from international partnerships, and
4. *A priority investment in technology and innovation*—strengthening and sustaining the U.S. capacity to meet national needs through transformational advances.

Efforts to establish each of these elements to ensure a strong foundation for the Nation's civil space program must overcome several impediments. The issues include a loss of focus on national imperatives, overly constrained resources, inadequate coordination across the Federal Government, missed opportunities to transition roles from government-led to private sector-provided services, obstacles to international cooperation, weakened institutional partnerships, and lack of emphasis on advanced technology development programs. Awareness of such issues—and not an effort to resolve specific instances—guided the committee in its development of recommendations to NASA, NOAA, and the Federal Government at the highest levels.

RECOMMENDATIONS

The committee found that, in spite of their promise and utility, components of the civil space program are not always aligned to fully capitalize on opportunities to serve the larger national interest. Decisions about civil space priorities, strategies,

and programs, and the resources to achieve them, are not always made with a conscious view toward their linkages to broader national interests. Accordingly, the committee recommends as follows:

1. *Addressing national imperatives.* Emphasis should be placed on aligning space program capabilities with current high-priority national imperatives, including those where space is not traditionally considered. The U.S. civil space program has long demonstrated a capacity to effectively serve U.S. national interests.

Recommendation 1 provides a broad policy basis on which the committee's subsequent specific recommendations rest. The recommendations that follow address a set of actions, all of which are necessary to strengthen the U.S. civil space program and reinforce or enhance the contributions of civil space activities to broader national objectives.

2. *Climate and environmental monitoring.* NASA and NOAA should lead the formation of an international satellite-observing architecture capable of monitoring global climate change and its consequences and support the research needed to interpret and understand the data in time for meaningful policy decisions by:

- a. Reversing the deterioration of the U.S. Earth observation infrastructure;
- b. Developing and implementing a plan for achieving and sustaining global Earth observations;
- c. Working with the international community to develop an integrated database for sensor information from all Earth-monitoring satellites;
- d. Aggressively pursuing technology development for future high-priority Earth observation missions; and
- e. Actively planning for transitions to continue demonstrably useful research observations on a sustained, or operational, basis.

3. *Scientific inquiry.* NASA, in cooperation with other agencies and international partners, should continue to lead a program of scientific exploration and discovery that:

- a. Seizes opportunities to advance understanding of Earth, the objects of the solar system including the Sun, and the vast universe beyond;
- b. Includes searches for evidence of life beyond Earth;
- c. Contributes to understanding how the universe works, who we are, where we came from, and what is the destiny of our star—the Sun—our solar system, and the universe, and of the physical laws that govern them; and
- d. Is guided by peer review, advisory committees, and the priorities articulated by the science communities in their strategic planning reports, such as the NRC's decadal surveys.²

4. *Advanced space technology.* NASA should revitalize its advanced technology development program by establishing a DARPA-like organization within NASA as a priority mission area to support preeminent civil, national security (if dual-use), and commercial space programs. The resulting program should:

- a. Be organizationally independent of major development programs;
- b. Serve all civil space customers, including the commercial sector;
- c. Conduct an extensive assessment of the current state and potential of civil space technology; and
- d. Conduct cutting-edge fundamental research in support of the Nation's space technology base.

5. *International cooperation.* The government, under White House leadership, should pursue international cooperation in space proactively as a means to advance U.S. strategic leadership and meet national and mutual international goals by:

- a. Expanding international partnerships in studies of global change;
- b. Leading an effort in which the United States and other major space-faring nations cooperate to develop rules for a robust space operating regime that

²The NRC decadal surveys have been widely used by the scientific community and by program decision-makers because they (a) present explicit, consensus priorities for the most important, potentially revolutionary science that should be undertaken within the span of a decade; (b) develop priorities for future investments in research facilities, space missions, and/or supporting programs; (c) rank competing opportunities and ideas and clearly indicate which ones are of higher or lower priority in terms of the timing, risk, and cost of their implementation; and (d) make the difficult adverse decisions about other meritorious ideas that cannot be accommodated within realistically available resources.

ensures that space becomes a more productive global commons for science, commerce, and other activities;

- c. Rationalizing export controls so as to ensure ongoing prevention of inappropriate transfer of sensitive technologies to adversaries while eliminating barriers to international cooperation and commerce that do not contribute effectively to national security;
- d. Expanding international partnerships in the use of the International Space Station;
- e. Continuing international cooperation in scientific research and human space exploration,
- f. Engaging the nations of the developing world in educating and training their citizens to take advantage of space technology for sustainable development; and
- g. Supporting the interchange of international scholars and students.

6. *Human space flight.* NASA should be on the leading edge of actively pursuing human space flight, to extend the human experience into new frontiers, challenge technology, bring global prestige, and excite the public's imagination. These goals should be accomplished by:

- a. Setting challenging objectives that advance the frontier, scientific and technological understanding, and the state-of-the-art;
- b. Establishing clear goals for each step in a sequence of human space flight missions beyond low-Earth orbit that will develop techniques and hardware that can be used in a next step further outward;
- c. Focusing use of the ISS on advancing capabilities for human space exploration; and
- d. Using human space flight to enhance the U.S. soft power leadership by inviting emerging economic powers to join with us in human space flight adventures.

National space policy too often has been implemented in a stovepipe fashion that makes it difficult to recognize connections between space activities and pressing national challenges. Often, senior policy-makers with broad portfolios have not been able to take the time to consider the space program in the broader national context. Rather, policies have been translated into programs by setting budget levels and then expecting agencies to manage to those budgets. The committee believes that the process of aligning roles and responsibilities for space activities, making resource commitments, and coordinating across departments and agencies needs to be carried out at a sufficiently high level that decisions are made from the perspective of addressing the larger national issues whose resolution space activities can help achieve. How this process is accomplished might change from administration to administration, but the need for an approach that will elevate attention to the proper level remains essential.

7. *Organizing to meet national needs.* The President of the United States should task senior executive-branch officials to align agency and department strategies; identify gaps or shortfalls in policy coverage, policy implementation, and resource allocation; and identify new opportunities for space-based endeavors that will help to address critical issues now confronting the United States and, to a considerable extent, the world as well.

The effort should include the Assistant to the President for National Security Affairs and the Assistant to the President for Science and Technology, and should consider the following elements:

- a. Coordinating budgetary guidance across federal departments and agencies involved in space activities;
- b. Coordinating responsibility and accountability for resource allocations for common services and/or infrastructure;
- c. Coordinating responsibility and accountability for stimulating, nurturing, and sustaining a robust space industrial base, including the commercial space industry;
- d. Coordinating responsibility and accountability for initiatives to recruit and develop a competent aerospace workforce of sufficient size and talent, anticipating future needs;
- e. Identifying, developing, and coordinating initiatives to address long-range technological needs for future programs;

- f. Identifying, developing, and coordinating initiatives to establish and strengthen international space relationships;
- g. Harmonizing the roles and responsibilities of federal agencies to eliminate gaps and unnecessary duplication in the Nation's space portfolio; and
- h. Regularly reviewing coordinated national space strategies and their success in implementing overall national space policy.

Chairwoman GIFFORDS. The hearing will come to order.

Good afternoon, everyone. I am so pleased that we are all here, having an opportunity to talk about this very important issue, but I am also excited, because this is the 40th anniversary of the launch of Apollo 11's mission to the Moon.

There are a whole series of commemorative events planned for this week and for next week, and it is clear that Apollo is still considered one of the most significant achievements of the U.S. space program, and I would go beyond that, and say of all of mankind.

It is, of course, fitting that we pause to honor those who blazed the trail that leads out beyond low-Earth orbit, both the brave astronauts who undertook those hazardous expeditions to the Moon, and the countless individuals and organizations who enabled those expeditions to succeed.

Yet, by definition, our civil space program is about the future, not about the past, and if our space program is to have a sustainable and productive future, it also has to be relevant. That is, America's space program must be relevant to our broad national needs if it is going to continue to be supported by Members of Congress and by the American people.

Yet, as the National Academies review, the Space Foundation's annual report, and the *NASA Authorization Act of 2008* all make clear, we can and should do more to enhance the relevance of the civil space program, so it can continue to be an important contributor to the Nation's strength and wellbeing in the years and the decades to come. By that, I don't mean that NASA and our space program should just be about spinoffs, as important as the past ones have been to our economy, to our science, and to our society.

Instead, what I am saying is that our space program is important to Americans scientifically, technologically, economically, and geopolitically, and we should recognize and nurture that reality, so that we can maximize the benefits we accrue from America's space program into the future. I think that the National Academies panel put it pretty well. I quote: "A preeminent U.S. civil space program with strengths and capabilities aligned for tackling widely acknowledged national challenges, environmental, economic, and strategic, is a national imperative today, and will continue to grow in importance in the future."

That is an imperative that both Congress and the White House will need to come to grips with if we are to have a productive future in space exploration, yet that is only half of the equation. You have all heard the old conundrum, if a tree falls in the forest and no one hears about it. Well, we face a similar conundrum with our civil space program. If we have an incredibly exciting and relevant space program, but the American people don't hear about it, don't understand it, and don't know about it, is it really that relevant to the American people? Because it is not an academic exercise, our space program is incredibly important to this country's future wellbeing, but we can't assume the public will just take the assertion on faith. We need to be able to demonstrate it.

So, today's hearing is a part of that process. It is really a first step in that process, and I can think of no better way to honor the achievements of those who have led America to the Moon, and cre-

ated a space program that has been the envy of the world, than to have a hearing like this today.

In closing, I again want to welcome our witnesses to today's hearing.

I now recognize Mr. Olson for his opening comments.

[The prepared statement of Chairwoman Giffords follows:]

PREPARED STATEMENT OF CHAIRWOMAN GABRIELLE GIFFORDS

Good afternoon. I'm pleased to welcome everyone to today's hearing on this the 40th anniversary of the launch of the Apollo 11 mission to the Moon.

There are a whole series of commemorative events planned for this week and next, and it is clear that Apollo is still considered one of the most significant achievements of the U.S. space program—and deservedly so.

It's of course fitting that we pause to honor those who blazed the trail that leads out beyond low-Earth orbit—both the brave astronauts who undertook those hazardous expeditions to the Moon and the countless individuals and organizations who enabled those expeditions to succeed.

Yet, by definition our civil space program is about the future—not the past.

And if our space program is to have a sustainable and productive future, it is also about relevance.

That is, America's civil space program must be relevant to our broad national needs if it is going to continue to be supported.

Yet as the National Academies review, the Space Foundation's annual report, and the *NASA Authorization Act of 2008* all make clear, we can and should do more to enhance the relevance of the civil space program so that it can continue to be an important contributor to the Nation's strength and well-being in the years and decades to come.

By that I don't mean that NASA and our space program should just be about "spinoffs," as important as past ones have been to our economy and our society.

Instead what I'm saying is that our space program is important to American scientifically, technologically, economically, and geopolitically, and we should recognize and nurture that reality so that we can maximize the benefits we accrue from America's space program in the future.

I think the National Academies panel put it well:

" . . . A preeminent U.S. civil space program with strengths and capabilities aligned for tackling widely acknowledged national challenges—environmental, economic, and strategic—is a national imperative today, and will continue to grow in importance in the future."

That is an imperative that both Congress and the White House will need to come to grips with if we are to have a productive future in space exploration.

Yet, that is only half of the equation.

You've all heard the old conundrum: "If a tree falls in the forest and no one is there to hear it . . ."

Well, we face a similar conundrum with our civil space program.

If we have an incredibly exciting and relevant space program, but the American people don't really know about it, is it really that relevant?

Because it's not an academic exercise—our space program is incredibly important to this country's future well being, but we can't assume the public will just take that assertion on faith.

We need to be able to demonstrate it.

Today's hearing is a first step in that process, and I can think of no better way to honor the achievements of those who led America to the Moon and created a space program that has been the envy of the world.

In closing, I again want to welcome our witnesses to today's hearing, and I will now recognize Mr. Olson for any opening statement he may care to make.

Mr. OLSON. Well, Madam Chairwoman, thank you so much for calling this afternoon's hearing. I would like to thank the witnesses for coming today to give us your time and your expertise. Thank you.

I look forward to discussing how Congress and the executive branch can collaborate to better enhance public perception of the

contributions that NASA and the civil space industry provide our nation's economy and our quality of life.

My thanks to our panel of expert witnesses again, for taking your time out of your busy schedules to appear before the Subcommittee. Your unique perspectives are greatly valued by the Members of this committee. Thank you again for coming today.

You know, Madam Chairwoman, I am glad we are holding this hearing today, but slightly discouraged that we have to hold it at all. I assure you that this hearing would not have been one that would have occurred on this day back in 1969. Forty years ago today, Apollo 11 launched on a journey that changed mankind's perception as to what was possible. We challenged our scientists and our engineers to develop never before used technologies to send humans on a mission that captivated the world's attention and stirred humanity's collective imagination. That alone made it relevant.

I am not sure it is possible to replicate that feeling today, that sense of achievement, that sense of unlimited possibilities, without an equally challenging goal, but that does not mean that other critical discoveries and new technologies NASA is developing or currently working on are not equally compelling. Our landing on the Moon was the beginning of a journey, not the end of one, and sometimes, I feel like we have forgotten that.

Let us look at some of the issues that are critical to our nation at this time, securing our economic future, strengthening our education system, developing alternative energy sources to ease our dependence on foreign oil, improving our health care system, and protecting our environment. All of these, all of these rate as high concerns among the American public polled.

NASA scores high ratings when it stands alone for public support, but suffers when put in a list of priorities with other competing goals. This is in part because many Americans aren't familiar with the wide breadth of space and Earth-related research that NASA conducts, and the spinoffs that have been developed from those experiments. To improve, we need to ensure that we have a worthwhile and challenging human space flight goal that is adequately funded, and we also have to effectively convey that America's space program provides concrete solutions to a wide array of societal problems.

The members of this panel are uniquely qualified to do that. General Lyles recently chaired a study that addressed many of these subjects. His report looked closely at the overall challenges facing our civil space program. Mrs. Smith and the Space Foundation, among other things, have published "*The Space Report: 2009*," which includes a host of invaluable information, but in my mind, the data provided about the space economy is second to none. I am also thankful that Mrs. Myers and Mr. O'Brien are here to give us some insight on communicating to and hearing from the public. After all, it is the public who we are asking to fund many of these endeavors.

When we are in this hearing room, particularly in this subcommittee room, there is no need for convincing. I would love to hear how all the enthusiasm that we share in this room about

space exploration can be conveyed to those people who are standing out in the hall.

With that, Madam Chairman, I conclude my opening remarks, and yield back my time.

[The prepared statement of Mr. Olson follows:]

PREPARED STATEMENT OF REPRESENTATIVE PETE OLSON

Madam Chairwoman, thank you for calling this afternoon's hearing. I look forward to discussing how Congress and the Executive Branch can collaborate to better enhance public perception of the contributions that NASA and the civil space industry provide our nation's economy, and our quality of life. My thanks to our panel of expert witnesses for taking time out of your busy schedules to appear before this subcommittee. Your unique perspectives are greatly valued by the Members of this committee. Thank you for agreeing to participate.

You know Madam Chairwoman, I am glad that we are holding this hearing today, but slightly discouraged that we have to hold it at all. I assure you that this hearing would not be one that would have been held on this date in 1969. Forty years ago today, Apollo 11 launched on a journey that changed mankind's perception as to what is possible. We challenged our scientists and engineers to develop never-before-used technologies to send humans on a mission that captivated the world's attention and stirred humanities collective imagination. That alone made it relevant.

I'm not sure it's possible to replicate that feeling—that sense of achievement—that sense of unlimited possibilities—today without an equally challenging goal, but that does not mean that other critical discoveries and new technologies NASA is developing or is currently working on, are not equally compelling. Our landing on the Moon was the beginning of a journey, not the end of one. Sometimes I feel like we have forgotten that.

Let us look at some of the issues that are critical to our nation at this time: securing our economic future, strengthening our education system, developing alternative energy sources to ease our dependence on foreign oil, improving our health care system and protecting our environment. All of these rate as high concerns when the American public is polled. NASA scores high ratings when it stands alone for public support, but suffers when put in a list of priorities with these other issues. This in part because many Americans aren't familiar with the wide breadth of space- and Earth-related research NASA conducts, and the spinoffs that have been developed. To improve, we need to ensure that we have a worthwhile and challenging human space flight goal that is adequately funded, and we also have to effectively convey that America's space program provides concrete solutions to solving a wide array of societal problems.

The members of this panel are uniquely qualified to help us do that. Gen. Lyles recently chaired a study that addressed many of these subjects. His report looked closely at the overall challenges facing our civil space program. Ms. Smith and the Space Foundation, among other things, have published *The Space Report 2009*, which includes a host of invaluable information, but in my mind the data provided about the space economy is second to none. I am also thankful that Ms. Myers and Mr. O'Brien are here to give us some insight on communicating to, and hearing from, the public. After all, it is the public who we are asking to fund many of these endeavors. When we are in this hearing room, particularly in this subcommittee, there is no need for convincing. I would love to hear how the enthusiasm that we all share in this room about space exploration can be conveyed with those out in the hall.

During this week, as we celebrate the 40th anniversary of Apollo 11, all of us should recognize what we have achieved, but do so with an eye on the many discoveries and achievements yet to come.

Chairwoman GIFFORDS. Thank you, Mr. Olson. I think we all agree with your comments.

I would like to take a moment to introduce our witnesses. First up, we have General Lester Lyles, who is testifying as Chair of the National Research Council's Committee on the Rationale and Goals of the U.S. Civil Space Program.

Next, we hear from Ms. Patti Grace Smith, who is a member of the Board of Directors of the Space Foundation. Then, we will hear

from Ms. Deborah Adler Myers, who is the General Manager of the Science Channel at Discovery Communications.

And finally, we have Mr. Miles O'Brien, who previously acted as CNN's Chief Technology and Environment Correspondent, now works as a freelance journalist, and I can personally say is probably the most passionate citizen when it comes to space. So, we are glad to have you here, Mr. O'Brien, and for all of our panelists as well, welcome.

As our panelists should know, we are going to require that we keep to around five minutes of testimony. I know that will be hard, but we would like to just get your testimony out. We will have the written testimony, of course, but then, we are going to open it up to questions, and I am really looking forward to having a great discussion.

And General Lyles, we will start with you.

STATEMENT OF GENERAL LESTER L. LYLES [U.S. AIR FORCE, RET.], CHAIR OF THE COMMITTEE ON THE RATIONALE AND GOALS OF THE U.S. CIVIL SPACE PROGRAM, AERONAUTICS AND SPACE ENGINEERING BOARD, NATIONAL RESEARCH COUNCIL

General LYLES. Thank you, Madam Chairwoman, Members of the Subcommittee. I thank you very much for giving us the opportunity to testify before this subcommittee today.

I can't think of a better date to have this particular hearing, and to talk about this very, very important topic. As you stated, my name is Lester Lyles. I am a retired United States Air Force four-star general, and during my 35 years in the United States Air Force, I have had the opportunity to be involved in numerous space programs: as the Commander of the Air Force's Space and Missile System Center; and in Los Angeles, as Director of the Ballistic Missile Defense Organization, now called the Missile Defense Agency; as the Vice Chief of Staff of the United States Air Force; and then, finally, as the Commander of the Air Force Materiel Command. Today, however, I speak to you as the Chair of the National Research Council's Committee on the Rationale and Goals of the United States Civil Space Program, which recently, last week, released the report *"America's Future in Space: Aligning the Civil Space Program with National Needs."*

My committee, the committee that looked at this particular topic, contained 14 members. We had distinguished experts in science and engineering, economics, political science, public policy, national security, and of course, space systems and space exploration. And with your permission, Madam Chairwoman, I am going to submit my prepared testimony for the record, and would like to just summarize, if you will, what our task was, and what the views were of this particular committee.

First, I will start by saying I thank the National Academy Presidents, Ralph J. Cicerone and Dr. Chuck Vest, Academy of Science and the Academy of Engineering, for sponsoring this very, very important topic. This was not a topic sponsored by some other agency, NASA, or any other organization. This was the Academies' opportunity and attempt to address a subject they thought was very important for the 21st century and for our country.

And what they tasked us to do was to take a broad look at identifying the key goals and critical issues for the 21st century for the United States civil space policy and civil space programs. They asked us to address overarching goals, to identify areas of national interest, and to identify, hopefully, solutions to some of the issues that we might encounter.

And even though we were asked to take a look, or told to take a look at specific programmatic things, we were asked specifically to stay at a strategic level. Don't get down into weeds, and describe how to build a rocket, or one rocket solution versus another, but to look at the big strategic goals for the country and for the civil space program in general.

We started out by taking a very broad definition of civil space. Most people, I dare say, even in this room, of learned experts in the space arena, when you say civil space, they immediately think of NASA. Our definition of civil space was much broader. It included NOAA, the National Science Foundation, it included commercial space opportunities. It included academia. It included everything except national security space or intelligence space, though we obviously had to touch upon those two entities, because of the common ground and common themes, and certainly, common industrial base shared by each one of those different entities.

So, our scope was rather broad, and we think we did as best we could to encompass all of the different arenas, and everybody we possibly could, to ensure we got a broad breadth look at this topic.

I think, to summarize what the bottom line for our study was, it is sort of revealed in the title of our final report. You quoted our sort of final context, if you will, of our study, Madam Chairwoman. Our overall conclusion is that we have a preeminent United States civil space program. It has been that way in the past, it is that way today, and it should stay that way for the future. And the strengths and capabilities of that, those civil space activities, we think, are vastly available and vastly able to contribute to broader national challenges beyond just space exploration, including dealing with issues of climate and climate change, environmental, economic challenges, strategic and leadership opportunities, the economy, et cetera.

In our term, you quoted it also, is that there is a national imperative to make sure that our civil space programs are aligned to do those kind of things that it can contribute solutions to so, in such a broad, broad sense.

