

**Hearing of the Senate Subcommittee on Science, Space, and Competitiveness**

**“U.S. Human Exploration Goals and Commercial Space Competitiveness”**

**Tuesday, February 24, 2015 - 2:00 PM – Russell Senate Office Building 253**

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Thank you, Chairman Cruz, Ranking Member Udal, and members of the committee, for providing an opportunity to discuss the important topic of the future of human spaceflight and the strategic national interests served by international leadership in such endeavors. My testimony today is based on previous writings and presentations, most notably, my 2014 Durand Lectureship in Public Services sponsored by the American Institute of Aeronautics and Astronautics.

**American Space Strategy Adrift**

I would like to talk to you today about American space strategy and the choices before us. Space activities today play critical roles in U.S. national security, economic growth, and scientific achievements. Satellite communications link the world. The Global Positioning System (GPS) is an integral part of several critical infrastructures, and enables functions ranging from survey and construction, to farming, finance, and air traffic management – not to mention critical support to US military forces worldwide. Less well understood is that the GPS time signal provides a global time base for encrypted communications – including point-of-sale transactions. Without GPS, much of today’s economy would come to a halt. We have rovers on the surface of Mars, and a probe that has left the solar system. The International Space Station represents a unique collaborative partnership between the United States, Europe, Canada, Japan, and Russia. New national entrants, some of them potential adversaries, may pose risks to the long-term sustainability and security of space activities as a result of increasing orbital debris and the proliferation of space capabilities.

While space touches every aspect of modern life, I would like to focus on human space exploration, as that topic is the one whose future is most in doubt today. This is unfortunate, as human space activities are among the most interdisciplinary of enterprises, requiring skills from every field of technical endeavor. Their successful accomplishment requires a degree of systems engineering skill found only in the most complex and demanding programs. The ability and willingness of a nation to lead such endeavors conveys much about the nature and intentions of that society. Thus, human spaceflight continues to possess enormous symbolic value, leading directly to important political, economic, and scientific consequences, both

domestically and internationally. Human spaceflight is therefore a matter of considerable interest to policymakers, and should be.

It is my argument that international space cooperation, space commerce, and international space security discussions could be used to reinforce each other in ways that would advance U.S. interests in the sustainability and security of all space activities. At present, however, these activities are largely conducted on their individual merits and not as part of an integrated national strategy. I will return to this point later.

The International Space Exploration Coordination Group (ISECG) is a coordination mechanism among the major space agencies created in response to the Bush Administration's Vision for Space Exploration. The ISECG has been able to combine previously separate "Moon First" or "Asteroid First" approaches for going to Mars into a single scenario where cislunar space is the next step for human explorations beyond low Earth orbit. This is a major accomplishment, in that it has been the inconstancy of U.S. policy choices that have made attaining an international consensus so difficult in recent years.

The central elements of the current U.S. approach toward human spaceflight are found in the President's 2010 National Space Policy, which says that the NASA Administrator shall "set far-reaching exploration milestones. By 2025, begin crewed missions beyond the moon, including sending humans to an asteroid." This declaration came as a surprise to domestic and international space communities, following as it did upon the heels of two prior Congressional Authorizations Acts in 2005 and 2008 in which a human return to the Moon was specifically set forth as the next focus of U.S. space exploration. The international space community in particular, which had been shifting attention to the Moon as the completion of the International Space Station (ISS) drew near, felt blindsided. Countries in Asia, such as Japan, India, China, and South Korea, saw the Moon as a challenging but feasible destination for robotic exploration and a practical focus for human space exploration, a goal offering missions in which they could reasonably expect to play a part. The lack of U.S. support during the present Administration for a program to return to the Moon made it difficult for advocates of human space exploration in the United States, Europe, Japan, India, and elsewhere to gain funding for any efforts beyond the ISS.