Our civil space program should be preeminent, in the sense that it can influence, by its example, other nations and their use of space, but also give us an opportunity to maintain strategic leadership, and use our space programs to help international cooperation, wherever we possibly could.

I was very, very pleased to see an op-ed published the day before yesterday by Congressman Ralph Hall, in which he talked about this very topic, and we thought was very, very appropriate. I agree with everything that Congressman Hall stated in his report. The only thing different is that from our perspective, we think that the civil space program alignment doesn't just focus in a narrow beam. We think we should continue doing the things we are doing today,

in addition to looking at ways we can make that appropriate alignment.

I will very quickly, because my light just lit up, the red light, point out the six goals that we defined and four foundational elements we think are critical. The first goal is to reestablish leadership for the protection of Earth and its inhabitants through the use of space research and technology. You could call this stewardship of the Earth. We think it is a very, very important goal, and should be one of the major things for civil space.

To sustain and expand our leadership in science, by seeking knowledge of the universe, and searching for life beyond. To expand the frontiers of human activities in space. To provide technological, economic, and societal benefits, where space technologies and space capabilities can contribute solutions. To inspire current and future generations, and to enhance U.S. global strategic leadership.

Those are our goals, and our recommendations sort of revolve around that. I won't, obviously, get into that, in the interests of time. Be more than willing to answer any questions about them. But I think it is important to very quickly mention four foundational elements that our report thought were absolutely critical to be addressed by the Administration, by the Congress, and by others, if those goals are to be achieved.

One is greater coordination through whatever means possible, a National Space Council, some other leadership forum where all of the agencies involved in space can do a better job of integrating and coordinating their space activities. The need for a competent technical workforce to address that from a broader sense than, perhaps, is being done today. To effectively size and structure the infrastructure for space with the organizations that are involved in space activities. And probably, very, very critical to one of the comments you mentioned, to look for priority investment or reinvestment in technology and innovation. And again, I can elaborate on each one of them.

I would like to just close very quickly, in talking about inspiration. I grew up here in Washington, D.C., Madam Chairwoman, and I was inspired when President Kennedy made his announcement about we are going to the Moon, and we are going to bring a human back. I was not about, just about to enter high school, actually, a few years from entering high school, here in Washington, D.C., and that statement, that goal, that far-reaching opportunity expressed by the President for the United States, inspired me to seek out a math and technology related high school in the District, and not go to the part of the District where, high school that I was supposed to go to, which was known mostly for basketball players and criminals, but—so, I chose another place to, because I was inspired by what the President stated.

I chose engineering at Howard University because of the inspiration of the Apollo program. Today, however, when I look at my own children, my four children, one doctor, one lawyer, one businesswoman, one businessman. They are very, very successful. They are inspired by things like the space launch yesterday, but on a day to day basis, what inspires them is what can be done to solve the economic problems in our country, the environmental problems, the

energy problems in our country. And I am just very, very enthused to think that they can be educated amongst as many others, in the hallways and in the public, and the Nation can be better educated by understanding how the civil space programs can contribute solutions to those big challenges that most people worry about on a day to day basis.

Madam Chairwoman, I thank you for being here. I am enthused about this subject, and very, very pleased that the Committee asked me to testify.

[The prepared statement of General Lyles follows:]

PREPARED STATEMENT OF GENERAL LESTER L. LYLES

Madam Chair and Members of the Subcommittee, I appreciate the opportunity to appear before you today. My name is Lester Lyles, I am a retired USAF four-star general and during my 35 years with the U.S. Air Force, I served as Commander of the Space and Missile Systems Center at Los Angeles AFB in California, Director of the Ballistic Missile Defense Organization, Vice Chief of Staff at USAF/HQ, and Commander of the U.S. Air Force Materiel Command.

Today, I speak to you as the Chair of the National Research Council's Committee on the Rationale and Goals of the U.S. Civil Space Program, which recently released the report *America's Future in Space: Aligning the Civil Space Program with National Needs*. The committee's 14 members included distinguished experts in science, engineering, economics, political science and public policy, national security, and of course, space systems and space exploration.

With your permission, I would like to submit my prepared testimony for the record and summarize my views for you here this morning, leaving sufficient time to answer any questions you may have.

Before addressing the questions posed by the Subcommittee, let me summarize our report.

CONTEXT OF THE REPORT

Without a doubt, the first 50 years of the space age have transformed the Nation and the world. Astronauts have stood on Earth's Moon while millions watched. Commercial communications and remote sensing satellites have become part of the basic infrastructure of the world. Satellites support worldwide communications, providing a critical backbone for daily commerce—carrying billions of global financial transactions daily, for example. Our understanding of every aspect of the cosmos has been profoundly altered, and in the view of many, we stand once again at the brink of a new era. We have discovered that the expansion of the universe continues to accelerate, driven by a force that we do not yet understand and that there are large amounts of matter in the universe that we cannot yet observe. We have discovered planets around other stars, so many that it is ever more likely that there are other Earths comparable to our own.

The next 50 years of civil space will occur in a globalized world of societies and nations characterized by intertwined economies, trade commitments, and international security agreements. Mutual dependencies are much more pervasive and important than ever before. Many of the pressing problems that now require our best efforts to understand and resolve—from terrorism to climate change to demand for energy—are also global in nature and must be addressed through mutual worldwide action.

In the judgment of the Committee on the Rationale and Goals of the U.S. Civil Space Program, the ability to operate from, through, and in space will be a key component of potential solutions to 21st century challenges. As it has before, with the necessary alignment to achieve clearly articulated national priorities, the U.S. civil space¹ program can serve the Nation effectively in this new and demanding environment.

In the committee's view, our study needed to address the top-level goals of the civil space program and the connection between those goals and broad national priorities. These connections form a foundation on which the Nation, both now and in the future, can devise sustainable solutions to nearer-term issues in the implementation of the civil space program. Therefore, the committee focused on the long-term,

¹The committee considered "civil space" to include all government, commercial, academic, and private space activities not directly intended for military or intelligence use.

strategic value of a U.S. civil space program, and our report does not address near-term issues that affect the conduct of U.S. space activities other than to provide a context in which more tactical decisions might be made.

The national priorities that informed the committee's thinking include ensuring national security, providing clean and affordable energy, protecting the environment now and for future generations, educating an engaged citizenry and a capable workforce for the 21st century, sustaining global economic competitiveness, and working internationally to build a safer, more sustainable world. A common element across all these urgent priorities is the significant part that research and development can play in solving problems and advancing the national enterprise in each area. Instruments in space have documented an accelerating decline in arctic sea ice, mapped the circulation of the world's oceans, enabled the creation of quantitative three-dimensional data sets to improve the quality of hurricane forecasting, and created new tools to address a host of agricultural, coastal, and urban resource management problems, to cite only a few examples. Such capabilities demonstrate what can be achieved when technologically challenging space problems stimulate innovation that leads to long-term advances with applications beyond the space sector. Civil space activities are central to the R&D enterprise of the Nation, often in a transformational way, and thus present powerful opportunities to help address major national objectives.

The committee's overall conclusion is that a preeminent U.S. civil space program with strengths and capabilities aligned for tackling widely acknowledged national challenges—environmental, economic, and strategic—is a national imperative today, and will continue to grow in importance in the future.

GOALS FOR THE CIVIL SPACE PROGRAM

For the United States to be a strategic leader in a globalized world, its civil space program must be of a breadth, competence, and accomplishment so that U.S. leadership is demonstrated, accepted, and welcomed. The committee identified six strategic goals that it regards as basic for guiding program choices and resources planning for U.S. civil space activities. The goals all serve the national interest, and steady progress in achieving each of them is necessary. These goals address such issues as U.S. leadership in science and technology, understanding climate change and protecting Earth's environment, providing economic and societal benefits, inspiration of future generations, strategic leadership in space, and human space flight, and they are articulated in more detail in the written report.

FOUNDATIONAL ELEMENTS

While the breadth of the civil space program has grown, there is also a sense that the program has been unfocused, sometimes at the expense of the effectiveness of the organizations and institutions that support it. The United States can no longer pursue space activities on the assumption of its unchallengeable dominance—as evidenced by the view of other nations that the United States is not the only, or in some cases even the best, option for space partnerships. U.S. leadership in space activities and their capacity to serve urgent national needs must be based on preeminent technical capabilities; ingenuity, entrepreneurialism, and a willingness to take risk; and recognition of mutual interdependencies. The time has come to reassess, and in some cases reinvent, the institutions, workforce, infrastructure, and technology base for U.S. space activities.

The committee identified four foundational elements critical to a purposeful, effective, strategic U.S. space program, without which U.S. space efforts will lack robustness, realism, sustainability, and affordability. Those elements (which are described in greater detail in the written report) are coordinated national strategies, a competent technical workforce, an effectively sized and structured infrastructure, and a priority investment in technology and innovation.

RECOMMENDATIONS

The committee found that, in spite of their promise and utility, components of the civil space program are not always aligned to fully capitalize on opportunities to serve the larger national interest. Decisions about civil space priorities, strategies, and programs, and the resources to achieve them, are not always made with a conscious view toward their linkages to broader national interests. The committee made recommendations addressing a broad variety of civil space issues, from Earth stewardship to human space exploration to scientific and technological innovation. For the purposes of today's hearing, I would like to highlight two recommendations.

Recommendation 1 states that emphasis should be placed on aligning space program capabilities with current high-priority national imperatives, including those

where space is not traditionally considered. The U.S. civil space program has long demonstrated a capacity to effectively serve U.S. national interests. This recommendation provides a broad policy basis on which the committee's subsequent recommendations rest.

Recommendation 7 uses a broader perspective on civil space to highlight that the success of all of the recommendations in the report relies upon the alignment of the various elements of the civil space program.

National space policy too often has been implemented in a stovepipe fashion that obscures the connection between space activities and other pressing needs of the Nation. Consequently, senior policy-makers with broad portfolios have not been able to take the time to consider the space program in the broader national context. Rather, policies have been translated into programs by setting budget levels and then expecting agencies to manage to those budgets. This has resulted in the much-repeated assertion, with which the committee agrees, that agencies like NASA are being asked to do too much with too little. The committee believes that the process of aligning roles and responsibilities for space activities, making resource commitments, and coordinating across departments and agencies needs to be carried out at a sufficiently high level that decisions are made from the perspective of the larger national issues regarding which space activities play roles. How this process is accomplished might change from administration to administration, but the need for an approach that will elevate attention to the proper level remains essential.

Therefore, the committee's recommendation is that the President of the United States should task senior executive-branch officials to align agency and department strategies; identify gaps or shortfalls in policy coverage, policy implementation, and resource allocation; and identify new opportunities for space-based endeavors that will help to address critical issues now confronting the United States and, to a considerable extent, the world as well.

The effort should include the Assistant to the President for National Security Affairs and the Assistant to the President for Science and Technology, and should consider such elements as budgetary guidance, resource allocation, the space industrial base, the aerospace workforce, long-range technological needs, international space relationships, elimination of unnecessary duplication of space efforts, and regular coordination of national space strategies and their success in implementing overall national space policy.

U.S. space activities—both national security and civil—are not isolated elements of the national enterprise. They interact with the broader aspects of our nation's commerce, transportation, education, and international relations. Civil space activities always have been, and will continue to be, excellent vehicles for educating future scientists and engineers, promoting positive international relations, and supporting the Nation's foreign policy objectives.

At this time, I would like to address the Subcommittee's questions.

THE RELEVANCE OF SPACE TO NATIONAL NEEDS

As mentioned above, U.S. space activities are not isolated elements of the national enterprise. Civil space activities, within which the committee includes academic, commercial and private sector activities, are a central part of the Nation's research and development portfolio and interact with the broader aspects of our nation's commerce, transportation, education, and international relations.

Our report cites numerous examples of the importance of space in addressing important national needs. For example:

- Observations of the Earth from space provide scientists and policy-makers with essential data on a wide variety of subjects, from the path and behavior of major storms to the regional consequences of global climate change.
- Space science missions have, among other discoveries, identified new effects that indicate our understanding of the basic laws of physics is incomplete. The impact of this discovery has stimulated research efforts across the country, supported by the National Science Foundation and the Department of Energy as well as by NASA directly.
- The construction of the International Space Station has provided significant experience in leading a large, international engineering project. Lessons learned in this endeavor have important implications in a future that is sure to include more frequent and complex international cooperative efforts.
- Communications satellites are a vital piece of the Nation's telecommunications infrastructure.

- The GPS system, though built and operated by the U.S. Air Force, has provided significant civilian benefits and has opened entirely new economic markets.
- Civil space efforts are an important part of the national system of innovation, which forms the basis of our economic strength and lays the foundation for our nation's continued prosperity.

MAXIMIZING THE BENEFITS FROM SPACE

The committee's report provides seven detailed recommendations which, if implemented, well maximize the civil space program's ability to benefit the Nation. In particular, I would like to take this opportunity to highlight those recommendations where Congressional leadership could have significant impact.

The committee recommends that NASA should continue its excellent program of scientific exploration and discovery, as a central component of the Nation's research and development enterprise. Continued Congressional recognition of the civil space program's role in this area, alongside agencies such as the Department of Energy, the National Science Foundation, and the National Institutes of Health, will help to keep these programs aligned with national goals and objectives.

The committee recommends several areas where NASA and NOAA should work collectively to improve our understanding of the Earth and communicate this knowledge broadly, both domestically and internationally. The Congress could assist in these efforts by continuing to recognize that the two agencies each have vital, complementary roles to play and by providing the necessary resources, guidance and flexibility for the agencies to smoothly transition new capabilities from NASA's R&D environment to NOAA's operational responsibilities.

The committee recommends that NASA establish an independent technology development program, modeled after the Defense Advanced Research Project Agency. This program should be independent of the Agency's flight programs and should focus on nascent technologies that could be broadly applicable to the space industry at large. It should support the best ideas and research, regardless of where the research team is found. In the near-term, Congressional leadership in the establishment and support of this effort will be crucial for its initial success. Over the longer-term, Congressional oversight will undoubtedly be necessary to ensure that the program remains true to these principles in the face of inevitable programmatic and budgetary pressures.

As part of its recommendation on how to use the civil space program to further U.S. strategic leadership, the committee highlights the need for reform of the International Traffic in Arms Regulations (ITAR), in order to prevent the inappropriate transfer of sensitive technologies to our adversaries while eliminating barriers to international cooperation and commerce that do not effectively contribute to national security. Congressional action is essential to this reform effort.

Finally, I would like to emphasize the necessity for the Executive Branch to align agency and department strategies. The committee recommends a broad outline for how this should be accomplished and the range of issues that should be covered. Congressional attention to, and oversight of, this effort will help to ensure that the goal of a maximally and efficiently beneficial civil space program is achieved.

DRAWING INSPIRATION FROM SPACE ACTIVITIES

As the committee states in the report, a space program that achieves its programmatic goals but does stimulate educational opportunities or inspirational moments would fail to achieve its full potential. The committee did not directly address the most effective ways to motivate future generations, but did point out that a successful space program demands advances in a wide range of activities, from biomedicine to the physical sciences to aerospace engineering.

COMMUNICATING THE RELEVANCE OF THE CIVIL SPACE PROGRAM

The committee believes that the fundamental role that space programs play in daily life has often been overlooked. Discussions of the space program are generally focused on the accomplishments of the 1960's and not on the broad, relevant program that exists today. Though seldom explicitly stated, there seems to be a national consensus that to be successful the space program needs to replicate the Apollo Program, either literally or figuratively. Our report argues that the Apollo Program is inextricably tied to the Cold War environment. The Nation needs to recognize that in our increasingly globalized world a broad, vigorous civil space program provides essential solutions to many of the challenges we face.

This completes my prepared remarks. Thank you for your attention to this report, and I would be pleased to take questions if you have them.

BIOGRAPHY FOR GENERAL LESTER L. LYLES

LESTER L. LYLES, Chair, is a consultant with the Lyles Group. He retired from the U.S. Air Force (USAF) in 2003 as commander of the Air Force Material Command at Wright-Patterson Air Force Base (AFB) in Ohio. Gen. Lyles entered the USAF in 1968 as a distinguished graduate of the Air Force ROTC program. He served in various positions, including program element monitor of the Short-Range Attack Missile at USAF Headquarters (USAF/HQ), special assistant and aide-de-camp to the commander of Air Force Systems Command (AFSC), Chief of the Avionics Division in the F-16 Systems Program Office, Director of Tactical Aircraft Systems at AFSC headquarters, and as Director of the Medium-Launch Vehicles Program and Space-Launch Systems offices. Gen. Lyles became AFSC headquarters' Assistant Deputy Chief of Staff for requirements in 1989, and Deputy Chief of Staff for requirements in 1990. In 1992, he became Vice Commander of Ogden Air Logistics Center at Hill AFB in Utah. He served as Commander of the center until 1994, when he was assigned to command the Space and Missile Systems Center at Los Angeles AFB in California. In 1996, Gen. Lyles became the Director of the Ballistic Missile Defense Organization. In May 1999, he was assigned as Vice Chief of Staff at USAF/HQ. He is a member of the National Research Council (NRC) Air Force Studies Board and served on the NASA Advisory Council. His numerous awards include the Defense Distinguished Service Medal, the Astronautics Engineer of the Year from the National Space Club, the National Black Engineer of the Year Award, Honorary Doctor of Laws from New Mexico State University, and NASA's Distinguished Public Service Medal for serving on the President's Commission on Implementing the U.S. Space Exploration Policy.

Chairwoman GIFFORDS. Thank you, General Lyles. Ms. Smith, please.

Ms. SMITH. Good afternoon, Chairwoman Giffords, Ranking Member Olson—

Chairwoman GIFFORDS. Ms. Smith, we are going to have you push your button, so we can—there we go.

**STATEMENT OF MS. PATTI GRACE SMITH, MEMBER OF THE
BOARD OF DIRECTORS, THE SPACE FOUNDATION**

Ms. SMITH. Good afternoon Chairwoman Giffords, Ranking Member Olson, and other distinguished Members of the Subcommittee. My name is Patti Grace Smith, and I am a member of the Board of Directors of the Space Foundation.

On behalf of myself and the Space Foundation's CEO, Elliot Pulham, I want to thank the subcommittee for providing the Space Foundation the honor to sit in front of you, to talk about enhancing the relevance of space to address national needs. I applaud the subcommittee for picking today to hold this hearing, on the 40th anniversary of Apollo 11 lifting off the pad on its historic mission to the Moon.

Before I begin to address the questions the subcommittee asked me to discuss, I would like to provide you with a little background on the Space Foundation. Our mission is simply to advance space related endeavors, to inspire, enable, and propel humanity. The Space Foundation was founded March 21, 1983, as an IRS 501(c)(3) organization, to foster, develop, and promote among the citizens of the United States of America, and among other people of the world, a greater understanding and awareness of the practical and theoretical utilization of space, on behalf of the benefit of civilization and the fostering of a peaceful and prosperous world.

As the global space community has evolved, so has the Space Foundation, embracing all facets of space: the commercial, including telecommunications and other satellite-based services; civil; and national security. Outside of Colorado Springs, the Space

Foundation's largest presence is in Washington, D.C., where our Government Affairs Team and our Research and Analysis Team reside.

The Research and Analysis Team works year-round in producing white papers, and most prominently, *The Space Report*, which we submitted for your review. This is our flagship publication, and *The Space Report* is a snapshot, we think, of the global space economy.

Now that I have provided some information for those of you who may be new to the Space Foundation and what we do, I will begin to address the questions. How relevant is space to addressing important national needs? What noteworthy benefits have been achieved as a result of past space related investments?

Well, let me just say right off the top, space is very relevant. It is so relevant that without it, many of us would be at a loss in conducting our daily lives. Space influences so many things, and benefits so many parts of our universe of our daily lives. Space is the bedrock of America's economic and strategic power. According to "*The Space Report 2009*," the global space economy has grown to \$257 billion. That is not an insignificant number, \$257 billion.

In the macro sense, "*The Space Report 2009*" cites, in depth, how space enables a variety of important needs, national needs. National security is enabled by space. The U.S. military could not fight as effectively and efficiently as it does without the aid of space systems. Other nations seek to emulate what we do with space, because they recognize the power and the benefit that it gives. With each new generation of military space systems, troops farther down the chain of command are given access to powerful space-enabled tactical capabilities that were once only available to senior commandants.

Governments, in the area of governance, policy-makers need accurate data, accurate data that they can rely on a variety of issues, ranging from climate to urban planning to resource monitoring. Remote sensing from space has provided this data, and will continue to do so, as long as the investment is made in new space systems for this purpose.

Take Hurricane Katrina, of the past. Satellite communications are often the only way for emergency responders to coordinate their efforts, in the absence of terrestrial infrastructure. They could not have done the job without the space assets.

Technology developed to detect stresses in the frame of the Space Shuttle has been adapted for use on Earth, and is now helping to monitor the structural integrity of bridges and other structures to ensure public safety. As far as the economy goes, financial systems rely on GPS satellites for accurate timing of transactions. Satellite-based Internet connectivity offers a practical way to bring rural populations into the Internet Age, and join the information economy, one of the Administration's goals.

Transportation. I personally know that space is integral to the next generation air transportation system being implemented by the FAA, which will enable cleaner, safer, and more efficient air travel. On the local scale, metropolitan authorities in several cities have implemented systems like the one now in place for D.C.'s Metro service, which allows passengers to check on the Internet or by telephone to see when the next bus will arrive. Innovations like

this encourage the use of public transportation, thereby reducing pollution and traffic.

The Space Report highlights a number of specific areas, it is not an exhaustive list, where everyday space products, services, and benefits are realized. And we must understand that space influences other parts of our economy and businesses that it touches, as it embraces the service it provides to our citizens. I would posit to the subcommittee that a day without space, a day without space-generated benefits for American consumers, would be a shocking, if not traumatic experience for most Americans.

And I see the red light, so let me wrap up quickly. Let me just say that in terms of how we maximize the benefits to be realized from the Nation's space activities, and the relevance of those space activities.

I want to first commend President Obama on his decision to review the entire U.S. space policy. We welcome that review. I think that the activities are pretty well aligned with our national goals and objectives. In fact, many of our goals and objectives depend on and are enabled by space assets. Having said that, however, I feel I must touch on a larger problem in order to address this question.

In order for the U.S. Government to maximize the benefits of this investment, and we all, as citizens, want to maximize the benefits of our investments in space, it must improve the acquisition of those systems. Currently, we are facing a number of gaps across the entire range of the civilian and national security space systems. From human space flight to solar radiation detection, to next generation GPS, to missile warning, to climate and weather monitoring, there are, and soon will be gaps in coverage and capability that will hamper our ability to derive benefits from space. And the gaps will eventually force us, if we don't act, to be more reliant than we already are on foreign space systems, and that would be not a good thing, I don't think.

Fourthly, we need to modernize the export control regime. That is an area that has been begging attention for some time. The Space Report 2009 shows that the commercial sector now makes up 68 percent of the global space economy, 68 percent. So, regulatory changes, such as export control, have the potential of generating considerably more R&D funds than direct investment by the government.

Is it inspirational? Absolutely. It is essential. All you had to do was be in the desert of Mojave in 2004, and see the thousands of people who assembled there, young and old, from all over the country, all over the world, to see their eyes light up with the first flight of a private human space flight vehicle, to know how exciting it is, and to see how the younger generation, the Gen Y generation, are so excited, so passionate about engaging in space in a different way. Look at the workforce that SpaceX has put together in California, largely made up of Gen Ys, and they are there because they feel that we are on the brink of something really exciting. They want to be a part of it.

So, finally, how well does the public understand? Not very well. And I would suggest that we need to look at the tools that the younger generation uses to communicate. They are not the traditional tools that we used, or others like us. They are Facebook.

They are other forms of technology that they are very, very adept at. It has become their new telephone. They communicate messages, groups like Netroots and others around the country are communicating all day in cyberspace, and can carry messages that we cannot carry otherwise. So, that is an area that I am very, very concerned about, very interested in. We need to move away from audiences that have space on the agenda, speaking to space choirs. We have got to broaden that audience to a broader public.

So, with that, let me stop here, and just say to paraphrase Arianespace's CEO, Jean-Yves Le Gall, when he said recently: "Launches speak louder than words." We have got to get on with it. That will tell the story better than anything will.

I welcome any of your questions at the end of this. Thank you.
[The prepared statement of Ms. Smith follows:]

PREPARED STATEMENT OF PATTI GRACE SMITH

Good morning Chairwoman Giffords, Ranking Member Olson, and distinguished Members of the Subcommittee. My name is Patti Grace Smith and I am one of the Board of Directors for the Space Foundation. On behalf of myself and Space Foundation CEO, Elliot Pulham, I want to thank the Subcommittee for providing the Space Foundation the honor to sit before you today to talk about enhancing the relevance of space to address national needs.

I applaud the Subcommittee for picking today to hold this hearing, on the 40th anniversary of Apollo 11 lifting off the pad on its historic mission to the Moon.

Background

Before I begin to address the questions the Subcommittee asked me to discuss today, I'd like to provide the Subcommittee with a little background on the Space Foundation.

Our mission: *To advance space-related endeavors to inspire, enable, and propel humanity.*

In 1983, a small group of visionary leaders in Colorado Springs saw a need to establish an organization that could, in a non-partisan, objective and fair manner, bring together the various sectors of America's developing space community and serve as a credible source of information for a broad audience—from space professionals to the general public. The Space Foundation was founded March 21, 1983, as an IRS 501 (c)(3) organization "to foster, develop and promote, among the citizens of the United States of America and among other people of the world . . . a greater understanding and awareness . . . of the practical and theoretical utilization of space . . . for the benefit of civilization and the fostering of peaceful and prosperous world."

As the global space community has evolved, so has the Space Foundation—embracing all facets of space—commercial (including telecommunications and other satellite-based services), civil, and national security. In fact, the Foundation is one of a few space-related organizations that embrace the totality of this community rather than focusing on a narrowly defined niche.

In the 26 years since its founding, the Space Foundation has become one of the world's premier non-profit organizations supporting space activities, space professionals and education. The Foundation's education programs have touched teachers in all 50 U.S. states and Germany. It sponsors and conducts the premier events for space professionals anywhere in the world today: the National Space Symposium, the Strategic Space Symposium in Omaha and the Space Business Forum in New York City.

Outside of Colorado Springs, the Space Foundation's largest presence is in Washington DC. This is where our government affairs team and our Research and Analysis (R&A) team reside. Our government affairs team are not lobbyists, but rather work to promote and educate decision-makers about space *writ large*. They hold informational and educational briefings on a variety of civil, commercial and national security space issues. The R&A team works year-round in producing white papers and most prominently, the annual *Space Report*. *The Space Report* is the Space Foundation's "flagship" publication. *The Space Report* is a snapshot of the global space economy.

As I mentioned earlier, my role with the Space Foundation is as a member of the Board of Directors. Our current chairman is retired General Tom Moorman Jr. USAF (Ret.), our Vice Chairman is Dr. Bill Ballhaus, our treasurer is Mr. Lon Levin and our secretary is Mr. Marty Faga. I'd like to point out to this committee that its one-time Chairman, Bob Walker, was also on our board and even served as its Chairman.

Now, that I've provided some information for those of you who may be new to the Space Foundation and what we do, I will begin to address the questions presented to me.

How relevant is space to addressing important national needs, and what noteworthy benefits have been achieved as a result of past space-related investments?

I am not saying anything new when I say to you that space is absolutely essential to all facets of modern human existence. Space is the bedrock of America's economic and strategic power. According to *The Space Report 2009*, the *global* space economy has grown to \$257 billion, a number that is not insignificant.

In the macro-sense, *The Space Report 2009* cites in-depth how space enables a variety of important national needs:

- *National security*: The U.S. military could not fight as effectively and efficiently as it does today without the aid of space systems. Other nations seek to emulate this capability because they have seen how powerful it is. With each new generation of military space systems, troops farther down the chain of command are given access to powerful space-enabled tactical capabilities that were once only available to senior commanders.
- *Governance*: Policy-makers need accurate data on a variety of issues ranging from climate to urban planning to resource monitoring. Remote sensing from space has provided this data and will continue to do so as long as the investment is made in new space systems for this purpose. When natural disasters such as Hurricane Katrina occur, satellite communications are often the only way for emergency responders to coordinate their efforts in the absence of terrestrial infrastructure. Technology developed to detect stresses in the frame of the Space Shuttle has been adapted for use on Earth and is now helping to monitor the structural integrity of bridges and other structures to ensure public safety.
- *Economy*: Financial systems rely on GPS satellites for accurate timing of transactions. Satellite-based Internet connectivity offers a practical way to bring rural populations into the Internet age and join the information economy—one of the Administration's goals.
- *Transportation*: I personally know that space is integral to the Next Generation Air Transportation System being implemented by the FAA, which will enable cleaner, safer, more efficient air travel. On a local scale, metropolitan authorities in several cities have implemented systems like the one now in place for D.C.'s Metrobus service, which allows passengers to check on the Internet or by telephone to see when the next bus will arrive. Innovations like this encourage the use of public transportation, thereby reducing pollution and traffic.

Additionally, *The Space Report 2009* enumerated an exhaustive list of 'everyday' space products, services and benefits. Some of the most prominent:

- Weather prediction/disaster mitigation
- Resource exploration/exploitation
- Erosion monitoring and management
- Global communications
- Guidance/navigation/timing
- Population forecasting
- Attaining a better understanding of our place in the universe
- The numerous spin-offs that have directly enriched the lives of people all over the world. Investment in space constantly generates new products and spinoff technologies that U.S. companies can build and market.

In *The Space Report 2009*, one new emerging area that more and more Americans are using via their iPhones and other hand-held PDAs is that of "geoinformatics." This is a very unique convergence of GPS, and remote sensing to enable the user to have real-time location-based content. The average user of such capabilities will

be blissfully unaware that space-based systems helped him find a flower shop at the last minute on his anniversary, he'll just be glad he has it and soon will take it, much like all other space enabled capabilities, for granted.

I would posit to the Subcommittee that a "day without space"—a day without space generated benefits for American consumers, would be a shocking, if not, traumatic experience for most Americans.

The inspirational value of space activities is equally important, but I will address that point later in my testimony.

What does the Space Foundation recommend be done to maximize the benefits to be realized from the Nation's space activities and the relevance of those space activities? How important is it for those activities to be aligned to national goals and objectives?

First off, I want to commend President Obama on his decision to review the entire U.S. space policy. Like each of his predecessors since President Eisenhower, the President realizes the importance of space and is making space a priority.

Secondly, I feel that most of our space activities are pretty well aligned with our national goals and objectives. Whether decision-makers realize it or not, many of our goals and objectives depend on and are enabled by space assets.

Thirdly, however, I feel I must touch upon a larger problem in order to address this question. In order for the U.S. Government to maximize the benefits of its investment in space, it needs to improve the acquisition of those systems. They should be developed faster and with more management discipline. We all know of space systems that have been over budget and behind schedule.

Currently we are facing a number of gaps across the entire range of the civilian and national security space systems. From human space flight, to solar radiation detection, to next generation GPS, to missile warning, to climate and weather monitoring, there are, or soon will be gaps in coverage and capability that will hamper our ability to derive benefits from space. These gaps will also force us to be reliant on foreign space systems. I also would say that it is beyond a coincidence that we are seeing such a systemic gap problem in so many areas. Once we get back to better management of space systems, we can deploy more systems more often and accrue more benefits from them.

Fourthly, we need to modernize the export control regime to allow U.S. space companies to compete effectively in the global marketplace. This is one area in which the U.S. already generates a positive trade balance, but it could be significantly larger and would provide more funds for U.S. companies to develop new jobs and innovations that help both the domestic space industry and the broader U.S. economy. *The Space Report 2009* shows that the commercial sector now makes up 68 percent of the global space economy, so regulatory changes have the potential to generate considerably more R&D funds than direct investment by the government.

How important is the inspirational component of the Nation's space activities, and what would be the most effective ways to use space activities to motivate emerging generations of Americans to pursue studies and careers in science and engineering?

In one word: essential.

Let me put this in perspective for the Members of the Subcommittee. While most of you have vivid memories of the Apollo moon landings, I am willing to bet you that the vast majority, if not all your staffers do not. Let alone were they even alive when the landings occurred. The post-Baby Boom generations do not have the memory of the Apollo, but instead the *Challenger* or *Columbia* disasters.

Furthermore it is *not* like the 20 and 30 somethings of today do not care about space. They do. These people are the most hi-tech infused generation in the history of humanity. However, being active or even somewhat participatory in the U.S. Government's space enterprises do not feel like a viable option. Instead they are going to other places where they can feel like they are making a difference. For example the amount of young people who are involved with Burt Rutan's spaceship developments on behalf of Virgin Galactic and future customers, the early Gen Y workforce SpaceX has assembled or elsewhere like the Google Lunar XPrize show that space is relevant and is important to young adults.

I am also happy to report to the Subcommittee that The Space Foundation employs a variety of programs and initiatives that educate and raise awareness about the importance and impact of the space industry:

Space Foundation education programs support teachers and Pre-K–12 students with standards-based curriculum that integrates science, technology, engineering, and mathematics (STEM) into all content areas:

- *NEW HORIZONS Space Education Program*, a community-centered, science enrichment program that infuses STEM education into a community through student enrichment programs, teacher workshops, field trips, town-hall meetings, and astronaut and space professional visits.
- *Space Discovery Institute*, week-long, intensive, graduate-level, in-residence courses that provide Pre-K–12 educators with space-related STEM education knowledge and content that is instantly transferable to the classroom; participants can earn continuing education credits, graduate credits, or work toward a master's degree in multiple related disciplines.
- *STARS Program (Science, Technology, and Academic Readiness for Space)*, a hands-on science enrichment program based on each school's academic needs.
- National Science Standards Lesson Bank, free downloadable Pre-K–12 national science standards-based lessons.
- *Teacher Liaisons*, advocates for space science education who: receive Space Foundation training and resources to further integrate space into their classrooms; participate in workshops and education programs at the National Space Symposium; and can receive specialized Space Foundation and NASA training with optional graduate-level credit, exclusive professional development experiences with optional continuing education credit, and special space-oriented student programs created just for them.
- *Space Career Fair*, an annual event in conjunction with the *National Space Symposium* that provides students and transitioning military personnel opportunities to network with the largest employers in the space industry, to submit resumes, and, occasionally, to interview for jobs.
- *Jack Swigert Aerospace Academy*, an aerospace-focused public middle school created and managed in conjunction with Colorado Springs School District 11 that drives STEM proficiency through a space-related curriculum, enhanced on-site laboratories and learning opportunities, and involvement with Space Foundation programs.

How well does the public understand the relevance of the Nation's space activities to meeting national needs and realizing societal benefits? Is there a need to "get the message out" on the relevance of those space activities and the benefits to be derived from our space-related investments? If so, how can that message be most effectively communicated?

Not very well. Far too many audiences are made up of the "space choir."

One of the ways the Space Foundation communicates this message to the larger public is by means efforts such as the Space Foundation's Space Certification Program, which enables companies to show that their product has a space technology heritage. This provides benefits in both directions, enabling the company to show off its high-tech space pedigree and by illustrating in a tangible manner the way in which space activity improves the lives of the ordinary consumer.

At the end of this month, your colleagues on the Aviation Subcommittee will be holding a hearing on next generation navigation. Undoubtedly there will be a major portion of this hearing focused on satellite-based capabilities. I think this highlights just how almost invisible and ubiquitous space has become.

I think the public at a very basic, fundamental level "gets it", but not much beyond that. The public gets understandably frustrated when they hear of budget and schedule problems. On the other hand, one only has to look at the interest from the general public in the Mars rovers, or the recent, and final, Hubble mission or to have witnessed the thousands, young and old, that assembled in the Mojave desert in 2004 to witness the historic first private human space flight as evidence that there is a thirst and an interest in what we do in space.

Honestly, I'm not sure a message campaign is the best way to move forward. We live in an age of almost constant message barraging. From pop-ads on the Internet, to seemingly constant political campaigning, I think a "command and control" ad campaign would not do much. If anything it could have the opposite reaction.

These younger generations are so technologically saturated, the space industry needs to take advantage of that and utilize these new channels to reach out and get kids excited about space. If kids get excited about it, the rest of the public will follow. I would also mention that you'd be surprised how much things like Facebook can help spread enthusiasm about space. The peer-to-peer discussions and sharing of information and enthusiasm for space is something that can surpass an ad campaign. Witness astronaut Buzz Aldrin's recent use of web 2.0 technology when he teamed with rapper Snoop Dogg to create "Rocket Experience" message about space.

For the larger public, not to sound flippant, but I think simply executing missions successfully will do more to help than anything else. I must paraphrase Arianespace CEO Jean Yves Le Gall, when he said recently, "launches speak louder than words." After all this is a generation that is about achieving things that have never been done, working as hard as necessary to achieve a breakthrough and talking less and doing more.

Conclusion

I again want to express on behalf of the Space Foundation our deep appreciation for allowing us to come before you today. I stand ready to answer any your questions.

Thank you.

BIOGRAPHY FOR PATTI GRACE SMITH

Patti Grace Smith served as Associate Administrator for Commercial Space Transportation for the Federal Aviation Administration, U.S. Department of Transportation, where for eleven years (ending February 2008) she headed the line of business responsible for licensing, regulating, and promoting the U.S. commercial space transportation industry. Smith joined the Department of Transportation in 1994. Smith has over 28 years of experience and knowledge of the Federal Communications Commission (FCC), the Federal Aviation Administration (FAA) and the U.S. Department of Transportation (DOT).

In an era of unprecedented private sector progress toward commercial human space flight, Smith worked hard to foster an environment where safety always comes first and innovation can flourish. During her career at the FAA and DOT, Smith was instrumental in the growth and change that the U.S. commercial launch industry has experienced, facilitating both technological and infrastructure developments and initiating and fostering greater cooperation and partnerships between aviation and space functions in the Agency. During her service at the FAA, key milestones were achieved that include the Mojave Air and Spaceport becoming the first inland Commercial Spaceport licensed by the Agency, and the launch of the X-Prize winning, historic SpaceShip One, a launch licensed by the FAA. Smith also oversaw the development of rules for human space flight mandated by congressional passage of the *Commercial Space Launch Amendments Act of 2004*.

Under Smith's leadership at the FAA Office of Commercial Space Transportation, the FAA became the recognized global leader in private human space flight. Smith initiated and helped forge partnerships with the Air Force on common launch safety standards, and kept safety, regulatory matters and insurance issues constantly in the public forum. She worked closely with FAA lines of business to draw on aviation expertise where appropriate to space issues and to address the impact of space flight on the National Airspace System. Smith was named by *Space News* as one of the top ten people in the U.S. space sector.

Smith also held positions in the private sector at the National Association of Broadcasters, Westinghouse Broadcasting Corporation, and Sheridan Radio Network; and in government at the Department of Defense and the Federal Communications Commission; and the Senate Commerce Committee. Smith is currently an aerospace consultant with Patti Grace Smith Consulting working with Virgin Galactic (The Virgin Group), CSSI, Inc., the Tauri Group and a number of other aerospace companies. She is on the board of SpaceDev (now Sierra Nevada), Space Foundation, American Astronautical Society, the American Bar Association's Air and Space Law Forum Board; the X Prize Advisory Committee Board, and the Conrad Foundation.

She is the recipient of numerous awards for her accomplishments in communications, external relations, and commercial space transportation. She is a regular speaker at a number of industry events.

Chairwoman GIFFORDS. Thank you, Ms. Smith. Ms. Myers, please.

STATEMENT OF MS. DEBORAH ADLER MYERS, GENERAL MANAGER, SCIENCE CHANNEL, DISCOVERY COMMUNICATIONS

Ms. MYERS. Thank you so much for inviting me here today. It is a great honor.

Since we are a media company, today, I am going to be sharing some video clips with you, so that we can help bring the discus-

sions to life. Our audience loves space programming, and I think it is because space captures imaginations and allows people to dream, really to think outside themselves, and marvel at the unknown.

Discovery is the brainchild of John Hendricks who, 24 years ago, believed that Americans would watch a network devoted entirely to programming that captures people's innate sense of curiosity of the world. He was personally inspired by a lifelong fascination and a love of space. Well, today, Discovery Communications, and especially, the team I am proud to lead as General Manager of the Science Channel, is rallying around President Obama's call to restore science to its rightful place. That call to action was absolutely music to our ears.

There is a barrier simply in the word science. Many of us struggled with science classes and children, and the cliché that we struggle against constantly is that science is dry and it is boring. And the key to developing a larger audience is igniting people's imagination, and encouraging them to be endlessly curious, because science really is creative. It improves your life every single day.

So, here on the Science Channel, we are experimenting with brand new ways to immerse and make people excited about science, and to create content and programs that immerse people, exactly what you were saying, on air, online, in Facebook, on Twitter, bringing all this great content to where people will consume it, and connect and explore it. We are developing alternate reality games, and we are even bringing this content into our classrooms. We are calling this Science 360°, and space is a really important part of this.

We have hosts and we have experts that include stars in their field, like Dr. James Garvin, who is the Chief Scientist at NASA Goddard, Dr. Michio Kaku, who is the co-creator of the string theory. They are our popular hosts, and people love the programming, when they bring space sciences and physics to life.

And we also have a campaign that I would like to share with you, called the *Brains of Science*, and it features role models like astronaut Buzz Aldrin, who seek to inspire a whole new generation, and get them excited about why they choose their careers, especially Buzz, as an astronaut. Take a look.

[Video]

So, our job is to find great science communicators in space and science, and help them bring their message to life. But on top of that, we are also seeking out "A" list celebrities who have a passion for science, and can bring even more people to the genre, because they bring in a larger ground. Whoopi Goldberg, for example, who is passionate about inspiring a love of science and learning in women and young girls. She is creating a science game on-air and online.

And we reach out to science organizations that have traditionally worked in their own silos, and we are working to bring them together. For example, we came to NASA with a big idea. Academy Award-winning actor Morgan Freeman has this lifelong passion for space, and he is fascinated by the great mysteries of the universe. So, this new alliance between Morgan Freeman and NASA is re-

sulting in an eight part series that we are very proud to be launching in April, and this is executive produced and hosted by Morgan Freeman.

[Video]

Space programming is one of our most popular genres that we run on the network, and we sprinkle this content into a lot of our programming. When we cut back on space coverage, we hear about it immediately from our viewers, and boy, are they vocal. In fact, so many people crave this information that we devote an entire week of it in our annual Space Week, which rates highly on-air and online, and people write in and Twitter in, and tell us all the time.

NASA also played a critical role in Discovery Education's 3M Young Scientist Challenge. They hosted this year's annual middle school competition, and this a wonderful challenge that is designed to inspire the next generation of great science communicators. Will Smith is the producer of our special on the Young Scientist Challenge, and he personally produced this spot to run across in our schools. Take a look.

[Video]

He was wonderful to work with, and not many people know that he was accepted to MIT. He wanted to be an engineer, and he is passionate about space and engineering, and finding new ways to get young people involved in considering that it is school to be smart, and ways to go into careers in space and in science.

We also bring original content directly into our schools nationwide through our Discovery Education division. Discovery Education Streaming offers classrooms thousands of science videos and digital content that teachers can easily integrate right into their classroom lectures, and they are able to customize the way that they are able to teach kids. Are they better to learn through hearing or reading, or bringing things to life? It is a wonderful tool.

So science and space, it is alive, it is optimistic, and it is the future. So, I want to express my sincere thanks for allowing Science Channel and Discovery Communications to show you our passion for space and all genres, really, of science.

We are proud to answer the call and be a champion for this critical movement to bring science back to its rightful place in the United States.

Thank you, and I am happy, later on, to answer any questions, because there is so much more to tell you about. Thank you.