While the United States continues to be officially uninterested in leading a human return to the Moon, the Moon is the next logical target for all of our potential international partners. Russia has made several presentations at various international conferences endorsing human missions to the Moon. China has not made an official decision to send humans to the Moon, but is proceeding with a steadily advancing robotic program that is putting in place the technical pieces necessary to conduct more ambitious missions when they so choose. They have landed a nuclear-powered rover on the Moon, unveiled designs for a Saturn 5-class heavy-lift launch vehicle, and are building a space station that will be open to

international participation. Growing space powers such as the Republic of Korea and India have their own unmanned lunar ambitions, and even the private sector is looking to the exploitation of lunar as well as asteroid resources.

Europe is more cautious about human missions to deep space. They would almost certainly join in a U.S.-led effort, but would not lead one without us. Unfortunately, there is no real U.S. plan or intent for human space exploration beyond the International Space Station, as there is no longer any real funding or any defined architecture for such endeavors. There is, however, a clear policy to create new U.S. providers of cargo and crew services to low Earth orbit to replace government capabilities. Using the ISS as an early market, the hope is that these new providers can provide lower cost services to meet government needs, be able also to compete for non-government payloads, stimulate new demand with lower prices, and thus contribute to U.S. economic growth. Cargo capability has been demonstrated, while crew capabilities are a work in progress. In addition, cost reductions are not yet evident in out-year projections of ISS funding needs.

There are risks in the current U.S. approach to human spaceflight. The United States finds itself reliant on the economic success of private service providers, and, through the intergovernmental agreements pertaining to the International Space Station our partners must now share this reliance. The companies themselves are also at risk. Should there be a “bad day” on the Station, this would be not only a disaster for NASA, but would also put an end to the near-term market for the so-called “commercial crew and cargo” companies. It would be very difficult to restart a U.S. human spaceflight effort without the pull of either the ISS partnership or the follow-on goal of a lunar return, and it is unlikely that private firms would, or even could, recreate a human spaceflight capacity without U.S. government demand and support.

Even assuming no accidents with the ISS, it will likely be impossible to operate the facility beyond 2028 due to life limitations on crucial station elements, obsolescence, and a lack of replacement parts. Political commitments may fade even earlier, as there is not yet a consensus among the partners to operate the facility beyond 2020.<sup>1</sup> Without commitments from the partners, it will continue to be difficult to induce scientific investigators to invest years of their career in carrying out an experiment which might fly once, if at all, before the facility is closed. And despite the promise of space tourism, it is also unlikely that the market will be large enough and stable enough by 2020 to replace the demand for human spaceflight now generated by the ISS partnership and NASA in particular.

Human space exploration and U.S. human spaceflight for the next decade will continue to be driven by U.S. space policy as reflected in the NASA budget. That budget is itself a political choice – it is a reflection of what we value as a society.

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<sup>1</sup> The White House and NASA announced on January 8, 2014 that the United States would extend its participation in the ISS until at least 2024.

NASA's budget has been declining in constant dollar terms for decades. If NASA today had the same budget in constant dollars that it did in 1992, it would be \$24 billion dollars. To the question of affordability, it should be understood that -- in constant dollars -- the Administration's stimulus program was greater than NASA's budget from 1958 to 2008. To emphasize: the United States sent humans to the Moon, built and operated a Space Shuttle fleet for 30 years, completed the initial robotic exploration of the solar system, built and operated several space telescopes, and contributed its share of the International Space Station for less than the cost of the American Recovery and Reinvestment Act.

That being said, fiscal limits are real and harsh. The performance requirements for getting humans safely to other worlds remain constant and demanding. As budgets are pushed down, schedules slip and risks increase. We cannot, however, focus solely on cost, as funds spent on any space activity have to compete successfully against other budgetary demands. If we are to sustain discretionary expenditures for civil space exploration, we must develop a clearer rationale linking such efforts to national interests that can be supported in a bipartisan manner over many years. In the absence of any larger strategic context for a human spaceflight program, ambitious mission concepts are insufficient to justify the required levels of effort.