[The prepared statement of Ms. Myers follows:]

PREPARED STATEMENT OF DEBORAH ADLER MYERS

Chairwoman Giffords and other distinguished Members of the Subcommittee on Space and Aeronautics, thank you for your invitation to testify today on this important topic. I'm proud to represent Discovery Communications and discuss our efforts to further the excitement and endless possibilities of science in general, and space in particular.

Discovery is the brainchild of John Hendricks, who, in 1985, believed that Americans would watch a network devoted entirely to documentary and non-fiction programming that captures people's innate sense of curiosity of the world. He was personally inspired by a lifelong fascination and love of space—he grew up in Huntsville, Alabama, home of NASA's George C. Marshall Space Flight Center, watching in awe as man achieved the impossible.

Today, Discovery Communications, and especially the team I'm proud to lead as General Manager of Science Channel, is rallying around the call to action issued by President Obama on April 27th. He challenged our nation to restore science to its

rightful place because science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been before.

That call to action was music to our ears. For the last year, we have been working on a four-part strategy to get people of all ages excited about the sciences—especially space and its related fields.

The strategy includes:

- 1) Experimenting with various ways to make science exciting and entertaining;
- 2) Finding and training strong science communicators including the “rock stars” of science and pop culture and training a new generation of science communicators;
- 3) Aggregating science by bringing together traditionally siloed organizations to create partnerships and exchange information;
- 4) Delivering all of this content and information in a way that allows adults and kids to access it—on air, online, in gaming, on phones and digital devices not yet created and, in schools.

The ability to connect our science programming on all these platforms is what we call Science 360°. I'll go into each of these in a little more depth.

The first part of this strategy is to reinvent how we talk about the field and make it entertaining. There is a barrier simply in the word “science”—many of us struggled with science classes as children, and in fact, studies show scientific engagement among students dips in middle school. The cliché we struggle against is that science is boring and dry and something I might not understand. The key to bringing it to a larger audience is sharing the great stories and creativity of science. We want to ignite the public's imagination, engage them in the quest for answers, and encourage them to embark on journeys to solve scientific puzzles. We bring science to life by making it relevant to people's everyday lives, celebrating the ingenuity in all of us.

Science Channel's mission is to be the creative magnet for all people—adults and kids who share a passion for innovation and the sciences—from space, technology and engineering to physics and the Earth and natural sciences. Our job is to keep experimenting to find the best, most creative ways to bring these genres, stories and challenges to life by entertaining and inspiring. We believe that if you capture people's imaginations, they will connect and engage.

The second part of the strategy is finding and training strong science communicators, those who have a gift for making science accessible and relatable. They make the hard stuff easy to understand and have an enthusiasm for getting people engaged. They are our hosts and experts—the rock stars of science, like Jim Garvin, chief scientist at NASA Goddard who participates in many of our space programs; Dr. Michio Kaku, co-creator of String Theory who explains black holes, time and the physics of the universe; and Dr. Basil Singer who takes us on space adventures. Sometimes they share their stories in short-form segments like our Brains of Science Campaign, which features people from all the sciences talking about their work and why they entered their chosen field. It's a great way to get people excited about different careers in science.

To bring an even larger audience to the Science Channel, we seek out “A-list” celebrities who have a passion for science and space and want to share that passion with an audience and particularly kids. Whoopi Goldberg, who is passionate about inspiring a love of science in women and young girls, is doing a trivia-based game show and a companion online game that can be played simultaneously at home. We're also working with Morgan Freeman, who has a love of space, and Will Smith, who was accepted to MIT before he decided to pursue his acting career. Celebrities are just one of the ways we bring new audiences to our networks. We entice new viewers with credible, enthusiastic celebrities and hold their attention with the entertaining information we present.

In addition to the current superstars of science and Hollywood celebrities, Science Channel is actively seeking out and training new science personalities. We created a science talent school where we take rising stars in the major fields of science, including Dr. Jennifer Eigenbrode from NASA and Dr. Hakeem Oluseyi from the Florida Institute of Technology, and groom them to be science television communicators. We will then use them throughout our programming and in some instances create series or specials around their area of expertise. Currently we are training 10 people a year and we hope to expand the program.

The third part of our strategy is partnerships, which are critically important to our success. Half of our battle is keeping track of all the amazing work going on around the world so we can bring our audience breakthroughs and innovations in all fields of science. Reaching out to science organizations that have been individual

silos and working to bring them together and share their work with the public is a big priority for us. We work with research centers, universities, science media, scientists and leading organizations—anyone who wants the public to understand and celebrate their work. Our partnership with NASA is an example of a success story.

We came to NASA with a big idea. Academy Award-winning actor Morgan Freeman has a lifelong passion for space. He's fascinated by the great mysteries of the universe and trying to find answers to questions that have been asked for all of civilization, like: Is there other life in the universe? How did we get here? Is time travel possible? We wanted to bring Mr. Freeman's passion for the topic to our audience and asked NASA if they would host us for a day-long brainstorm about their current research and planned missions. They discussed with us the profound implications of what their upcoming missions could tell us about our world and ourselves. The result of that conversation is an eight-part series we're launching in April hosted and executive produced by Morgan Freeman.

NASA also played a critical role in our Discovery Education 3M Young Scientist Challenge, an annual competition for middle school students designed to inspire the next generation of great science communicators. The finals of last year's competition were held at NASA Goddard Space Flight Center. The inspiration our students felt when they worked for several days inside NASA alongside working scientists will forever change their lives. The event was also filmed by Science Channel for a television special, executive produced by Overbrook Entertainment, which aired earlier this year.

Science Channel also had the privilege of partnering with NASA to film their amazing achievements and then bring them to the viewer at home. Together we created two live television specials in the past year, tied to their Mars and Hubble missions. In addition to traditional televised programs, these specials also spoke to audiences in media formats that they prefer, with extensive web sites that allowed people to explore at their own pace and new media tools, including NASA scientists posting Twitter updates and answering viewers' questions in real time as the actual missions unfolded. We also aired short-form content throughout the day with mission updates.

Space is one of many genres that we program on Science Channel, and our viewers tell us that it is one of their favorite subjects. Beyond our anecdotal evidence, our ratings research confirms that our viewers love this genre—last quarter, space programming rated 25 percent higher than our network average. Our television shows cover a wide range of space and exploration topics—from space travel to string theory and wormholes to black holes. We start from the Big Bang beginning and go right to the edge of what we know is possible in the future. We've brought back classics like *COSMOS* and created our own original series like *When We Left Earth* and *Meteorite Men*.

When we decrease our space coverage we hear about it immediately from our viewers, so space-related topics and segments are also woven into many other series and specials. In fact, so many people crave space programming that we devote an entire week of our evening television schedule to our annual *Space Week*, which rates highly on air, and online. We launched a new series during *Space Week* this year called *Exodus Earth*, where we explored what would happen if for whatever reason we decided to leave Earth. The series looked at where would we go, how would we live and what would be waiting for us. At Science Channel we constantly experiment with different kinds of story-telling devices to bring topics to life.

We're also bringing our content to teachers and students. Reaching tomorrow's scientists today is critical, so Discovery Communications' Education Division, which combines scientifically proven, standards-based digital media and a dynamic user community to empower teachers to improve student achievement, has created services to engage students in scientific inquiry.

Utilizing America's broadband network, Discovery Education *streaming*, Discovery's flagship service, offers American classrooms thousands of science videos, delivered via the Internet, correlated to state standards, and in three- to five-minute clips that teachers can easily integrate into their classroom lessons. In addition, Discovery Education also produces specific digital content services for both elementary and middle school classrooms, called Discovery Education Science, which propels school curricula with standards-based digital content, virtual labs, simulations, and more. Together, these services help educators encourage exploration, stimulate critical thinking, and deepen understanding of science.

While the promise of digital content to positively impact student engagement in science is great, any plan to integrate digital content or other educational technologies into classroom curriculum is doomed to failure without ongoing professional development, supported by school districts. Discovery Education works directly with school districts to provide professional development strategies that model best prac-

tices: namely, strategies for providing students with consistent feedback, utilizing cooperative learning structures, embedding digital content into instruction, and promoting the creation of content for the web in an effort to better engage 21st century students in science instruction.

Advisory board

Underpinning all that I've discussed here today is the world-class board of advisors led by our Chairman John Hendricks. Members include representatives from the Massachusetts Institute of Technology, the National Science Teachers Association, the Florida Institute of Technology, Hudson Alpha Institute for Biotechnology, The Franklin Institute, National Academy of Sciences, Electronic Arts, Popular Science, and, of course, NASA. Our advisors play a critical role in making sure we know about amazing research and technologies. They help us find new science communicators. They assist us with developing programming and they help us shape our efforts to do even more in the areas of science literacy and education.

In conclusion, I want to express my sincere thanks for allowing Science Channel and Discovery Communications to show you our passion for space and all genres of science. I think our audience loves space programming because it's a quest to discover the great mysteries of our time. It allows people to dream, to think outside themselves, to wonder about what else there is in the universe and to marvel at the beauty and fragility of the world in which we live.

Science isn't just something you learn in school—it's alive, it's optimistic, it's the future. We're proud to answer President Obama's call and to be a champion for this critical movement to bring science back to its rightful place in the United States. Thank you.

BIOGRAPHY FOR DEBORAH ADLER MYERS

As General Manager, Science Channel, Debbie Myers leads the development, production, scheduling, research, marketing, digital and communications efforts, with direct responsibility for driving the revenue and ratings for the brand. In her role as Executive Vice President of programming for Discovery Emerging Networks, Myers also spearheads the development, production and programming units for Investigation Discovery, Military Channel and HD Theater, some of the fastest-growing networks in cable. Charged with commissioning and creating brand-defining series and specials for all four networks, Myers also leads the effort to attract top scientists, experts and personalities to appear on air and online.

Since joining the Emerging Networks group in March 2008, Myers has launched more than 40 new series, including 20 for Science Channel, and secured major programming deals with Morgan Freeman, Whoopi Goldberg and Paula Zahn.

Myers first joined Discovery Communications in June 2005 and has been responsible for thousands of hours of content across all of Discovery's networks, including the launch of TLC's franchise *Little People, Big World*. As Vice President of production and then Senior Vice President of programming, daytime and fringe, for TLC, Myers oversaw the launches of *LA Ink*, *Say Yes to the Dress*, *Big Medicine*, *Take Home Chef* and *Take Home Handyman* and managed continuing series including *What Not to Wear*, *Miami Ink* and *A Baby Story*.

Prior to joining Discovery, Myers ran her own production company, Aha! Entertainment, where she created series and pilots for NBC, Paramount, VH-1 and 20th Television. Myers was also instrumental in launching several cable networks, including E! Entertainment and Oxygen. She served for eight years as Vice President of programming and development at E!, where she created and ran 17 signature series, including the Emmy Award-winning *Talk Soup* and *E! News*.

Myers is the former Governor of the Production Executives group of the Academy of Television Arts and Sciences.

Chairwoman GIFFORDS. Thank you, Ms. Myers. We appreciate that. Well, speaking of new media and Twittering, and MySpace, and blogging, one of the best space technology folks, that we are going to hear from next, is Miles O'Brien.

STATEMENT OF MR. MILES O'BRIEN, JOURNALIST

Mr. O'BRIEN. I have been tempted to tweet this whole time. I have been tempted to tweet, but I probably should pay attention.

Madam Chairwoman, it is nice of you to invite an unemployed journalist to this event. Of course, it is harder and harder to find employed journalists, especially in my beat. I have been covering space for more than 17 years now. I am a pilot and an airplane owner, and I come to the space beat as an enthusiastic supporter of all things that fly, well, maybe not mosquitoes.

I appreciate the adventure that is inherent in exploring a frontier. In fact, I spent several years trying to convince NASA to give me a ride in the Shuttle to the Space Station, and I did have a deal that we would have announced about a week or so after the safe landing of Columbia, in February of 2003. Unfortunately, that was a different story.

In all, I have covered about three dozen Shuttle missions, including John Glenn's flight, with no less than Walter Cronkite as my co-anchor. And I got to ask him a lot of important questions, like would you like a little more cream in that, sir? Actually, when I first met him, we were talking about how we would cover this mission together, and I made the mistake of telling him he didn't need to worry about the Shuttle, that I would handle that, and all he had to do was regale us with tales about the Mercury 7 days. He was visibly upset, and he asked me to get him a report on every Shuttle mission, all the who, what, when, where, why, whether the mission succeeded or not, and I asked him if he wanted that for all 94 missions at that time. And his eyes were wide open. He said there have been 94 missions? And to paraphrase Lyndon Johnson, if we have lost Walter Cronkite, we have lost the Nation.

Now, some of this has to do with novelty. Lindbergh's flight was news. When I flew the Atlantic in a little plane a few years ago, no one cared, except for my wife. John Glenn's first mission was news, and certainly, the intrepid crew of Apollo 11 was the obvious lead story for days 40 years ago today.

But I just came last night from covering the launch of the 127th Shuttle mission, and this room, of course, is a choir, but who outside of this room knows what they are doing, or who is aboard the Space Shuttle right now, or that there is a mission at all? Now, part of the problem is NASA has served up a mission that seems mundane, I emphasize seems, no more interesting than watching airliners depart a national airport, and in fact, the Shuttle was sold to Congress with the promise that it would make space travel cheap and as easy as airline travel. And, as if to make it all seem real, even though it wasn't, the Agency sort of went out of its way to make it look ho-hum. Then, of course, Challenger happened, and the story changed.

But there is also another factor at work here. Apollo is NASA's greatest accomplishment, to be sure. It is also its biggest curse, in a sense. It was a story that sold itself, and in fact, the media frenzy at the time was so great, in those heady Moon race days, that the Agency really had to build some walls and moats, and hire PR people who were more like the palace guard. And unfortunately, a lot of that culture remains in place. And that is aided and abetted by the astronauts who live in the palace, and only open the doors and let us in for brief audiences, usually on their own limited terms.

Now, the sad irony is, these people are some of the most amazing people I have met. There is even twin commanders on the Shuttle,

I hear, and if they would just get out of the palace, and let the public in a little more, I think they would sell the program better than any piece of hardware we are latching onto the Space Station.

Which leads me to the guys and gals who make the hardware, the engineers. God love them. They make the magic happen, but they just don't get the communication thing. The public affairs mission is simply not a priority within NASA. Matter of fact, it isn't even on the list of requirements for missions. Forty years ago, they were fighting to keep the cameras off the Apollo spacecraft. After all, they simply just add weight. There was nothing in the mission requirement for it.

Now, imagine if that thinking had prevailed. It might not have prevailed, but that some kind of debate rages on, as they are designing the Orion capsule. Public affairs should always be a mission requirement, and a high priority requirement. And I know that this committee has recognized this. NASA Authorization Bill of 2008 gets into this issue of participatory exploration, and how important that is.

We have got to take that first step and go further with it. You know, the TV cameras are worth their weight in gold, because they let the public participate in the exploration. And let us not forget who is paying the bills here. You know, you leave the public behind, there won't be any missions, much less requirements for missions.

Which brings me to some of the places where NASA is doing a good job engaging the public. You know, think of those little rovers, Spirit and Opportunity, explore Mars, making the Energizer Bunny look like a piker. Now, this is an example where the scientists and engineers have natural common ground with the PR folks. The images from the other worlds feed the scientists as well as the public interest, and it happens simultaneously. How brilliant is that?

You know, this all started, you will recall, with Pathfinder years ago, the first big Internet webaganza, if you will. Average people could see the images as they came down from Mars at the same time as the scientists at the Jet Propulsion Lab. They were peeking over the scientists' shoulder as they were doing their job exploring. That is heady stuff. That is engaging.

That trend has continued. Phoenix became the first spacecraft to tweet. It was the idea of a former colleague of mine, Veronica McGregor. She is at JPL now. She got the idea from, where else, her kids, as a way to let people know about the landing during the Memorial Day weekend. It happened on a Sunday, Memorial Day. She just thought it might be one way to make sure people knew it happened. Well, she got a tiger by the tail. The thing went viral, tens of thousands of followers, tons of detailed questions from space geeks the world over, but it broadened beyond the choir very quickly, and that is the magic of this new media, is that in an exponential fashion, friends tell friends, and on it goes, and suddenly, the public is engaged in a mission they may not have heard anything about. And were interested, with questions that Veronica, frankly, said were better than she got from the mainstream media, I must confess.

Now, to their credit, in Houston, they saw this, and they saw how potent it is, and astronaut Mike Massimino became the first

person to tweet from space, in between space walks to fix the Hubble Space Telescope. Now, that is a giant leap for webkind.

And speaking of Hubble, the granddaddy of all missions where science is also a good PR message, look what happened when NASA tried to cancel that mission to repair Hubble. Engagement led to anger, and ultimately activism, and it changed things.

So, that brings me to my final point. The agency is dispersed geographically by centers of expertise, by geography. It doesn't really speak with one voice. It doesn't have a cohesive public relations strategy. Public affairs here in Washington needs to have more authority to direct these far-flung PR operations, which kind of answer to their flowcharts in a balkanized fashion, and frankly, PR, public affairs here in Washington, needs a budget. The current budget is zero right now. And you get what you pay for.

There is no doubt the mission is the message, ultimately, and NASA needs to be taking us places where we haven't been before, and that will capture the fancy of a jaded public. But the message is also part of the mission, and it should never be an afterthought.

Thank you for inviting me.

[The prepared statement of Mr. O'Brien follows:]

PREPARED STATEMENT OF MILES O'BRIEN

Nice of you to invite an unemployed journalist to testify—of course it is harder and harder to find employed journalists—especially on my beat.

I have been covering space for more than 17 years now . . . I am a pilot and airplane owner—and come to the space beat as an enthusiastic supporter of all things that fly—and the adventure that is inherent in exploring a frontier. In fact, I spent several years trying to convince NASA to give me a ride to the space station—and we had a deal—that we would have announced a week or so after *Columbia* would have landed in February 2003.

In all, I have covered about three dozen Shuttle missions—including John Glenn's flight—with Walter Cronkite as my co-anchor. I got to ask him a lot of important questions—like would you like a little more cream in your coffee sir?

Actually, when I first met him—and we were talking about how we would cover the mission together.

I made the mistake of telling him he didn't need to worry about the details of the Shuttle—I would handle that—and all he needed to do was regale us with tales of the Mercury 7 days—he got very upset—and asked me to get him a report on every Shuttle mission—all the who what when where why's a how's—I asked him if he wanted that for all 94 missions at that time . . . he said greatly surprised "there've been 94 missions?"

Paraphrasing Lyndon Johnson—if we have lost Walter Cronkite—we have lost the rest of the Nation.

Some of this is novelty—Lindbergh's flight was news—but when I flew the Atlantic in a little plane a few summers ago—no one cared. John Glenn's first mission was news—and certainly the intrepid crew of Apollo 11 was the obvious lead story for days—but I just flew in last night form covering the 127th shuttle launch—and who knows who is aboard and what they are doing up there?

Part of the problem is NASA has served up a mission that seems mundane—no more interesting than watching airliners depart from National Airport. And in fact, the Shuttle was sold to Congress with the promise it would make space travel as cheap and easy as airline travel—and as if to make it all seem real (even though it wasn't)—the Agency went out of its way to make it look ho hum—before *Challenger*.

But there is another factor at work here. Apollo is NASA's greatest accomplishment to be sure—but it is also its biggest curse. It was, after all, a story that sold itself—and in fact the media frenzy was so great in those heady moon race years that the Agency had to build some walls and moats—and hire PR people who were more like the palace guard.

A lot of that remains in place—and that is aided and abetted by the astronauts—who live in that palace and only open the doors and let us in for brief audiences—usually on their own limited terms. The sad irony is these people are some of the

most amazing people I have met—and if they would just get out of the palace—or let the public in a little more—they would sell the program better than any piece of hardware they might be latching onto the space station.

Which leads me to the guys and gals who make the hardware—the engineers—god love them—they make the magic happen—but they just don't get the communication thing. The public affairs mission is simply not a priority. Matter of fact it isn't even on the list of requirements. Forty years ago, they were fighting to keep cameras off the Apollo spacecraft—after they simply add weight—and do nothing for their mission requirements. Imagine if that thinking had prevailed . . .

Well it may not have prevailed—but the debate is still alive and well as they design the Orion capsule.

Public affairs should always be a mission requirement—and a high priority requirement. The TV cameras are worth their weight in gold because they let the public participate in the exploration. And let's not forget who pays the bills. Leave the public behind and there won't be any missions—much less requirements.

Which brings me to some of the places where NASA goes a good job engaging the public—think of those little Rovers Spirit and Opportunity—still on Mars making the energizer bunny look like a piker. This is an example when the scientists and the engineers do not have some natural common ground. The images from other worlds—feed the scientists—as well as the public interest.

This all started with Pathfinder years ago—the first big “web-aganza”—if you will—average people could see the images at the same time as the Martians at the Jet Propulsion Lab. Peeking over the scientists shoulders as they explore! What heady stuff! Talk about engaging!

That trend has continued—Phoenix became the first spacecraft to tweet—and quickly became one of the first twitter sensations—my former colleague Veronica McGreggor at JPL got the idea from her kids—of course—as a way to let people know about the landing on a Memorial Day Sunday—she got a tiger by the tail—and went viral—with many tens of thousands of followers as fast as a speeding spacecraft—there were tons of very detailed questions from the space geeks—but soon it broadened—as the choir started telling their friends. The public was engaged—exponentially.

To their credit—in Houston they saw this how potent—and astronaut Mike Massimino became the first person to tweet from space in between space walks to fix the Hubble Space Telescope. A giant leap for web-kind.

And speaking of Hubble—the granddaddy of all missions where the science—is the best PR message—and look what happened when NASA tried to cancel that final repair mission—engagement led to anger and ultimately activism.

Which brings me to my final point—the Agency, dispersed geographically as well by centers of expertise and excellence—does not speak with one voice as it should. Public Affairs here in Washington needs more authority to direct the far flung PR operations—and frankly they need a budget—which currently is 0. You do get what you pay for.

There is no doubt the mission is the message—and NASA needs to be taking us places where we have not been before to capture the fancy of a jaded public.

But the message is also part of the mission—it should never be an afterthought.

DISCUSSION

IMPROVING NASA'S COMMUNICATION WITH THE PUBLIC

Chairwoman GIFFORDS. Thank you, Mr. O'Brien.

At this point, we are going to begin our first round of questions, and the chair will recognize herself for five minutes. I will keep my question, actually, down to one, because we have several representatives of the majority that represent NASA centers, so let me be brief.

It was not by coincidence that we had our first two panelists talk about the how and the why, why this is such an important aspect of who we are as Americans, and who we are, in terms of policy-makers and people that really care about our national interests.

The second part of our panel, we heard about the how do we attempt, how do we do a good job, or hopefully do a good job at getting that message out to the American people.

So, my question is, in terms of Members of Congress, specifically, what are the things that we can and should be doing, besides someone like myself, a single Member, who was going into the cloakroom a few hours ago, and saw the Tyra Banks show on television, switched it to the NASA station, to make sure that my fellow Members could watch the coverage of the fortieth anniversary, instead of watching the Tyra Banks show while we were in between votes, and also, the White House.

What are the steps that the White House could be doing? We talked a little bit about that, but in terms of really making this relevant to the American people? And General Lyles, let us start with you.

General LYLES. Madam Chairwoman, let me, I am glad you asked that specific question. I would like to sort of piggyback off of Miles' comments and also Debbie's.

One of the major things I think the Congress could do almost immediately is to make sure that the civil space agencies, and particularly, NASA, understand that communication, that PR, that public affairs, that marketing are okay, that to some extent, they are a form of communication. They are certainly a form of education, and both of those, to me, are seeds for inspiration.

Let me give you the context of why I say that. I serve on the NASA Advisory Council, and for the last two or three years, the Advisory Council, at different times, in conversation with the NASA Administrator, almost begged the Administrator and the Agency to find ways they can better get the word out about everything that NASA does. And the immediate response was Congress has told me I can't do that.

There is language, probably appropriation language, that precludes NASA from spending any money on anything that looks like marketing. I take a broad definition of the word marketing, because to me, it does equate to communication and education, and all the things that Debbie and Miles were talking about. I think one immediate thing is to look to see if there are restrictive language, even if it is a perception of restrictive language, that precludes NASA from doing the kind of things that Miles so expertly pointed out, I think that would be very, very helpful.

Chairwoman GIFFORDS. Thank you. Ms. Smith, please.

Ms. SMITH. I definitely think that the public affairs and the messaging is extremely important. I think, having been in a government agency myself, I think that one of the things that agencies often are conflicted about is, especially those that are regulators, such as FAA, the conflict exists about how can I carry out that message? Is it possible to carry out that message, and at the same time, promote and encourage the industry that I am responsible for?

My old office, the Office of Commercial Space Transportation, I would say, did an excellent job in drawing the bright line between safety and promotion, but recognizing that in order for us to foster the further growth and development of our industries, we have to promote them, and there is nothing wrong with the government doing that, as long as it understands what its principal mission is, and in our case, it was to protect the uninvolved public.

I also think that, in terms of what Congress can do, one of the challenges that I faced in that role was talking to Members of Congress and their staffs, who very straightforwardly and honestly said, you know, this is not necessarily a bread and butter issue for me. I don't hear from my constituents on it in the same way.

I think that Congress has an obligation to make that message come alive, and to recognize that if it affects the economy and the national security of our nation, then yes, it is a bread and butter issue.

So, what are the ways to bring it right down front for the constituent? And I think, looking at where we are right now in the world of space and the United States, we really are at a crossroads, I think. The need for a real clarion call that takes us forward into the future, and we all have a role to play in that. Congress has a role. The executive branch has a role. We, as citizens, have a role, and those who are business people in the industry, to carry that message forward.

So, I think, first and foremost, making it a bread and butter issue. It is. It affects you in your daily lives. It is a part of our national economy and national security. Carrying that message forward in a more prominent way, I think will go a long way to engage those constituents who are very, very interested in this, but may not know just how to bring it forward.

Chairwoman GIFFORDS. Okay. Ms. Smith, I am going to end with you. I would like to hear from the other panelists, but I really want to get to the other Members here. So, maybe if you have particular points, you can weave them into your answers to their questions.

Congressman Olson.

HOW SHOULD NASA COMMUNICATE ITS CONTRIBUTIONS TO SOCIETY?

Mr. OLSON. Well, thank you, Madam Chairwoman. I will kind of follow up. We didn't plan this before, but I also, I would like to ask Ms. Myers and Mr. O'Brien for the first question, and if we have time, General Lyles and Ms. Smith, but it is right along that same line of communication.

How do we communicate how beneficial NASA has been to our society, from a technological, from a national security perspective, and from an inspirational perspective? And you all talked about what Congress and the government can do, but one thing I find when I meet with constituent groups, we just had a group up here yesterday, from all the NASA centers, you know, some employees. And they all ask what could I do? What can I do to help you, or to help make sure that the American public understands how important this is for our future?

Ms. Myers and Mr. O'Brien, I would like to give you the first crack at that. What can we tell our constituents? What could they do to make a difference?

Ms. MYERS. I think part of it, sorry, part of this is really underscoring the importance of matching up national agencies with private businesses, private sectors, so that we can figure out together how do we tell these great stories? So, it is putting those partnerships together, and encouraging those partnerships to happen, so

that we can help work with people to understand what the stories are about, and how best to share that with the public.

Depending on the goals, depending on the type of stories, it is hero stories. It is talking about people who go into space, and the dangers that are there. That makes them stronger and braver as heroes. It is trying to find the way to make it relevant into people's lives. It is, when you have all this great information, it is that partnership with the people and the companies and the agencies and the journalists, and the talent that can help bring that to life.

Another part is to find great science communicators. We have started an experiment called Talent School, where we have gone out, and we have worked with different agencies in space and science, and we have found people that are really smart, they have the twinkle in the eye. They have a great stage presence about them. But how do we take what they do, and teach them how to connect with viewers at home, and teach them how to put that language into ways that resonate with everyday people, so everyday people care about it? So, I think it is inspiring people, inspiring people to work together with companies and with broadcasters and with journalists that can help tell their story in the best way possible, because they are great stories.

Mr. OLSON. Mr. O'Brien.

Mr. O'BRIEN. You know, I think the irony is, at 40 years after the launch of Apollo 11, NASA suffers from a bit of timidity when it comes to unleashing the message.

Now, they have a natural legion of foot soldiers, evangelizers. Everybody I meet who is involved in space is deeply passionate about what they do, love what they do. They are committed to their jobs in ways most people are not. And unfortunately, if they attempt to blog about it or tweet about it, they get shut down. This happens all the time, because the concern is that they will be off message.

It is important to empower the Agency, and thus, its foot soldiers, to know that they can be a part of this. If a flight controller wants to tweet and let her social network in on what is going on inside mission control, assuming we are not, you know, in some sort of mission-critical situation that would cause danger to somebody, why not empower her to do that? But instead, the message is you can't.

So, I think what Congress can do is, to the extent that they can streamline the rules for NASA and make it easier for them to do marketing, but also, to the extent that they can avoid the tendency to get on the phone every time something comes across the bow, that might offend somebody and somebody's constituency, because what that does is it cows the Agency. And they need to be empowered, too, because if you unleashed the power of that workforce, and allowed them to spread the word, we could just stand by and watch them win the country over.

Mr. OLSON. Just a little food for thought, based on the comments earlier, about how NASA could market itself. I had one of the constituents yesterday, it is not legal for the government, but a very interesting idea, what if we put a little NASA sticker on every product that was influenced, or had some benefit coming from space.

You would look around this room. Every piece of electronic gear would have a little NASA sticker on it, and somehow, we need to communicate that to the general public.

And I appreciate your time.

Chairwoman GIFFORDS. Thank you, Congressman Olson. Next, we are going to hear from Parker Griffith, who represents Marshall Space Center.

Mr. GRIFFITH. The comments are interesting. You know, the day after the revolution, the revolutionaries become the establishment, and I appreciate Mr. O'Brien's comments. And I think we are suffering from that right now in our space program.

I am from Huntsville, Alabama. Took care of many of the space scientists that came in from Germany, so we have a real dedication there. Mr. Hendricks, we are grateful to him, in no uncertain terms.

In the '60s, you could cut the tension in America with a knife. I see the young people here. We were not allowed to wear Army uniforms on the street. We would get stoned or spit on. The society was in turmoil. We were coming loose at the fringes. The Yale, Berkeley, Harvard campuses were in revolt. Kent State was in turmoil. We had blood in the streets, and yet, we stayed committed to a space program through the death of John Kennedy. 1968, we lost Robert Kennedy. 1968, we lost Martin Luther King. Our society was questioning itself, but we stayed with the commitment to space.

We are seeing a challenge today on our space program. We must remain strong. Ares I, Ares V, is not an option. It is essential to the United States. We represent six percent of the world's population. In order for us to maintain our superiority, in order for us to maintain what we know we can achieve, space is absolutely essential. It is the high ground scientifically, whether we want to know what is in the Van Allen fields, or it is essential for us to maintain our military superiority.

I certainly agree and appreciate the panel. You can tell I am fascinated and dedicated to space. I am an oncologist by training. What has happened in space has allowed our CT scans, our MRIs, the miniaturization of our instruments. The development of drugs in space is our next frontier. We have to do this. It is no longer an option. So when we hear it discussed as can we afford it, yes, we have to afford it.

So, thank you for being here. I really appreciate it. I have one question for Mr. O'Brien. You said on a blog that you were tired of hearing that we cannot sustain our space program during hard times. The truth is that \$18 billion, NASA gets a fraction of 1 percent of the U.S. budget. Chump change, I used to tell people, it is about what we spend collectively on coffee each year. I appreciate you, by the way. Stay with it.

Mr. O'BRIEN. Yeah. Thanks.

Mr. GRIFFITH. In your opinion, what should we be doing to let taxpayers know that the return on investment from our investment in space is absolutely huge? We have to market this.

Mr. O'BRIEN. So, maybe we should put the meatball in that Starbuck's latte. What do you think?

Mr. GRIFFITH. Absolutely.

Mr. O'BRIEN. What, we get Starbuck's, but no bucks for the stars? You know, something like that. I don't know. I think that the more we remind people of what we spend, and really, in the context of all that has transpired in this country in recent months, when you consider the size of these bailouts, the NASA budget just seems so tiny. It really does, and shouldn't NASA get a bailout, too? And it doesn't need much to keep going. It really doesn't.

And you know, it is, in a sense, it is a testament to the success, and the fact that there is a natural interest in this, that people assume we spend all this money on space and on NASA. It gets tremendous bang for its buck, and it is very difficult to quantify its value to our society, in the way it inspires our children, in the way it provides high tech jobs, in the way it ensures national prestige.

Look, India would love to have a manned space program. Per capita annual income in India, about \$800. Now, if Calcutta can afford it, can't Cleveland? And what is it that they are learning that we have forgotten?

Mr. GRIFFITH. One last comment, Madam Chair. Thank you for allowing me to comment. The great danger here is that we are going to be sitting in our living rooms with our feet propped up, having our gin and tonic, and the NASA touchdown, or the space touchdown on the Moon are going to be two Chinese. And I think the line is drawn. The challenge is there. It is another 1957 Sputnik moment, and we have to meet that challenge.

Thank you, Madam Chair.

Chairwoman GIFFORDS. Thank you, Mr. Griffith. Now, we are going to hear from Congresswoman Kosmas, who represents KSC.

COMMUNICATING THE VALUE OF THE ISS TO THE PUBLIC

Ms. KOSMAS. Thank you, Madam Chairman, and I appreciate everyone who is here today. Kennedy Space Center is in my district, and I have become a very vocal and outspoken cheerleader for space.

As I tell my constituents, I live about thirty miles up the river from Kennedy Space Center, and I have seen the Shuttle launches from every imaginable place, whether it is a rooftop or a boat, or the top of a car. We have seen, the beach, anywhere you can imagine seeing one, we have seen them. But since being elected to Congress, I have had the pleasure of having a little greater view, and I want to say that I have been preaching in my district very much the same kinds of things that you all are talking about today, that we are missing an opportunity to ensure that the next generation is inspired by what we do in space, and that they understand the significance of it.

And so, I am, again, I am part of the choir that you are preaching to, and now, I am preaching back to you. But at the same time, I think it is important that we do put a focus on how important this is to our lives and to our national security. I liked your comment, General Lyles, that communication and education are seeds for inspiration. I think that is a really good quote to use.

I also appreciate what the Space Foundation does, and I love the TV. What I had envisioned at some point, was that someone would do a commercial like what you were talking about, and literally take it from an average person's life today, and withdraw, one by

one, it is kind of the counter to putting a sticker on something, is to say take away, one by one, all of those developments that have been created as a result of our interest in science and technology that began with our space exploration, and see what is left. Because I think the next generation would be shocked to know how sparse many things would be, many arenas would be.

So, that is just my one, two cents worth. I have been working very hard, as I have said, within my district, to ensure that the people there are working in the school systems, that we are advancing the STEM programs, and that we are doing all of those possible opportunities of bringing astronauts into the schools and everything, to do this. We also, the Chairwoman and I, have taken a CODEL, of our Congressional delegation, of our fellow Congresspeople, to Kennedy Space Center, to see a launch. Unfortunately, it was scrubbed, but we had a really good opportunity to tour the Space Center, and for others to, in this body, who provides the opportunity for NASA to do what it needs to do for them to get a firsthand feel for how exciting it is, how challenging it is, and how inspirational it is.

So, I have anointed himself as the cheerleader within Congress, along with the Chairwoman, to make sure that we bring along our colleagues, in order to see the importance of it.

I had one question. Again, I really appreciate all the comments here, but this is for Mr. O'Brien, and it has, it references a comment that you made also on a blog. In the time period when the Shuttle retires and the Orion, the time between those two things, known as the gap, the only symbol of U.S. human space flight will be the International Space Station. And in May 2009, you did a blog about human space flight and the Hubble, and you said: "Sadly, most Americans do not fully appreciate the amazing accomplishment that the International Space Station is. They overlook its incremental role in pushing out the frontier, and they see it more like a big public works project."

And I think, you know, we have talked a lot about the Shuttles and the launches, but we haven't talked a great deal about the International Space Station, the investment that the United States has made in that fabulous frontier.

Could you suggest to me some ways in which you think we might be able to advance the recognition of how significant that is?

Mr. O'BRIEN. Aside from sending me there?

Ms. KOSMAS. I want to go too.

Mr. O'BRIEN. Let us go together.

Ms. KOSMAS. Okay.

Mr. O'BRIEN. That would be a great story.

Ms. KOSMAS. You are on.

Mr. O'BRIEN. I, you know, I think we don't know the story of the Space Station yet, because it just finally got a six person crew. Imagine that. There are going to be 13 people on that Space Station for the next couple of weeks. The toilets better keep working, I will tell you that, right.

It is very exciting, after all these years. You know, I remember looking at the sketches for Freedom in the mid-'80s, and to finally see it looking like those sketches is very exciting to me. Why that hasn't resonated with the public, you know, it is, you know, who

likes to watch buildings being built? You know, six year old kids, right? It is a lot like that. It has been very slow, incremental process, an amazing engineering challenge, which in many respects, some would argue exceeds on an engineering level what was accomplished in Apollo. It is an amazing thing, but it is still only 250 miles above us, and it is difficult, and it requires a little bit of nuance to explain to people why that is important, when you are talking about looking at new horizons, new worlds, and exploring the solar system. But it is all part of the picture.

I don't think that message has come through very clearly. That could be some of the media's fault. That could be a little bit of NASA's fault. It could be that the public is kind of jaded. You know, some of this is, they go to see a movie, they go to see Star Trek, and they expect NASA to have warp drive, you know, or you know, they still think there is an antigravity room at the Johnson Space Center. So, in some respects, Hollywood has been a terrible foe of the reality, because it pales by comparison. The real thing is awfully darn hard. But that is what Kennedy challenged us to do in September of '62 at Rice University. Do it because it is hard.

Ms. KOSMAS. Well, thank you very much for that answer. Do I have any time left?

Chairwoman GIFFORDS. Yeah, Ms. Myers, would you care to comment?

MODERNIZING PUBLIC RELATIONS ON THE ISS

Ms. KOSMAS. Ms. Myers, would you like to comment?

Ms. MYERS. Just want to add on top of that, too. Now, if you can get us to be able to capture the stories on that Space Station, of all these people living together, and hands-on, how they are doing their work, and see it and feel it, and it is real, and it is real people, real passion, real stories. It is like a smart version of Big Brother that is going on. So, again, make it relatable to people. Open it up, so that they can twitter and talk to us. Make it real. Make it alive. These are heroes. These are great stories, willing to be captured. Don't make it so sanitized. Bring it to life.

Ms. KOSMAS. Well, that would require overcoming the timidity, right?

Ms. MYERS. That is right.

Ms. KOSMAS. Okay. General Lyles.

General LYLES. If you don't mind, just one comment about the Space Station. There is a great story to be told about what it is, but also, the story that needs to be told about what it could be. One of the major things at the Human Spaceflight Commission that Norm Augustine is trying to, is currently chairing, and I am a part of, is looking at is what happens after 2016? Currently, the budget plans for the Space Station run out for the United States at 2016, so the fact that the Space Station has been declared a formal National Laboratory, as a possible testbed for great science, and there are great science experiments that are possible up there with the infrastructure currently on the Space Station, if something isn't addressed about how to extend it beyond 2016, which obviously includes budgetary, then none of the possibilities are going to be realized.

That is one of the things the Human Spaceflight Commission is going to be looking at, but it is more than a story of what it is. It is a story of what it could be and should be.

Ms. KOSMAS. I completely agree with you there, and I hope we are able to assist in extending the time period budgetarily. Yes, Ms. Smith.

Ms. SMITH. And I think that that also requires engaging all of government in this endeavor. And what I mean by that is, the fact that the Space Station allows experimentation, scientific experiments to go on, maybe this is something that NIH needs to be more aware of, and to identify parts of its budget that could be allocated to increase the number of experiments on the Space Station. We have got conditions that we are trying desperately to solve, and space provides a ready opportunity, a laboratory for experimentation that I know, as a public member of board at NIH, that work is not being exploited. The Space Station is an opportunity to conduct those experiments.

Ms. KOSMAS. Thank you very much. Thank you, Madam Chairman.

REDUCING MISSION RISK

Chairwoman GIFFORDS. Thank you. Next, we are going to hear from Congresswoman Edwards, who represents Goddard.

Ms. EDWARDS. Thank you, Madam Chairwoman, and thanks so much for holding this hearing. You know that is a passion of mine to tell the NASA story. I spent several years at Goddard Space Flight Center, working on the Spacelab project, and feel really passionately about the story that NASA can tell.

I think one of the challenges has always been, and I think part of the reason that I ended up actually at Goddard was because, not because I was an engineer by training initially, but because I was an English major, and because they needed people who could communicate all of the wonderful technical work that was being done to the rest of the world.

And so, I am glad to have been able to share in that experience, and you know, having grown up, also, on the space, you know with the space program sort of embedded, I feel that passion, but I am not sure that it is a passion that is widely felt across the United States. And you hear that from our colleagues, and I think this is part of the challenge that the Chairwoman expressed, among our colleagues who, you know, with a lot of other national priorities and needs of the American public, often stack that against the space program, and say, what do we get out of it? Well, our job, NASA's job, really, is to share with the American public what it is that we, indeed, get out of the program.

And I know, apart from my work experience at Goddard Space Flight Center, that what we get is we get lives that are saved and changed. When I was in a car accident four years ago, but for NASA's airbags in my car, I don't know that I would be sitting here today. And I think that we have to tell that story in a real way to the American public, and so, I share the passion that each of you has expressed in very different kinds of ways, want to acknowledge Discovery Communications. I know that half of the building is in

the Fourth Congressional District in Maryland, of Discovery Communications. That is an interesting block.

But I want to say also, and just ask you to respond to it, is that we have the challenge at NASA, of exploration and science and risk-taking, and I would like you to focus on that risk-taking, because that requires a lot of investment, and sometimes, it works, and sometimes, it doesn't. It is the nature of exploration and science. And we tend to, in the public, we can highlight the failures when it doesn't work, and not how we build on that in science, because we build toward the next success.

And I would like you to share with us ways in which you think that NASA can even communicate some of those failures in the most positive way, for the public to understand why the investment is needed, and sometimes, why it works and it doesn't work. Ms. Smith.

Ms. SMITH. Yes. Share the risk, is what I would say. We have an entrepreneurial new space community that is galvanized to be a part of the future of space. NASA has an excellent example of how it has approached it in its COTS program, where the risk is shared, because if the company, if the private company, does not meet its goals, it doesn't get paid.

I don't think that the government needs to take on all of the risk when it has such a willing partner. What would happen if low-earth orbit were turned over to the entrepreneurial community, to the new space community, and NASA could get on with its exploration mission? That is a current question, a question in need of an answer, but also, in a way that galvanizes the entrepreneurial spirit, which has been so much a part of our nation, in a real way, in a beneficial way.

Share the risk.

IMPROVING COMMUNICATION TO THE PUBLIC

Ms. EDWARDS. Ms. Myers, I wonder if you could comment on that, in terms of the way we communicate with the public?

Ms. MYERS. I think people can relate to, you learn more in failure sometimes than you learn in success, and that science is a journey, and exploring and growing is a journey. And I keep bringing everything back to how do you make it relatable, how do you tell these great stories that go on? And I think it is the honesty of there are big goals that people are out to do, and that NASA is out to accomplish, and it is sharing those stories, so that when it fails, you explain it. You see people go through okay, we are excited. We think this is all going to happen, and when it fails, you tell those stories. What did you learn from that failure that can push that out?