### **Budget Volatility**

There is a line from the movie "The Right Stuff" in which the actor playing Gordon Cooper says: "You boys know what makes this bird go up? FUNDING makes this bird go up." I would go further and say: "What creates funding? Bipartisan support creates funding."

Bipartisan agreement was reached in the aftermath of the tragic loss of the Space Shuttle *Columbia* that the United States should continue to explore beyond Earth orbit, returning to the Moon and then voyaging to Mars. President Bush called the Vision for Space Exploration "a journey, not a race" and one that would not be done by the United States in competition with other nations, but in partnership with them. The Congress passed two successive NASA authorization bills in FY2005 and FY2008 with strong bipartisan majorities endorsing this direction.

The Obama Administration decision to overturn that consensus led to the protracted battle over the FY2010 NASA Authorization Act. The future of human spaceflight and the role of U.S. leadership were at the center of the debate between Congress and the White House. The result of this conflict was budget volatility as well as policy uncertainty, two factors that have burdened the U.S. human spaceflight effort for several years now. In addition to the flawed policy direction of focusing on an asteroid mission in the near term and an unknown path to Mars in the long term, the Administration's unstable budget requests for NASA have created immense challenges for the Agency's managers, scientists, and engineers. As an illustration of budget volatility, see Figure 1 below. It shows enacted budgets for NASA as well as the five-year budget request for FY2010-2016. The FY2010

budget had a “pause” in human spaceflight in the out-years while the Augustine Committee was working. The FY2010 budget top-line returned but internal Agency priorities were greatly different, leading to the conflicts with Congress. FY2011 saw a dramatic drop and flattening of the NASA budget request, creating more uncertainty for planning. The situation worsened in FY2012, FY2013, and FY2014 – leading to the wry comment at NASA that “flat is the new up.” This year, the FY2016 request shows a significant increase, but without changes in policy priorities to know if this change will be stable going forward.