It is getting people invested in their minds, in ways that they can relate to, and in their hearts, so that these become something that you feel invested in. And I think if you go back to the space program in the '60s, we were all rooting along. We are all invested in there. These were our heroes. And how do we make those stories, how do we make those risks relatable and connect to it, and I think that is part of it? A different spin journalistically, than to capture people's imagination and take them along for the ride. The successes as well as the failures, what did you learn from it? Be-

cause science is about questions, and when you have those questions that are out there, you get the answers. That leads to more questions. And if you don't keep experimenting, you don't move it forward.

Ms. EDWARDS. Well, thank you very much, and Madam Chairwoman, my time has expired.

Chairwoman GIFFORDS. Mr. Rohrabacher, would you like to go now, or would you like to wait until after Mr. Wilson?

Mr. ROHRABACHER. I can hold on for a few minutes.

Chairwoman GIFFORDS. Okay. We will go to Mr. Wilson. Mr. Wilson.

EXAMINING NASA PROMOTION TECHNIQUES

Mr. WILSON. Thank you.

Mine is not so much a question as one that, I live in Ohio. Unfortunately, I don't have a NASA center in my district, but we certainly do have NASA Glenn in Ohio, and I was just amazed when I was elected, and actually started learning more about NASA Glenn and what really happens. The amount of jobs that have been generated throughout our state, the amount of research, and the very things that I just sort of took for granted, as a lifelong Ohio resident, that those were not, I didn't know they were connected. And I think that was talked about earlier.

And so, mine is a question of, one of the gentlemen said he thought it would be a good idea that everything that was generated from NASA research would have a little NASA sticker on it. That is the best idea I have heard in a long time. And I think it is very good.

I like the idea, because really, so many times, even those of us who live in Ohio, and have been around NASA Glenn all of our lives, don't realize the intensity in our lives that has gone on there. So, how do we do a better identification, or a better education, if you will?

General LYLES. Congressman, I am going to be a little bit parochial myself, since I commanded Air Force Materiel Command at Wright-Patterson Air Force Base in Dayton, Ohio. I had the same problem in the United States Air Force, with all the technology programs we were involved in, and particularly, I would use Ohio as an example. We never did a good job of communicating, communicating to the public and the state that you had Glenn Research Center, you had Wright-Patterson Air Force Base, the center of all technology for the United States Air Force, but nobody ever talked about it.

And it was sort of self-imposed. We don't, we did not have great communicators who could tell the story for us, people like Debbie. And where we did have communicators, we didn't do a good job of educating them on the facts, so they could get the story out, and utilizing their great communicative skills.

To me, I have always used one three word term for great management. It is communicate, communicate, communicate. And somehow, if we could take that seriously, and do a better job of bringing all of the right people to get the word out, I think we can do a far better job in Ohio and the other 49 states, and even the world, for that matter.

Mr. WILSON. You know, I attended the fifty year celebration last fall, and it was held in Cleveland, and it was amazing the amount of people, and certainly, the astronauts that have come, the heroes that have come from Ohio, but yet, it doesn't all connect. And I think that communicate, communicate, communicate is a big part of where we need to be.

Thank you, Madam Chairwoman.

Chairwoman GIFFORDS. Thank you, Mr. Wilson. Excuse me, Mr. Rohrabacher.

WILL THE PRIVATE SECTOR PLAY A GREATER ROLE IN THE
FUTURE?

Mr. ROHRABACHER. Thank you very much. I apologize for being late, and we run from one thing to another here on Capitol Hill. And General Lyles, nice to see you again, and we have followed each others career for so long now, and I congratulate you for all the wonderful things you have done, and the rest of the panel as well, in terms of space.

Let me, however, put a little bit of a different twist on communicate, communicate. I think, I see, when I was a young reporter, one of the first stories I covered as a younger reporter was when Senator, I even forget his name now. He was, it will come to me. In California, and he was only one term, so I don't need to remember him, but he was endorsing the Space Shuttle, and anyway, when I went there, there was only a couple reporters who showed up, and it was there in Downey, where they had the markup of the Space Shuttle. And when I went in, there were five PR men there ready to meet my every need. Would you like a cup of coffee? How about some tea? Would you like a sandwich? How about this big packet of information? Pictures? Would you like to get a picture here? Five of them. I was making \$100 a week, and I think they were making \$500 a week each.

I think NASA has a lot of money that it spends on promotion. It does. I mean, even to this day, I will look at the NASA Channel. There is a lot of promotion going on. I think where we are weak is not communicating. I think where we are weak is not focusing on specific things that we can do in space, and we can show specifically how they impact on the lives of our people. And there is such an array now of things that we depend upon from space. Space-based assets, I used to only be able to call my grandparents when I was a kid, like once a month at most, and it was a \$5 call, you could barely hear it. You had to go through operators who hated you for bothering them, and because of our space-based assets, that call, that was \$5 in those days, and in this day's money, it would be like \$25. And we brought down the calls where people can call up their loved ones and communicate. Space-based assets.

And we could go through the whole thing now, where space-based assets have made such a significant change in our lives, I don't believe the American people understand that. It is not necessarily communicate, communicate, but looking specifically at what things that have changed lots, not some guy, where they see the guy taking a space walk, and we get all sorts of pictures of the guy taking the space walk, and it looks like fun, but how are our lives changed? How will our lives change in the future?

I was just, I have this question for General Lyles. Do you see, first of all, I see the private sector playing a much greater role now than what it did in the past, and do you see the commercial space in, efforts will actually play a greater role as well in the future of this trend, toward having commercial enterprises, rather than just government-run enterprises in space?

General LYLES. Congressman Rohrabacher, it is great to see you again, and the answer is absolutely. One of the recommendations, key recommendations of our National Research Council study was the need to look at the infrastructure and strategies on how people are involved in the space activities.

And it wasn't so much to imply that there shouldn't be leadership and expertise at the NASA centers, but the NASA centers need to figure out a way they can open up the aperture, if you will, to allow commercial entities, academia, and others to sit at the table, and to provide solutions to help solve the problems.

Today, the perception is, everything is NASA-centric. That may or may not be true, but commercial entities, and certainly academia feel they have been left out, in some cases, as our report points out, and we think just changing the way you approach business and the way you approach allowing people to work the solution will go a long way towards achieving that goal.

WHAT SHOULD NASA DO REGARDING SPACE DEBRIS?

Mr. ROHRABACHER. We are not talking about major new expenditures. We are talking about making sure we open up the way we do business, so that people who, on the outside of the circle, can now get involved, and they are already involved in some ways, but expanding that.

One other question about this. To get the, to utilize space and the potential of space, we are facing a huge roadblock that nobody seems to want to face, and that is space debris. And I personally, of course, have focused a lot of my activity in this committee on near-Earth objects which are coming down and space debris.

I would just ask to the committee in general. Shouldn't we be focusing on that effort, to clear that space debris, so that we will open up new opportunities, without having to worry about a bolt coming through somebody's new space station, or space project?

General LYLES. Well, my answer is, I think there is attention, greater attention now to that particular problem. And something I think, again, our report points on, there is a need for greater integration and coordination amongst the different agencies, particularly the civil space agencies and DOD, on how you address common problems.

And one common problem is what do you do about space debris? It is sort of a global commons, if you will. There is international interest in this. This is an opportunity to bring a lot of different players to the table.

Mr. ROHRABACHER. It certainly is. Yeah.

General LYLES. Commercial, international partnership, et cetera. I think it is sort of a ripe sort of example for people to tackle as an enterprise.

Mr. ROHRABACHER. That is exactly right, general. We can bring people like the Russians and other people in, and the Europeans.

We can make this an international effort that would clean up the skies, so that we can use those heavens.

Anyway, thank you very much, Madam Chairman.

Chairwoman GIFFORDS. Thank you, Mr. Rohrabacher. And remember, we had a pretty interesting hearing on space debris about two months ago, and hopefully, we will follow up with that as well.

Mr. Grayson, please.

VIABLE SPACE-BASED BUSINESS MODELS

Mr. GRAYSON. Thank you.

Interesting movie in the theaters right now called Moon. I don't know if any of you have seen it. The premise of the movie is that there is a manufacturing operation on the Moon that mines helium-3 and sends it back to Earth for use in fusion reactors on the Earth.

I am not going to ask you for a movie review, but it does raise an interesting thought, which is what are the possibilities for actually using space for economic purposes? At this point, historically, we only have one successful model in that regard, and that is satellites. Satellites are a viable business that provide economic benefit that exceed their costs, and therefore, has functioned as a business over the past couple of decades.

We are starting to see the beginnings of a second business like that, like tourism, space tourism. And over the course of the next decade, we will see how that pans out, but it looks like there is the possibility that we will be able to, again, provide goods and services that exceed the costs of production, and therefore, have a viable business model.

What I would like to know from all of you, in my three minutes and 53 seconds remaining, is what other potential models do you see in the future? What models can be viable economic uses of space in the next 20 years, or even the next 50 years?

Let us start with you, Ms. Smith.

Ms. SMITH. Certainly, there are companies that are looking at other uses of space for business purposes. One such company, Virgin Galactic, I am consulting with them. And while their core business will continue to be space tourism, they are looking at non-space tourist markets, solar energy, atmospheric testing, using the White Knight captive carrier vehicle, which has the capacity and the ability to provide itself as a testbed for other kinds of testing, as a business. Bigelow Aerospace, with its space habitats, has already offered a number of business opportunities to other countries who want to do astronaut training on platforms, when our Space Station is not available, other parts of the world might look at that as a business opportunity.

So, I think that people who are in this for the long haul, and many of the companies that I have worked with in the past and continue to be, are looking at playing it full out, all the way out, exploiting all of the opportunities that exist in space for business purposes, but also, to benefit mankind.

Mr. GRAYSON. Well, some of the other opportunities that have come up over the years, but haven't reached fruition yet are other forms of energy production. We have heard of that.

Ms. SMITH. Yes, solar energy.

Mr. GRAYSON. Zero gravity high precision manufacturing. That is one that has come up from time to time. Occasionally, biotechnology applications. I want to know what you think are the cutting edge, the ones that are most likely to come to fruition. What about you, Ms. Myers?

Ms. MYERS. Would like to do a little bit more research on that, and get back to you on it.

Mr. GRAYSON. Okay. General?

General LYLES. Congressman, I, you are talking mostly about commerce and business in space, and utilizing space. I have also always wanted to focus on commerce as a result of space technologies.

The best example of that, of course, is GPS. Nobody could have envisioned when the GPS program was started by the Air Force, where it would lead, in terms of all the services. And I think, when you look at the technologies that will come out from energy perspective, with the electric propulsion for satellites, advanced materials even greater than the ones we have today, lighter, more durable, et cetera, those technologies generated as a result of space activities, I think, will change the way we do things around the world in so many different ways.

It is commerce as a result of space, not in space, but to me, that is just as viable and just as valuable.

STREAMLINING VIABLE AEROSPACE BUSINESS MODELS

Mr. GRAYSON. All right. So, it seems like we have a number of different alternatives here. They are all possibilities. What do you think that we can do to try to see that those are more likely to come to fruition? In other words, how do we make the future come faster? And Mr. O'Brien, I haven't picked on you yet.

Mr. O'BRIEN. Well, see, I am a big believer that the area we should be looking at is space-based solar power. I think that is, when you start looking at the numbers, and you start comparing it to say, building another nuclear plant on the ground. It is not that far off, and one way that you could get that going is, there are certain applications, specifically at the Pentagon, for example, where there is a need to get remote power to remote installations, and in order to keep an encampment in a hostile part of the world going, can be very expensive and very risky, as you convoy in fuel and whatever you need.

Wouldn't it be nice if the government, perhaps, started looking at some, maybe some seed money to think about small, space-based solar power applications that could take care of forward bases for the Pentagon? They certainly have a lot of money, right?

Mr. GRAYSON. Well, it is a very interesting subject, but my time is up. Thank you, Madam Chairman.

IMPROVING OUTREACH TO CHILDREN

Chairwoman GIFFORDS. Thank you, Mr. Grayson. When I think about how we make NASA and space more relevant to Americans. It is really making NASA relevant to all Americans, and you know, I mean, from my vantage point and Members of the Committee, we

look out and we see you, but we also see the portraits of former Chairs of this committee.

And if you look around and you see all of the Chairmen, they look surprisingly similar in many ways. And I know that, obviously Mike Massimino was the first astronaut to twitter from space, but now, we have the first astronaut twittering in Spanish in space, and that, of course, is Jose Hernandez. And you know, it is true, NASA has done a much better job recruiting astronauts and training astronauts that don't, aren't all the same type of American. But I am not convinced that we are doing a good enough job reaching out to a more diverse audience of kids.

And I was just hoping the panelists could talk about ways that we could do that, either from an educational standpoint, or a marketing standpoint, or what NASA is able to do. Ms. Myers.

Ms. MYERS. This is a subject I am very passionate about. It is making, reaching out to kids in school, reaching out to make it come to life, reaching out to empower kids that it is cool to be smart. Because for so many years, the smart kids didn't feel empowered to be smart, especially in the inner cities. So, that was why we turned to a Will Smith, who is a role model, and said you are smart. You did it. You grew up in Philadelphia. Be a role model, and inspire kids that, to get excited about science, space, innovation, capture their imagination, and to make it something proud to be involved in.

And to empower teachers, to give them the tools that they need, because kids learn differently. They learn as individuals in different ways, and it is a new generation that grows up with video games and twittering, and on the net, and they watch TV differently than any generation. So, empowering those teachers with the tools to be able to capture kids' imagination.

And I think we all have to do a better job of getting kids excited about what careers exist. Because we don't tell the stories of the people, and what lights them up, and what gets them excited about their jobs. And when you talk to people in the space program, and you have a conversation of why did you get into this, or tell me what you really get excited about at the end of the day, or what are you working on, they become childlike, and it is contagious.

We have to do a better job of getting those messages to kids, so that they see a bigger array of jobs to choose from, and we get them excited that they can change the world. And it is important subject.

MARKETING ROLE MODELS TO THE PUBLIC

Chairwoman GIFFORDS. Let me just touch in on something. I was speaking with a woman astronaut a couple of days ago about how many women there are in the United States Congress, and our percentages are actually very similar, the women in the astronaut corps and the women in Congress. And while I think for men going into politics, there is sort of the sense of, well, I am the best person for the job. Of course I should get elected. I can't say whether or not it is the same for someone who goes through the rigorous aspects of what it takes to be an astronaut, but I know, as a woman in politics, for me, it was meeting another woman and seeing her do it, and realize if she can do it, I can do it.

Ms. MYERS. Right.

Chairwoman GIFFORDS. So, it wasn't so much even having the information. And again, I think that is a story that you will hear from women that intended to go into this area. So, I am just curious whether or not the message also should be different for a different audience, whether it is different gender or different ethnic background, whether or not those messages should be different, and reach out to those large populations we have in this country.

Ms. MYERS. It is that relatability factor. It is so important that we need those role models, and that we change to whoever we are trying to appeal to and speak to, present those role models and make it real, make that connection come to life. So absolutely.

CREATING A ROLE MODEL: EXAMPLE

Chairwoman GIFFORDS. Mr. O'Brien.

Mr. O'BRIEN. I think NASA should really go out of its way to put those role models forward. I mean, I really do think it is important to hear from those members of the astronaut corps, and make sure they are front and center. That should be a very high priority, when it comes to any public affairs campaign.

And just when you talk about, you know, engaging kids, you know. It is really important that they also have a sense of participatory exploration. I am on the Board of Directors of the Challenger Learning Centers, which I know you are all familiar with. My first experience there was just amazing. I walked in with a CNN crew in tow. This is a room full of middle schoolers, and usually, a room full of middle schoolers plus camera crew leads to havoc. And they are waving, they are making, they act like kids. They act like kids, you know.

And I walked there, and they are in this mission control center, and we are getting the camera in their face, and they are like get away from me, we are trying to save the Space Station right now. I thought wow, this is magical. Imagine that. This is something that really has engaged kids, you know. You know, that is how kids learn. They didn't know they were learning. They were having a ball. And who knows how many of those kids, you know, I am convinced one of those kids will be on Mars one of these days, you know. Probably went to a Challenger Learning Center.

And I was just at one recently, the Lower East Side of Manhattan, and it was in the midst of astronaut Scott Parazynski, recently summated Mount Everest, and I was part of that project, helping him tell his story in, you know, viral Web 2.0 way. I never got to leave my laundry room. He got to go to Everest, but in any case, I brought down, we did kind of a two way conversation with these kids using Skype with, you know, this astronaut at Everest, to a group of kids across all ethnic origins and socioeconomic, you name it.

And kids are kids. They were fascinated by the whole thing, and there was nothing about it, I didn't detect a barrier. Nobody in that room said I can't do that. As a matter of fact, everybody was like wow, this is cool. I want to be a part of this. So, it really isn't rocket science, but it does take money, and it does take effort.

And you know, the kind of science teaching I got, unfortunately, kind of turned me off, and I ended up a history major, and the rest

is history. But who knows? Maybe if I had gone to a Challenger Learning Center, I would have gotten my ride on the Shuttle already. Who knows?

TELLING THE STORY OF ASTRONAUT DIVERSITY

Chairwoman GIFFORDS. Thank you. General Lyles.

General LYLES. Congresswoman, let me just echo one of the comments made by Miles. As I mentioned, I serve on the Augustine Human Spaceflight Commission, with Sally Ride and Leroy Chiao, an Asian American astronaut.

We were down at Marshall Spaceflight Center a week before last, and just walking through some of the activities and facilities there, and there, on the wall of one of the buildings was a poster I have never seen before, and it was a poster that had very small pictures of all of the astronauts. Now, obviously, you can imagine the number of astronauts, so the pictures had to be very small, but it immediately jumped out at me how diverse we already have in our astronaut corps, but we don't do a good job of spreading the word, of getting the word out about that.

We certainly need to do more. I absolutely believe in that, but let us take advantage of what we currently have, and tell that story. It just blew my mind away, to look at that poster and see the diversity that already exists in that astronaut corps, which could be role models to so many different kids, so many different inner city places, and around the world, for that matter.

Chairwoman GIFFORDS. That was absolutely correct. Mr. Olson.

A NEW NATIONAL SPACE COUNCIL: ADVISOR OR MISSION
COORDINATOR?

Mr. OLSON. Thank you, Madam Chairwoman, and one question for you, General Lyles.

In your report, you advocated for the creation of an entity like the National Space Council, to coordinate the activities of the various Federal Government space organizations. Do you envision this entity being a governing body that would coordinate the actions of the various space agencies, and direct their programs to comply with the consensus of the group, or would it be strictly an advisory role?

General LYLES. Congressman, I think it is probably more on the lines of an advisory role. The last thing that NASA or any of the other civil space agencies, or even DOD, for that matter, DOD space need, is another bureaucratic layer in between their activities and what jobs they have to get done.

What we see the need for, however, is better coordination and integration of the various space agencies, to look for those common grounds, look for those things that they need to work together, to leverage the resources and capabilities of the various agencies, and probably more than anything else, a common theme this afternoon, to educate each other on what they are working on, what they are involved in, what the challenges are, so we can take advantage of lessons learned and best practices from each of the different agencies.

Our report specifically said that the President should charge two senior executives in the Administration, we specifically mentioned the National Security Advisor and the head of OSTP, to figure out the right policy and process. We stopped short, because the Academy does not like to tell the country, tell the government how to do business and organize, we stopped short of saying National Space Council, but that is sort of the role model, or the model that we thought would be appropriate. There needs to be a process, needs to be an institutionalized sort of organization to make that happen.

INSPIRING AMERICA'S YOUTH

Mr. OLSON. Thank you for that answer. And I would like to just make one closing comment, sort of follow up on everything we have all been, talked about, about what we need to do to inspire America's youth. And one little story, and some of you may have heard this before, but it is just a great story. I love it.

Our youth, the love of space and human space flight is in them. And I saw it firsthand. I watched the STS-119 launch back in March, with 60 kids at a third grade elementary school in Sugarland, Texas. Now, as you can imagine, those kids, they came in about 25 minutes before the launch, and as seven and eight year olds would do, they just, you know, sat down. I talked to them a little bit about what was going to happen, what they were, expect to see, and opened up for questions.

These kids grilled me. I mean, they grilled me for 24 and a half minutes, and good questions. And you know, we got down to 25 seconds left on the countdown, and they cut to a camera angle that had the big mission clock, you know, with the front of the Shuttle. And of course, didn't see this coming, but you know, anybody else in the room could have. Those kids started screaming out the countdown at the top of their lungs, you know, 25, 24. And they are howling, and having a ball. But then, the most, the best part of it, the most inspirational thing happened right down as the countdown got down to about 5, and the main engine started to come down to life, and then, the solid rocket boosters fired, and she left the pad. And when she did that, every kid in that room was quiet and just stared at that TV, watching that Shuttle climb up into orbit and into space.

NASA has the power to inspire. It is out there, and we just need to find a way to tap it. Thank you all for coming today.

Chairwoman GIFFORDS. Thank you. Thank you, Mr. Olson. You know, it wouldn't be a Space Subcommittee hearing, if we didn't have a chance to hear from Mr. Ralph Hall. So, Ralph, I just wanted you to, I know you didn't have a question, but we would love to hear from you.

Mr. HALL. Thank you, Madam Chairman. What a great chairman you are, and thank you for, not even bad to look at. And I have tried to get in touch with you when your husband was out of this world.

Thank you. I have been in a very unhealthy atmosphere of a health bill, I was giving opening statements, so I am still kind of goofy, but this is very important to me, and this is a great witness

group here. And I am sorry, I did get to read some of the opening statements.

I didn't get to hear the questions, but I really thank you, because what you tell us is things that we need to know for the future, and I am sure I have an idea of what you said. But what we are all saying now is, I don't know about what part of the R&D that we are entitled to or we get, but we need just a little more of it, because we need to close that four year gap in there some way.

And I tell this story, and I told it to the gentleman who is heading up the study, the former CEO of, Norm Augustine, that, and my kids hate for me to tell them stories about the Depression and World War II, but I make them listen, and sometimes, I tell them a story, and then I will wait about ten minutes, and I will start over telling it again, and their eyelids will click at one another, you know, hit one another. And I am just practicing for when I really get in that shape, you know. Got to be looking ahead.