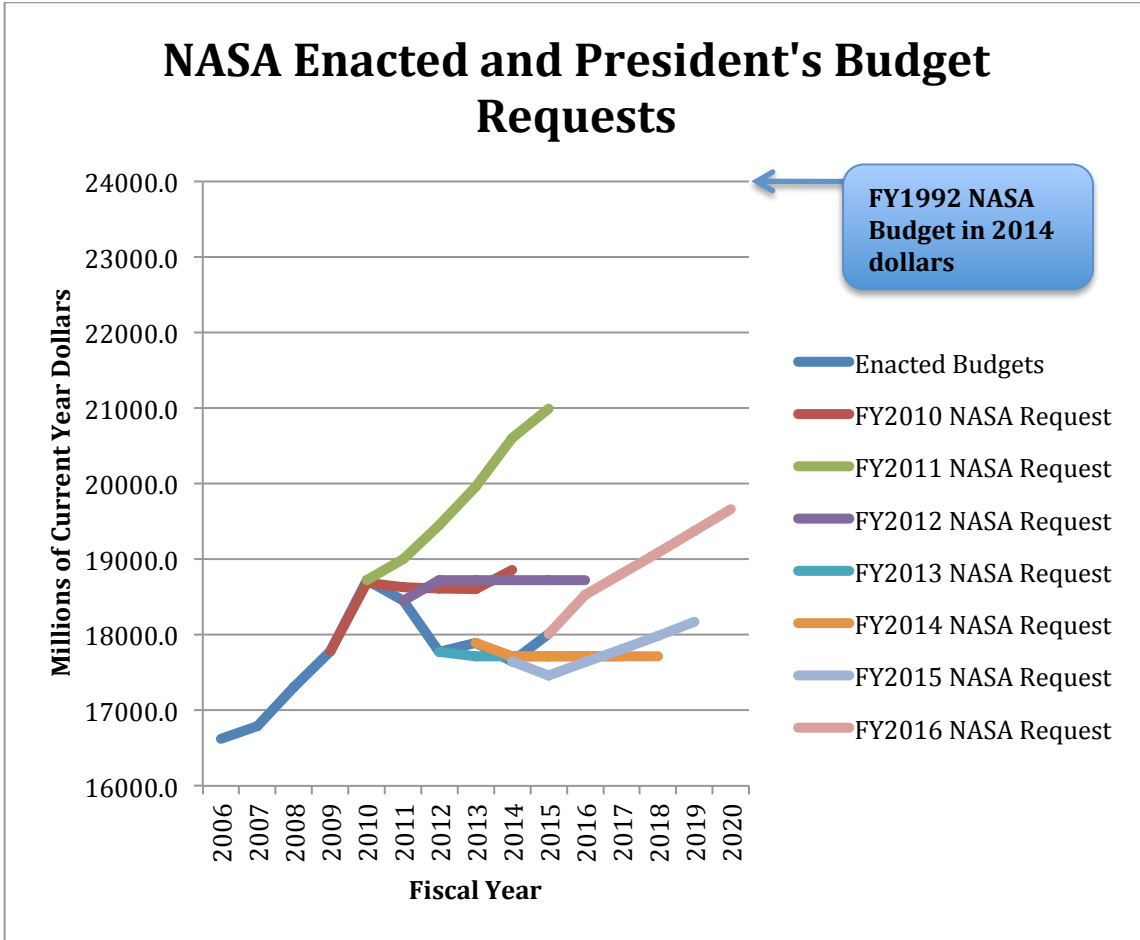


Figure 1 – NASA Enacted Budgets and Presidential Budget Requests FY2010-16

### Global Space Competition

The uncertainty and drift attending human spaceflight efforts today have consequences beyond our borders. Working in a school of international affairs, it is easy to see the importance of cross-national “functional” issues such as security, trade, development, and technology to U.S. foreign policy. Of particular importance are debates over areas beyond traditional definitions of sovereignty, such as the high seas, international air space, the Polar Regions, space, and cyberspace. These are today’s frontiers, and are thus areas of potential conflict and cooperation among

state and non-state entities that impact U.S. interests. As with past frontiers, it is those who show up, not those who stay home, who create the rules and establish the norms in new areas of human activity.

In a world in which space capabilities are increasingly global, no one state will be in a position to impose rules unilaterally for the exploration and development of space. Similarly, the diversity of competing national interests in space make it unlikely that a single international space authority or even a new space treaty will emerge anytime soon. Thus, the task for the United States, if it wishes to influence how space is developed and utilized, is to create attractive projects and frameworks in which other nations choose to align themselves, and their space activities with us, as opposed to others. Just as the United States shaped the postwar world with a range of international institutions, so we should look to the creation of new arrangements to advance our interests, values and freedoms in space.

There is nothing inevitable about U.S. leadership in space unless we make it so. I attended the International Astronautical Congress in Beijing in 2013. As might be expected, U.S., Russian, and Indian attendance was light. Nonetheless, the Chinese did a good job hosting the conference with welcoming remarks from Li Yuanchao, Vice President of the People's Republic of China, and a display of their three-man Shenzhou 10 capsule. There were also displays of Brazilian, Ukrainian, and South African cooperation with China, and one could easily see what a global space community might look like without the United States. It was in effect a picture of a post-American space world, with a full range of manned and unmanned space activities, but without American leadership or even, in many cases, an American presence.

China is planning to deploy its own space station in less than a decade, about the same time that the International Space Station may be ending. If China is able to offer pragmatic opportunities for space cooperation on its own space station or as part of efforts to send humans to the Moon, and the United States cannot, then other countries will likely find it attractive to forge closer relationships with China. Such a shift in international space influence away from the United States and toward China will, no doubt, impact a wide range of U.S. national security and foreign policy interests, both in space and in other arenas.

The United States retains several advantages in space, however. We have decades of experience and close relationships with almost every spacefaring nation on a wide range of projects. The entrepreneurial energy of the private U.S. space community, both large and small, is a source of admiration by and occasional puzzlement to the international space community. At the same time, a proud history and a nascent private industry cannot alone substitute for national and international leadership in space, and likely cannot survive, much less thrive without it. Both international cooperation and private sector initiative are necessary aspects of any effective American strategy in space, but are not by themselves sufficient. A focused national

strategy is also needed to provide a coherent context for both cooperative agreements and private ventures.