But I told Norm about the last days of the Battle of Midway, before the Battle of Midway, which won the Pacific and ended the war against Japan. We had one carrier that was really fighting shape. We had another carrier that it was to take seven months to repair it, to where it could leave the port of Honolulu. And Admiral Nimitz went aboard, and that was on a Monday, and after his speech to them, he told them that that carrier was going to go along with the other carrier, and they were going to be a certain spot northwest of Midway, waiting for the Japanese to attack. We had broken their code. We knew they were coming. We knew where they were coming from. He said this ship will be ready no matter what it takes.

And that is what I want somebody to say to them. It is money, and if we can't close it on that four years, either from one side, using the bird we have, and I don't know any better way to put it than, other than robbing off of the other two, but to make it as safe as we can, and get two years down to meet the two years that we could encourage the completion of our goal.

It has to be done. We just don't have any choice. We can't be subject to Russia's whims, and we can't lose Japan and all those other people, as partners as they are now. We have got so much to lose, and NASA is great, but I don't think they have been great enough to let the word go forth of how great they really are, and what they really do for us, and what they have done for people my age, and the fallout from health. We simply have to have our Space Station, and we need to accept nothing less than that. We just got to fight and battle and scratch for it. I think everybody here feels about the same way I do about it, and I certainly thank you all for your testimony.

Chairwoman GIFFORDS. Thank you, Mr. Hall. Mr. Rohrabacher.

REWARDING SCIENTISTS AND ENGINEERS WITH COMPETITIVE PAY

Mr. ROHRABACHER. Yeah. I just would like to make sure that there is one point that needs to be on the record, at least. And that is, I think that inspiring young people is more than just fluff, and a lot of times, when we take PR approaches, that it turns out to be just fluff, and young people can see through that.

And as I say, when I went to that first press conference, they had five PR men for NASA, and all focused on the fluff, and here is the pictures of the astronauts having fun in the space walk. That is less inspiring than having NASA being involved in projects that really are going to affect the lives of the people on this planet, and that we are fully capable of.

If we are going to inspire young people, we need that, we need substance, and we have got, the potential for substance is there. We have now reached a plateau where we have got so much in our foundation, intellectually, that it is almost unlimited what humankind will be able to do in the future, because of what we have, the plateau we have already reached.

If we are going to have young people, just again, this last point, the young people are not going to be inspired if engineers and scientists are not paid as much as lawyers. I mean, it is as simple as that. Right now, you are not going to inspire young people to get involved in engineering and scientific endeavors, if they know that engineers and scientists drive around in old jalopies, and the lawyers drive around in sports cars and live in beautiful homes, and the engineers can barely afford to pay their rent.

We have got to make sure our engineers and scientists are paid well, and to do that, I know this is going to go against everybody's grain, we should not be bringing in engineers and scientists from India and China and elsewhere to lower the amount of wages that will be paid to our own people. We need to build our own capabilities up, make sure that when someone becomes an engineer, and sort of bringing down the pay level, by bringing people in from overseas, we should be paying more money to our own engineers and scientists.

That starts right in education. We have to pay our teachers who teach science and engineering more money than we do those teachers who are teaching history, I am sorry, I am a history major, but there is lots of people who want to teach history. We need the scientists and engineers teaching our kids, and the kids need to know, they are actually, we reward something because we need those skills. We need to pay the teachers who teach that more money than someone who teaches basket weaving or gym or history or whatever.

So, those things, if we are going to inspire people, let us be serious about it. That is where you start, by making sure the kids know they are going to, that their own lives are going to be able to be better by earning more money, by getting into those professions.

Enough said. Thank you.

Chairwoman GIFFORDS. Thank you, Mr. Rohrabacher. Yes, Ms. Smith.

Ms. SMITH. One of the things that the Space Foundation is not timid about at all is going into failed situations, such as failed school districts, with space programs to revitalize, to inspire and encourage students to get into American science.

We recently stood up such a project in Colorado in a failed school district, and using space as a curriculum there. I think that, as we look at K-12, and where does it need to start, and whether it is appropriate at K-12 or later in the school system, I think it is ap-

appropriate for it to start wherever it starts, and that we have got to galvanize the interest of students, get them more excited than they have ever been about math and science, and the potential, and the possibilities that space provides.

Having people know what some of those benefits are is a beginning point. I was talking to a group of 13- to 20-year-olds last week, and talking about the fact that at the gas station, that your credit card is cleared by a satellite in space. Do you know that? They went no, no I didn't know that. How does that happen? There are too many of those examples like that, that if highlighted, I think we would be able to bring this message closer to the average citizen, and we have got to do that.

Chairwoman GIFFORDS. General Lyles.

General LYLES. Yes. I agree 100 percent with Congressman Rohrabacher. But I might point out that where, perhaps, resources are not available to pay people the way they should be, the other thing I have found that galvanizes and incentivizes and motivates engineers and scientists is having great things to work on.

Last week, I was at, as part of the Augustine Commission, we were out at SpaceX, and talking to Elon Musk's team out there. Bunch of young engineers and scientists. Every one of them said exactly the same thing. They are not there for the pay. Right now, the pay is not there. They are still early beginning stages of their organization. They are all there for the excitement of what they can possibly do to contribute to the space program. I have seen the same thing in the Air Force, as you know. We don't pay our civil servants a great deal of funds, but they are all there, because of the excitement of what they can do, and the possibilities of the technologies that they can get involved in.

So, that is another way we need to try to motivate the engineers and scientists.

MATCHING NASA'S BUDGET WITH GOALS

Chairwoman GIFFORDS. Well, I have one final question, and it actually stems from the wisdom of Mr. Hall, when he mentioned the gap that we are going to have with, only now, seven Shuttle launches remaining.

Mr. Lyles, or excuse me, General Lyles, this is for you, and looking at your report and the comments made, there was an observation that NASA is inadequately funded to pursue many of its responsibilities, and that the Agency is being asked to accomplish too much with essentially too little.

The report language says: "A coordinated, sustainable set of strategies should ensure that responsibilities are realistically matched to available resources. Such a match does not exist today. For example, NASA has a central role in civil space, yet by any reasonable measure, it is inadequately funded to pursue many of its responsibilities." It goes on to say, the report, that: "Rather than requiring that a broad and ambitious program should be fit into an arbitrarily constrained budget as has been the case in recent years, a sustainable strategy would first define the program that the Nation is committed to undertake and then realistically define the resources that are required to accomplish that program."

Would you please elaborate for the committee how you were able to reach that conclusion, and what exactly you meant?

General LYLES. Well, Madam Chairwoman, I think just looking at all the things that are on the plate for NASA, and again, our study was of broader civil space activity, but we, in that particular case, were looking at NASA. All the things that are on the plate for it, for the Agency, all the missions that they are being asked to do, all the visions, if you will, for what we would like to have out of NASA, whether it is space exploration, whether it is the first "A" in NASA, aeronautics, and they are heavily dependent upon to contribute to the aeronautical domain for FAA and others, if you will, that the resources do not match all of the things that they are tasked to do.

And our recommendation was that we take sort of another look, if you will, not at taking away any of the missions, because I don't think any agency is better equipped or better stated for doing the things that we have asked NASA to do, but figuring out, how can we set the strategy for when some of those things get accomplished.

I was part of President Bush's Implementation Commission for the Space Vision, the Aldridge Commission, back in 2004. And one of the things we recommended in even taking on the broad exploration mission was a statement we called go as you can pay. Recognizing that the resources may not be there to do everything we want to do in the timeframe, but structure a program so you could have successes, and move forward, and get closer to your goal, even within the available budget. But don't give up the goal.

So, that was sort of the notion for why our study sort of came up with that particular statement. Let us figure out what should be the pace, what should be the structure, what should be the milestones that we achieve with available resources, if we can't get more to add to the mission?

Chairwoman GIFFORDS. Well, I think I can speak for, on behalf of the entire subcommittee and the full committee, that we are anxiously awaiting the report from the Augustine Commission, and I think the Nation really is waiting, as well.

I have no further questions. Any other Members?

Mr. HALL. Madam Chairman.

Chairwoman GIFFORDS. Mr. Hall.

Mr. HALL. What would you think of a bailout for NASA?

Chairwoman GIFFORDS. Well, Mr. Hall, I believe Mr. O'Brien had recently, actually, it has been about half an hour, suggested a NASA bailout.

Mr. HALL. I don't know anywhere they could spend it any better. And we ought to go demanding those things. You know, Jay Leno got right to the point, when he said that those automobile makers ought to keep on making automobiles, and those folks on Wall Street ought to start making license tags. And we need to bear down on them, and back NASA up. And it is money, and if we are throwing money away like we are, right, left, and sideways, why can't they put it somewhere where it really means something, to everybody from K to 12 to graduation from college, and some brilliant people like you four, tell them we need that.

We ought to start a write-in right today, urging that this \$450 billion laying up there somewhere, out of that first \$800 billion, and we just \$3 or \$4, or maybe \$4 or \$5 billion. A little old billion, a little bitty billion dollar bills.

Madam, thank you for a good job.

Chairwoman GIFFORDS. Thank you, Mr. Hall.

In closing, we, of course, have to congratulate our new Administrator at NASA, Charlie Bolden and our new Deputy Administrator, Lori Garver, talking about diversity. We are going to have an incredible new team, from the Obama Administration, that begins today.

And I think reflected for many of the Members, you know, we hear this tremendous concern, our national economy, our energy resources. What is happening in health care, what is happening in terms of global terrorism? And in terms of, I believe, representing the best foot forward that our country can make is having a strong space program. And that is something that I know that we are going to work collectively on.

So, I want to thank our panelists for being here today, our witnesses, for helping us remind the Nation, this great promise, and this great potential that NASA brings to us, and the ability to communicate that greatness to America and to the world.

That is the end of our hearing, and I would like the Members to know that the record will remain open for two weeks, and if there are additional statements being made by the Members, they can submit those questions, follow up questions on the Subcommittee to our witnesses, and the witnesses are now excused, and the Subcommittee is adjourned.

[Whereupon, at 3:57 p.m., the Subcommittee was adjourned.]

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Appendix:

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by General Lester L. Lyles [U.S. Air Force, Ret.], Chair of the Committee on the Rationale and Goals of the U.S. Civil Space Program, Aeronautics and Space Engineering Board, National Research Council

Questions submitted by Chairwoman Gabrielle Giffords

Q1. You testified that "Today, the perception is, everything is NASA-centric. That may or may not be true, but commercial entities, and certainly academia feel they have been left out . . ." You went on to say, "as our report points out, . . . we think just changing that way you approach business and the way you approach allowing people to work the solution will go a long way towards achieving that goal." Are there any examples from previous years in which the way that NASA worked with commercial entities, academia, and other institutions was particularly effective? If so, what made those institutional relations so effective?

A1. First, the committee was concerned that over recent years NASA has strayed from focusing its energies and expertise on advancing the frontiers of cutting-edge development of new technological capabilities and has diverted too much of its attention and resources to the operation of proven elements of space systems. NASA needs to be the creative engine that concentrates its energy on pushing the technological envelop, and it needs to leave the relatively more routine operation of proven systems to the private sector. Second, NASA has shifted towards protecting the work of its field centers at the expense of drawing more broadly on the expertise of some of the nation's premier universities and other private sector institutions to pursue civil space program needs.

Q2. What are the implications of your committee's recommendations on aligning space with national priorities for Federal agencies? Was the committee suggesting that NASA's mission focus be changed? For example, what would you envision NASA's role in addressing national priorities such as the provision of clean and affordable energy to be relative to the Department of Energy's role? Is there a risk of diffusing the objectives for NASA to the point that the agency becomes ineffective?

A2. No, the committee did not mean to suggest that NASA's mission should change but, rather, that its mission should be more consciously assessed in terms of how it supports broader national needs. For example, in the case that you cite regarding national energy issues, the committee meant to emphasize that NASA should recognize that (a) its climate research program plays a critical role in providing information that will help policy makers assess the implications of alternative energy policy decisions and (b) its advanced technology programs are relevant to searches for new insights to energy technology challenges. The capacity of civil space activities to serve foreign policy interests is another example of how NASA can align itself with broader national priorities. So the committee certainly does not intend to diffuse NASA's objectives but, rather, to encourage the government to think about NASA's role in the context of how it has the capability, within reasonable boundaries of the civil space program, to serve a range of broader national interests.

Q3. Your report's first recommendation—Placing emphasis on aligning space program capabilities with current high-priority national imperatives, including those where space is not traditionally considered—provides a broad policy basis upon which the committee's other specific recommendations are made. Are you saying that your other recommendations cannot be implemented without successfully establishing such an alignment? Do we risk missing unintended breakthroughs from broad R&D research if we primarily focus on these national imperatives?

A3. That is not the committee's intention. The committee feels that the over-arching need is for the civil space program to be understood and supported for its role in supporting broad national priorities. Nevertheless, there are important actions to be taken both in support of that broad national context and to facilitate a meaningful civil space program at any level. However, it is difficult to cite specific examples of actions that are needed and that would not also advance broader national interests. For example, a strong program of scientific research, a strong Earth observation program, rationalization of export controls so as to promote a more competitive U.S. aerospace industry, and a more robust space technology development program are all necessary to sustain U.S. leadership in space and to make the civil space pro-

gram a stronger tool to advance broader national priorities. Hence, the recommended actions are needed to meet the broadest national needs and to sustain a viable space program.

Q4. Your report states that "National space policy too often has been implemented in a stovepipe fashion that makes it difficult to recognize connections between space activities and pressing national challenges." The report goes on to recommend that the President "task senior executive-branch officials to align agency and department strategies" and identify opportunities for how space activities can address priority issues for the United States and, to an extent, the world. Could you elaborate on, what specifically, this recommendations means in practice? To what extent can Federal agencies with different missions and requirements be aligned? What would you envision as the challenges in carrying out this recommendation and what are your thoughts on how those challenges should be addressed?

A4. The recommendation was to urge for a process to gather the technology needs of various federal agencies, and, to see if these needs can be addressed by the technical capabilities of the space program. One way to do this is a broad agency call for technical needs that can be examined by NASA for applicability to its programs. The technical needs could be from any agency. Likewise, this process could be applied in the reverse. That is, other organizations (e.g. 000) may have technologies that can satisfy NASA's needs. The broad purpose of this recommendation is to do a better job of leveraging the technical capabilities and resources of agencies rather than have them all do their own thing.

Q5. Your committee's report recommended that "NASA should revitalize its advanced technology development program by establishing a DARPA-like organization within NASA as a priority mission area to support preeminent civil, national security (if dual-use), and commercial space programs." Could you elaborate on what led the committee to make this recommendation? How would the goals and priorities of this organization be established? How would it differ from NASA's former Institute for Advanced Concepts (NIAC)? Should aeronautics technology development be included too?

A5. Our report explained that "Because of budget pressures and institutional priorities, however, NASA has largely abandoned its role in supporting the broad portfolio of civil space applications, and the [nation's] space technology base has thus been allowed to erode and is now deficient. The former NASA advanced technology development program no longer exists. Most of what remained was moved to the Constellation Program and has become oriented specifically to risk reduction supporting the ongoing internal development program." We then called for a program that would be "focused not so much on technology that today's program managers require, but on what future program managers would wish they could have if they knew they needed it, or would want if they knew they could have it." We also recommended that the program "should engage the best science and engineering talent in the country wherever it resides—in universities, industry, NASA centers, or other government laboratories-independent of pressures to sustain competency at the NASA centers" and that priorities should be driven by an extensive, independent, assessment of the current state and potential of civil space technology. A rejuvenated NIAC could be one element of such a program but not the only one.

The committee did not address NASA's aeronautics technology program, but in my personal opinion, NASA's Aeronautics Mission programs are an example of this problem. Previously, there was little focus on the fundamental aeronautics needs of NASA or agencies the agency supports, e.g. the FAA. In the last couple of years, the Aeronautics Mission area has developed a "Fundamental Aeronautics" program that addresses the basic aeronautical sciences and engineering needs of the future. This Fundamental Aeronautics program has been especially valuable in nurturing and sustaining critical expertise in universities and research companies.

Q6. Your report's second recommendation is aimed at NASA and NOAA taking leadership in forming an international satellite-observing architecture capable of monitoring global climate change and its consequences and support the research needed to interpret and understand the data in time for meaningful policy decisions. In particular, you call on NASA and NOAA to plan for transitions to continue demonstrably useful research observations on a sustained, or operational, basis. As you know, such transitions have been difficult in the past. What must NASA and NOAA do to make them successful? How should the broader issue of transitioning NASA R&D into applications and operational utility to serve national needs be managed?

A6. The 2003 NRC report, *Satellite Observations of the Earth's Environment: Accelerating the Transition of Research to Operations*, concluded that "the [current] transition process in general is largely ad hoc . . . and no mechanism is available to ensure that the transition process in general is efficient and effective." To put it more starkly, no one either at NASA or NOAA is explicitly accountable for planning for and ensuring that transitions are accomplished. Therefore the report's principal recommendation called for establishment of "a strong and effective joint NASA-NOAA office to plan, coordinate, and support the transitioning of NASA research to NOAA operations."

With respect to the broader issue of transitioning NASA R&D to serve broad national needs, the committee's recommendation for a DARPA-like organization to support a preeminent advanced technology program should have responsibility for facilitating research-to-applications transitions as part of its charter.

Q7. *Your committee's report deals forcibly with the risk of human space flight. The report also characterizes the high return to be achieved for conducting human space flight. Is there a mechanism capable of clarifying the tradeoff of risk versus benefits for space activities? If not, what are the key areas of risk and benefits that should be considered in human space flight? What are some examples of transformative outcomes?*

A7. As you note, the report says that worthwhile human space flight activities should have the potential for producing transformative cultural, scientific, commercial, or technical outcomes. Such results could include achievement of a fundamentally new understanding or perspective, a more comprehensive approach, an essential new enabling capability, or the opportunity to visit and observe some unique new location. The risk-benefit tradeoffs for human space flight are probably not quantifiable. But the committee felt that an acceptable U.S. human space flight program should be able to serve broad national interests in terms of technological development, economic growth, and inspiration, and should be of such a caliber that they demonstrably contribute to U.S. global strategic leadership. Examples of such transformative outcomes in the past would include the Apollo Moon landings, successful engineering and construction of the ISS, and the repeated repairs and upgrades of the Hubble Space Telescope.

Q8. *Your report recommends that the U.S. government, under the leadership of the White House, "pursue international cooperation in space proactively as a means to advance U.S. strategic leadership". The report recommendation goes on to list several goals that this strategic international space cooperation should involve including partnerships in global change studies, expanding partnerships in the use of the ISS, and engaging developing nations in the use of space technology to facilitate sustainable development. How did the committee envision the potential implementation of this recommendation? How would you envision this strategic leadership be carried out so to align with the US government's foreign policy goals and agency roles and responsibilities? For example, is this a topic to be included in a G-8 Summit agenda? Do you see a risk in "sharing the fruits of our ingenuity", as you put it, with others?*

A8. There are many areas where other nations have achieved technological capabilities that are competitive with those of the U.S. Examples include Europe and Japan in Earth observation and robotic scientific spacecraft, Europe and Russia in space launch vehicles, and Russia in human spaceflight systems. In cases such as these, the risk of collaboration is not about losing our competitive edge by sharing with others but about losing an opportunity to play global leadership roles and remaining competitive by cooperating and collaborating with others. In other cases, the U.S. has an unquestionable technological lead, for example compared to third world countries in using space observations to benefit agriculture and other terrestrial economic sectors. In those cases, the U.S. can also exert leadership to promote global well-being without putting its technological advantages at risk. A third kind of interaction involves opportunities to cooperate with countries where we also compete geopolitically, because civil space activities provide a means to promote peaceful nonthreatening partnerships even during times of international tensions. This was the case with U.S.-USSR cooperation in human spaceflight during the height of the cold war. This might be the mode for future U.S.-Chinese cooperation in space.

Decisions about which modes of cooperation to pursue and about which elements of the program to utilize need to be made at the highest levels of the government. They need to be made in the context of how U.S. foreign policy is framed to serve the national interest. Once those decisions are made, then there are a variety of platforms, including the G-8 and existing international space fora, at which proposals can be introduced to foreign partners.

Questions submitted by Ranking Member Pete Olson

Q1. Your committee recommends the creation of a DARPA-like organization within NASA. What budgetary needs would the creation of such an office require and if an increase would not accompany it, where would such funding come from within the current budget?

A1. In testimony before the committee, former NASA Administrator Michael Griffin suggested that a proper budget for a good advanced technology program would be about ten percent of the agency's development budget or approximately \$1 billion, and I think that is the right level. Our report was very clear about the fact that there must be a realistic match between NASA's assigned responsibilities and its resources: "Rather than requiring that a broad and ambitious program be fit into an arbitrarily constrained budget as has been the case in recent years, a sustainable strategy would first define the program that the nation is committed to undertake and then realistically define the resources that are required to accomplish that program."

Q2. Please elaborate on the differences as you see them between the benefits to having a long-term vision as opposed to a more short term one? How, in light of President Bush's Vision announcement in 2004 and two subsequent Authorizations by Congress, did the program become "unfocused?" What can be done to prevent such a thing from occurring in the future?

A2. In my opinion, the long-term vision presented by President Bush in the "Space Exploration Policy" of 2004 seems to have gotten off-track both at NASA and in the budgetary process involving OMB. NASA focused many of its resources and efforts on the Constellation program. Some basic science programs, and other developments, were not funded if they did not seem to support Constellation. This was not helped by OMB, which did not support programs that were not linked to Constellation. The solution to this is to mandate that any such program be balanced between long-term needs and short-term efforts, which may actually be enablers for future capabilities.

Q3. You talk about aligning space program capabilities in areas not traditionally considered. What are some of those non-traditional areas?

A3. NASA's core mission has always revolved around space exploration, space science, and space technology. The committee did not intend to redirect NASA from those roles but to encourage attention to how those areas could serve a broader range of national interests. For example, space technology programs can benefit from and contribute to the state of the art in advanced materials, computational design and modeling, batteries and other energy storage devices, fuel-cell and compact nuclear power systems, fault-tolerant electronics, optics, and robotics. These areas are important in energy and transportation management, medicine, and many manufacturing sectors. Another example, which extends to both NASA and NOAA, relates to the fact that Earth remote sensing measurements from space and studies of the science of climate change are critically important for energy policy decision making, because alternative choices about approaches to meeting energy demands can have profound and profoundly different environmental effects.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Patti Grace Smith, Member of the Board of Directors, The Space Foundation

Questions submitted by Chairwoman Gabrielle Giffords

- Q1. *Your written testimony refers to the use of new communications channels such as Facebook to reach out to kids and get them excited about space. Do we know whether or not social networking media sustain interest in space? What happens to those Facebook users beyond their online interaction? What content do you think will be most successful in sustaining kids' interest in space?*
- Q2. *The trends described in The Space Report 2009 regarding interest and achievement in the math, science, and technology subjects vital to the space industry give me pause, especially the finding about 18% and 23% of U.S. high school seniors being proficient in science and math respectively. Are there any initiatives that the Space Foundation has undertaken that give evidence of increasing student engagement in math and science? If so, could you briefly describe them?*

A1. We've seen in the past few election cycles that people who connect through social networking sites, can and will translate their on-line interest with real world activity and support. *The Wall Street Journal*, *CNN*, *Forbes* and other established media outlets have all reported that companies are investing a lot of time and energy into understanding and eventually harnessing the power of these social networking sites for their own business interests. Those of us who care about our future as a space faring nation need to take this seriously and see what we can learn in order to engage and sustain the interest and support of young people.

I also feel I must point out the incredible amount of usage of Facebook and Twitter during the recent political unrest in Iran. These can be powerful tools.

One caveat I must provide the subcommittee is that usage of social networking is not an across-the-board phenomenon. Now that Web 2.0 has been around a few years, researchers are finding that better educated, more affluent children are utilizing it more than less affluent children. Our community cannot have a one-size-fits-all approach. We need to be flexible and adapt communication abilities that fit whichever audience we are seeking.

As for content, I think we need for it to be-honest, compelling and present near-term opportunities for young people. We also need to be ready to jump onto whatever comes after Web 2.0.

A2. We have an entire education department that works with students and teachers K-12 on improved STEM curriculum. In my full testimony I touched upon those specific programs. In my oral testimony in response to a question about education I briefly mentioned the brand new program the Space Foundation has embarked upon with a school district in Colorado.

Colorado Springs School District 11 (D-11) has approved a proposal to create an aerospace-focused middle school in the former Emerson Middle School in partnership with the Space Foundation.

The new school, which will be named Jack Swigert Aerospace Academy in honor of former astronaut and Colorado native John L. "Jack" Swigert, will open this fall with a space-related curriculum designed to drive proficiency in science, technology, engineering, and mathematics (STEM). It is located at 4220 E. Pikes Peak Ave. in southeastern Colorado Springs.

The Space Foundation will:

- Deliver on-site space-related education programs for students and teachers;
- Provide opportunities for students and teachers to participate in Space Foundation programs that bring space industry leaders and leading-edge technologies to the Colorado Springs area;
- Provide enhanced professional development for Swigert Aerospace Academy teachers;
- Create state-of-the-art teaching facilities and equipment; and
- Develop an on-site National STEM Teacher Training Center that will serve the entire district as well as bring in educators from throughout the country.

Student Programs

Among the student programs provided at the new space school will be a customized version of the Space Foundation's *Science, Technology, and Academic Readiness* program.

ness for Space (STARS) curriculum. STARS includes 90 minutes of Space Foundation-provided instruction each week as well as follow-up classroom activities on topics such as rocketry principles, astronomy, earth systems science, and principles of flight. Students may also have opportunities to attend education sessions at the National Space Symposium and to interact with government and industry space leaders.

Teacher Programs

The Space Foundation will ensure that teachers have the skills to provide space-related instruction in the classroom through a series of in-service, professional development, and training programs. The Space Foundation will also conduct its Colorado Springs *Space Discovery Institutes* at the Swigert Aerospace Academy beginning in 2010. These intensive week-long classes provide ready-to-use space-related STEM lesson and activity plans and can be applied toward master's degrees in a variety of science and space studies specialty areas.

Teaching Facilities and Equipment

The Swigert Aerospace Academy will house three learning labs to enhance classroom learning opportunities:

- The Mission Control Lab, which will open during the second semester, will simulate launch, flight and landing of a plethora of satellite space missions.
- The Planetary Rover Lab, which will open during the 2010–2011 school year, will include construction of a simulated Martian terrain to be used for robotics missions using student-designed-and-built robots.
- The Science on a Sphere (SoS) Lab, which will be built if adequate philanthropic support can be secured, will house a room-sized global display system that uses computers and video projectors to display planetary and solar system data and images onto a six-foot-diameter sphere. Developed by the National Oceanographic and Atmospheric Administration (NOAA), SoS can illustrate many compelling images, including atmospheric storms, climate change trends, ocean temperatures, and celestial bodies.

Although primarily for use within the Swigert Aerospace Academy, the labs can also host classes from other schools within the district and students from other districts, providing additional financial resources for the school.

Question submitted by Ranking Member Pete Olson

Q1. Compared to other industries, can you give an overview of the state of the aerospace industry, particularly in regard to its growth?

A1. Aerospace is not immune to the larger global economic forces currently at work. Major aerospace companies have begun to have layoffs due to expected flat budgets at NASA and the Department of Defense on major new sophisticated programs. The most recent forecast from the Aerospace Industries Association (AIA) has forecasted for the near term future reduced federal R&D budgets that will impact American aerospace. Recently both Boeing and Airbus have had trouble delivering new flagship airliners on time to their customers.

The most recent *Commercial Space Transportation Forecasts* from the FAA's Office of Space Transportation, which looks ahead through 2018, project an average annual demand of 26.7 commercial space launches worldwide from 2009 to 2018. The forecasts are a decrease of 3 percent compared to the 2008 forecast of 27.4 launches per year. Twenty-eight commercial launches occurred worldwide in 2008. Additionally, Forecast International (FI) projects 636 expendable launch vehicles to be produced over the coming decade, worth approximately \$48 billion.

As stated in our *2009 Space Report*, the recent credit crunch has also impacted the ability of commercial space companies to obtain capital. This crunch may delay the acquisition of replacement satellite systems by commercial satellite fleet operators. Companies with strong balance sheets in this period of economic uncertainty may also see to build alliances with industry partners or seek outright mergers and acquisitions.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Debbie Adler Myers, General Manager Science Channel

Questions submitted by Chairwoman Gabrielle Giffords

Q1. In Mr. O'Brien's prepared statement, he said that NASA's Public Affairs needs to "speak with one voice." At the same time, he testified during the hearing that NASA workers "need to be empowered" and "spread the word." He mentioned being allowed to twitter as one example of empowerment. That of course raises the issue of how to approach having NASA speak with one voice while also encouraging empowered workers to speak as individuals without being concerned about being "off message" can be reconciled. What is your reaction to Mr. O'Brien's statements?

This notion of "staying on message" while also having freedom of expression is something we've considered at Science Channel as well. We often have new hosts and presenters on our series with personal interests in Facebook, Twitter or other forms of social media. Some are also working journalists, either professional bloggers or print reporters. We've developed guidelines to help our social media-inclined talent understand how we talk about Science Channel and when it's appropriate to share information.

What could be very exciting for NASA is developing a program that would allow chosen employees to begin using social media. NASA could identify the best people, at all levels of the organization, not just at the top, who would be ambassadors to spread the word about their agency and specific missions. Once selected, they would be trained and given ground rules, then encouraged to reach out to their social networks or create new ones. Allowing a large, but selected group of people to authentically spread the word about their work would give NASA a greater voice and allow the personalities and passion of the employee base at the agency shine.

Q2. What do you view as the most significant barriers for NASA in communicating the relevance and inspiration of space to the public at large? What would you recommend be done to overcome those barriers?

A2. The biggest challenge is how to make what NASA is doing understandable and exciting to a general audience. Public-private partnerships could help overcome this barrier. Science Channel and other private companies play an important role in getting the word out. If NASA could create a forum for regularly sharing information about their upcoming missions and research, it would allow the private sector to help them get the general public invested in their success. Quarterly briefings to media organizations would allow NASA the opportunity to not just tell us what the data says, but also what it really means, or could mean to the future. At Science Channel, it's our responsibility to take the work of NASA and make it relevant to people's lives—our job is to take the information provided and craft it into amazing content that lives on television, online, mobile and devices yet to be invented.

Q3. Your prepared statement speaks to the interest that your viewers have in space and notes that "it is one of their favorite subjects" and "space programming rated 25% higher" than your network average during the last quarter. How do you reconcile the interest that your viewers express with the oft-expressed notion that there is waning public interest in space?

A3. We look for great space stories and present them in a way that engages our audience and inspires them to think and feel. It's important to note that we aren't presenting research papers or showing missions in real time (unless we are live)—instead we have the tremendous luxury of following a project for months and editing it into a riveting hour of television. That's very different than watching a silent space walk in real time—we can explain what's happening, provide background about the dangers the astronauts face and put the mission in the context of human achievement. It takes a team of incredibly talented producers and editors, as well as willing astronauts and scientists, to make this hour of television.

Customizing content for different audiences is not a "one size fits all" format, it's an art form. We seek to make people feel a connection to space. We've found that viewers want information for their brains, but they need us to capture their emotions at the same time. In short, we do not believe that interest in space is waning, but that the citizenry is simply demanding that space information be presented in engaging and accessible formats that make space relevant to their lives.

Q4. In your written statement, you note that "we bring science to life by making it relevant to people's everyday lives, celebrating the ingenuity in all of us." That

gets to the heart of this bearing. How do Science Channel and Discovery go about making space relevant to people's everyday lives? In that regard, you note in your prepared statement that "the cliché we struggle against is that science is boring and dry and something that I might not understand." How does Discovery work to entertain without compromising depth and scientific accuracy?

A4. Scientific accuracy is absolutely essential to all that we do without it, we're a pure entertainment channel. What we've found is that a mix of approaches to science is critical to success. We have nights of very deep science, including physics and mathematics. But we're also programming lighter nights, with a science trivia show or an engineering competition series. It's important to appeal to people with widely different interests in (and understanding of) science. We give them a base of knowledge and encourage them to sample our more challenging fare. If presented in the right way—with engaging experts and great visuals, with a storyline that makes it clear that this science matters, that it's part of their lives—then we've succeeded. We also provide a depth of resources online for people who might want to learn more—this is hosted on a combination of ScienceChannel.com and HowStuffWorks.com. And, finally, we're experimenting with new ways for audiences to connect with our mission and content, through Twitter, Facebook, gaming and mobile devices.

Q5. For what purposes and with what type of content does it make sense to use social media, such as Facebook and Twitter, for outreach on space activities and when does it not make sense?

A5. Social and new media is absolutely critical to the future success of our business. This is an entirely new language for the current generation. What we've found is that when people feel like they can see behind the scenes, they get a sense of ownership and connection. When we open up our content and mission via social media, we give a voice and personality to Science Channel and we provide a more intimate relationship to our audience.

A majority of our time has been spent on Twitter outreach—it's an instantaneous assessment of what our viewers like, what kinds of information they seek out and how they're reacting to our website or programming. We have a very active Twitter channel where we host scientists, talent and our own staff members for live sessions and we also re-post information that we think is pertinent to our audience—like interesting articles from Popular Science or a science magic show in New York City. In the space genre, we actually hosted a NASA scientist on our Twitter live during the Hubble repair mission. Our audience loved it—their questions were answered in real time as they watched the launch.

It makes sense to use Twitter if you have the time to create a "personality" for your feed. It helps to have just a few people creating a voice for the organization and then host people who can provide a greater depth of information. Imagine how exciting it would be for people to tweet with a former astronaut during an important mission. Or with a NASA Mars expert during the next Hollywood feature film that has a storyline about a colony on the red planet? Using Twitter would make NASA exciting and more three dimensional.

Q6. In your prepared statement, you refer to Discovery's partnership with NASA, and other entities, "to film their amazing achievements and then bring them to the viewer at home." You also noted how a dialogue with NASA about its research and future missions led to an eight-part series you'll air on the big questions in space. How well are these types of partnerships working? What are the best ways to leverage the strengths of both NASA and outside communications entities to inspire, engage and educate about space and the benefits of space to society?

A6. The partnership with NASA Goddard that lead to the series with Morgan Freeman has been a tremendous success. Our first meeting set the stage for a deeper partnership and we are now creating an "advisory committee" to help us shape the program further. NASA has provided us with access to scientists, footage and technology and will serve as our technical advisor on the series to ensure accuracy. Our goal is to take what NASA is doing now and project it three more steps into the future, so the accuracy of our projections is critical.

Q7. 1A provision in the NASA Authorization Act of 2008, which became Public Law 110-422, focuses on ways to enable public participation in space exploration missions to the Moon, Mars or other bodies by using technologies that can deliver a rich, multimedia experience of the actual exploration mission to the public through broadcasts and the Internet. What are your thoughts on how digital

communications and communications technologies might help bring the public closer to experiencing space exploration?

A7. As discussed above, there are a multitude of options. NASA could have a former astronaut or other expert available to twitter during a key mission, or have interactive quizzes or fast facts available on a dedicated website page so that viewers could follow up on or dive deeper into topics they find to be of particular interest, or partner with media companies who can provide access to supplemental entertainment and educational resources such as space-related movies, documentaries, or books, or reach out to schools by showing missions in the classroom over broadband connections so that teachers can guide students' experiences as part of their curricula.

Questions submitted by Ranking Member Pete Olson

Q1. What might Congress do to enable better and more effective partnerships between private broadcasters and government agencies?

A1. Congress' information-gathering and lawmaking authority well positions it to ensure that public-private partnerships exist. Simply knowing that Congress feels this is critically important is very motivating. Pose the questions to us and challenge the public and private sectors to come up with solutions together. I recommend starting a media advisory committee to work with NASA and NOAA to help them better communicate their messages to the media. We need better access to scientists and people who want to tell their stories and we also need to help those people learn how to make their stories compelling. I would welcome the opportunity to help the agencies with this process and with setting up engaging quarterly briefings for media.

Q2. What obstacles have you seen within NASA that, as a government agency, prohibit it from publicizing its achievements?

A2. Because NASA's core mission is not one of story-telling or self-promotion, but rather one of scientific exploration, it can benefit from public-private partnerships with entities whose primary mission is to educate and inspire the public. We were incredibly lucky to find a champion at NASA Goddard to help us navigate the agency and this has been critical to the success of our partnership and our ability inform the citizenry about the exciting things NASA has done and plans to do. Congressional encouragement of such partnerships and NASA's ongoing education of its partners about what it is doing are essential to the creation of vital and productive partnerships-partnerships that tell engaging stories and make space relevant to people's lives in ways that would be difficult for NASA to do alone.

Q3. Regarding NASA's communications and messaging strategies; what is NASA particularly good at? In what forum and on what subjects is NASA the most effective?

A3. NASA is at its very best when something BIG is happening, such as potentially finding water on Mars. No one is better at the big finds, providing free footage, access to experts and amazing resources to media.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Miles O'Brien, Journalist

Questions submitted by Chairwoman Giffords

Q1. In your prepared statement, you stated that "the agency, dispersed geographically as well by centers of expertise and excellence -does not speak with one voice as it should. Public Affairs here in Washington needs more authority to direct the far flung PR operations . . ." In addition, you testified during the hearing that the NASA workforce needs "to be empowered . . . because if you unleashed the power of that workforce, and allowed them to spread the word, we could just stand by and watch them win the country over." You mentioned allowing workers to twitter as one way to help empower them. How do you reconcile the need for the agency to "speak with one voice" while at the same time allowing each individual worker to speak as an individual and not be concerned about being "off message"?

A1. The remarks may seem inconsistent, but I am talking about the difference between strategy and tactics. The Public Affairs Office in Washington needs to have more direct authority over the PAO offices in the field centers and the EPO personnel assigned to specific mission directorates. All of these entities have tremendous autonomy to conduct public relations as they see fit. This leads to inconsistencies, inefficiencies and parochial interests trumping the greater good for NASA on a national level. NASA must have a single entity that is seeing the big picture when it comes to messaging. All that said, there is tremendous untapped potential to harness the enthusiasm, passion and knowledge that NASA foot soldiers possess. Social networking is an amazingly powerful tool to engage people in the adventure of space in a very personal way. NASA's workforce should be empowered to engage people in this manner—but just like the PAO and EPO offices in the Centers and Directorates—the people who engage in social networking must be aware of the boundaries and the overall priorities of the agency. NASA is filled with smart people who want to do the right thing for the agency (and for the great goal of keeping the public engaged in space) so I suspect the agency might be pleasantly surprised at how effective this approach might be. Loosening the reins is not without risk, but the upside far outweighs the possible occasional embarrassment that might arise.

Q2. What do you view as the most significant barriers for NASA in communicating the relevance and inspiration of space to the American people and to the public at large? What do you recommend be done to overcome those barriers?

A2. The biggest barrier is timidity and fear. Frankly, NASA has become so worried about making a misstep that will offend a member of congress, an OSTP staffer or the general public that it often delivers a message that is bland to the point of banality. The irony is NASA, an agency that knows as much about risk (and managing it)—is risk averse when it comes to talking about that very risk. This is a problem that primarily infects the piloted space side of the house—and has deep roots in the way the space shuttle program was sold to Congress. NASA sold the STS as a routine "airliner-like" avenue to space—and thus downplayed the tremendous risk of flying a space shuttle. This gave the public good reason to tune out when the missions flew—and then alienated and angered people when it became tragically apparent that it was not the case. NASA should embrace the risk—and speak candidly about it. The public will be all the more fascinated if they know the real stakes when people push the high frontier.

Q3. For what purposes and with what type of content does it make sense to use social media, such as Facebook and Twitter, for outreach on space activities and when does it not make sense?

A3. It makes good sense for NASA workers to share the day to day excitement and challenge associated with their jobs. What is it like to be faced with a huge problem that no one has solved—and have to think up a solution—and by the way—human lives are at stake . . . Or how do smart people decide where to land on a distant planet. And what are the trade-offs between weight, capability, budget and time as you build a spacecraft. What amazing findings have NASA's armada of spacecraft yielded—and what do they tell us about the universe? Are we alone? What do NASA people think? Why are they so excited to go to work every day? Why is learning something really hard, like engineering or physics, so worth it? Why does an astronaut with a family believe it is worth risking his/her life to go to space? It goes on and on . . . NASA is a narrative rich environment. There are so many good stories

to tell that would engage people. The areas where NASA folks on the social nets should steer clear should be obvious: talking about operational decisions in real time, commenting on agency policy or making political statements. But if NASA can trust its people with the lives of its astronauts, surely they can be trusted to speak freely (within boundaries) about their work with the public.

Q4. There's an ongoing national conversation about the news industry being in jeopardy, and the role of journalism in society. With regard to science, we depend on skilled journalists who can sort through the complex issues, who can report in a balanced way, and who can help people understand what they need to know about current science and research, and how it impacts their families and communities. This matter is particularly relevant to today's hearing on the relevance of space to people's lives. To what extent does the quality of journalism about space affect the public attitudes, understanding, and awareness of space?

A4. The skilled journalists who have expertise in this realm are still out there—but they are no longer at the mainstream outlets—which have gone out of their way to ignore science and technology coverage—Even in the face of evidence there is a large audience with an appetite for the content. That said, the mainstream outlets, with few exceptions, are in their own race to the bottom and no one in Congress or at NASA should spend much time pondering cures to what amounts to a terminally ill patient. The good journalists are finding homes in new places. They are on the web, blogging, tweeting and meeting their audience on Facebook. They are producing video content for virtually no cost at all—and they are informing an audience that finds them wherever they are in the world. The good journalists are still out there but they are in a different neighborhood. They are no longer constrained by the confines of Michael Jackson, Balloon Boy and Tiger Woods and thus they are providing much more in depth coverage than ever. This only further buttresses the case that NASA needs to be a player in this league.

Q5. You are now covering Shuttle launches for web viewers through a website. Does the difference between a general audience, as is the case for national news outlets, and a space-specific audience, as is likely the case for most space websites, alter the way you report? Are there any conclusions you would offer as to how space activities might be reported more effectively to the general public in order to generate and maintain viewer interest?

A5. Clearly when I am on for six straight hours, I have time to indulge viewers in minutiae and details that would never see the light of day on CNN. But as a history major. I come to the technical field always cognizant of the Humanities Nation. You need to be unafraid to delve into the world of the left brain—while always operating from the right brain. It is possible to introduce an audience to complex ideas—so long as you are learning with them. This is how you keep viewers engaged and that is where NASA, an organization of scientists and engineers, often misses the mark with the general public. Not everyone speaks the language of space—indeed most people are positively phobic about it. Finding people who have a foot in the world of the arts and language—and no fear of the technical is the key to pushing NASA outside its bubble.

Question submitted by Ranking Member Pete Olson

Q1. What obstacles have you seen within NASA that, as a government agency, prohibit it from publicizing its achievements?

A1. See response to number 2.

Q2. Regarding NASA's communications and messaging strategies; what is NASA particularly good at? In what forum and on what subjects is NASA the most effective?

A4. I would give a gold star to JPL—for allowing the public to engage in a special kind of participatory exploration. They were the first to allow people to see science at the same time the scientists got the raw data—and they have never blinked since then. Their efforts to pioneer the use of Twitter and other social networks remain in the vanguard for NASA. In Houston, there are pockets that have understood this and have pushed the social networking envelope—but it is in spite of Public Affairs—not because of it. The lesson here is there are passionate people champing at the bit to share their love of space with a larger audience. NASA must find a way to give them some freedom—or ultimately the agency will become irrelevant.

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