### **Choosing a Direction**

It is crucial to remember that international space cooperation is not an end in itself, but a means of advancing national interests. Those interests can be for security, commerce, science, international influence, or any combination thereof. A human space exploration effort driven by geopolitical interests and objectives provides the historic model and rationale for the United States. The United States undertook the Apollo program in the 1960s to beat the Soviet Union to the Moon as part of a global competition for Cold War prestige. The Apollo-Soyuz program symbolized a brief period of détente in the 1970s. The Space Station program was established in the 1980s, in part, to bring the developing space capabilities of Europe and Japan closer to the United States and to strengthen anti-Soviet alliances. Russia was invited to join a restructured International Space Station in the 1990s to symbolize a new post-Cold War, post-Soviet relationship with Russia.

The next steps beyond low Earth orbit will require international partners for practical and political reasons. Therefore, it makes sense to ask what our partners would like to do, and what they are capable of doing in the future. The answer is the Moon – with Mars and other destinations in the distance. A U.S. commitment now, to lead a multinational program to explore the Moon would be a symbolic and practical first step as well as a means of creating a broader international framework for space cooperation. At the same time, the geopolitical benefits of improving relations with growing space powers through greater U.S. engagement could support more ambitious space exploration efforts than science alone might justify. Providing commercial cargo delivery to the lunar surface would be an attractive post-ISS market for U.S. industry; the volume and duration of that market would be enormously more attractive to industry than that for the ISS could ever be. The Moon is not just a destination, but also a means of answering questions, creating capabilities, training organizations, and forging new relationships to serve the interests of the United States and its allies.

The United States is crucially reliant on space systems, and the future sustainability and governance of space activities are key strategic interests for us. U.S. human space exploration today is “capability driven,” with ambitious goals in the distance that are not well connected to other national interests, notably in international relations and commerce. If we are to have an effective American space strategy, we need to align our policies, programs, and budget priorities with enduring national interests. This means looking beyond individual missions and seeking to determine what future humanity might have beyond the Earth, and what values will be part of that future. I would like those values to include the things we value today – democracy, human rights, the rule of law, and free markets.

I will close with a quote from Oliver Wendell Holmes, Sr. "I find the great thing in this world is not so much where we stand, as in what direction we are moving - we must sail sometimes with the wind and sometimes against it - but we must sail, and not drift, nor lie at anchor." We need the confidence to choose what course offers the greatest advantage to our nation and our values.

Thank you.



## Comments on the President's FY2016 Budget Request for NASA<sup>2</sup>

The President's FY 2016 budget request contains a 7 percent (\$74 billion) increase over the FY 2015 Omnibus spending level, with NASA receiving \$18.5 billion – a nearly \$500 million increase above the FY15 Omnibus and nearly \$1 billion above the President's budget request last year.

The proposed increase to NASA's budget largely benefits two of the Obama Administration's top priorities: Earth Science (+175M) and Commercial Crew development subsidies (+438M). These increases come at the expense of Exploration systems under development, including the super heavy lift Space Launch System (SLS) and the exploration crew spacecraft, Orion, which completed a successful inaugural test flight in December 2014.

The proposed cuts to SLS and Orion almost directly correspond with the budget's nearly half billion jump in funding for the Commercial Crew program. In September 2014, NASA announced the selection of Boeing and SpaceX to continue development of spacecraft for crew launches to the International Space Station by 2017-2018. Congress has repeatedly sought to constrain spending for this program and to narrow the number of program participants. SLS and Orion are the systems that will enable human exploration of space beyond low-Earth orbit. Of particular concern are potential reductions to the funding of SLS core stages that would further delay the program and increase total costs.

Overall, space technology budgets fare well in this year's request: the budget again proposes a \$128+ increase to the Space Technology mission directorate and the Advanced Exploration Systems account, which funds exploration systems like habitat and landers, receives an increase of \$48 million. While modest, funding for AES is important to ensure that systems are developed which leverage NASA's SLS and Orion capabilities enabling a return to the surface of the Moon.

For the third year, the budget continues to propose funding for an Asteroid Redirect Mission, which has been widely panned by the Congress, the scientific community, and NASA's international partners. The administration is again proposing to divert funding in the Advanced Exploration Systems and Space Technology accounts to pay for this mission.

The budget also continues efforts by the administration to cut programs favored by Congressional stakeholders, like Planetary Science and Aeronautics. Both programs are cut by approximately \$80+ million relative to the recently enacted FY 2015 Omnibus.

Although the President's budget violates sequestration budget caps and makes unrealistic assumptions about new revenue to allow for increases in discretionary

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<sup>2</sup> Adapted from *The Hay Bulletin*, Issue 34, The John Hay Initiative, February 12, 2015, p. 7

spending, the topline increase for NASA is welcome and should be encouraged within the allocation provided by the House and Senate budget resolutions. Republicans and Democrats in Congress both approved funding for NASA that was well above the President's request last year and should be encouraged to prioritize investments in the space program. For example, the Congress should enforce balance in the science portfolio to ensure that programs like Planetary Science and Earth Science receive funding consistent with their scientific merit.

The appropriations process should prioritize investments in NASA's Exploration program by fully funding SLS, Orion and Advanced Exploration Systems, while restricting spending on the Asteroid Redirect Mission. A heavy-lift capability of 130 mT (e.g., Saturn V class) is highly beneficial for a human return to the Moon and a necessity for eventual human missions to Mars. Lacking such a capability would mean doing multiple orbital assembly flights at substantial additional cost and risk. The upper stage necessary to reach the 130 mT capability continues to be underfunded.

As a possible offset to the administration's proposed increase for Commercial Crew, Congress could direct NASA to adopt a "leader-follower" approach with the final level of funding provided for the program. Under this approach, NASA would provide full funding to the primary crew award winner to ensure the development of domestic access to ISS by 2017, while the second crew system would come online later, pending the availability of resources and the progress made by the "leader" and an evaluation of the market for these services.

Through authorization and appropriations bills, Congress should provide clear direction for NASA on an exploration mission for the 2018-2025 timeframe as SLS, Orion, and other exploration systems currently under development begin operations. The Congress should direct NASA to focus on the mission concepts for an international return to Moon, with private sector partners, in anticipation of a new Administration in 2017.

## Scott Pace

Dr. Scott Pace is the Director of the Space Policy Institute and a Professor of the Practice of International Affairs at George Washington University's Elliott School of International Affairs. His research interests include civil, commercial, and national security space policy, and the management of technical innovation. From 2005-2008, he served as the Associate Administrator for Program Analysis and Evaluation at NASA.

Prior to NASA, Dr. Pace was the Assistant Director for Space and Aeronautics in the White House Office of Science and Technology Policy (OSTP). From 1993-2000, Dr. Pace worked for the RAND Corporation's Science and Technology Policy Institute (STPI). From 1990 to 1993, Dr. Pace served as the Deputy Director and Acting Director of the Office of Space Commerce, in the Office of the Deputy Secretary of the Department of Commerce. He received a Bachelor of Science degree in Physics from Harvey Mudd College in 1980; Masters degrees in Aeronautics & Astronautics and Technology & Policy from the Massachusetts Institute of Technology in 1982; and a Doctorate in Policy Analysis from the RAND Graduate School in 1989.

Dr. Pace received the NASA Outstanding Leadership Medal in 2008, the US Department of State's Group Superior Honor Award, *GPS Interagency Team*, in 2005, and the NASA Group Achievement Award, *Columbia Accident Rapid Reaction Team*, in 2004. He has been a member of the US Delegation to the World Radiocommunication Conferences in 1997, 2000, 2003, and 2007. He was also a member of the US Delegation to the Asia-Pacific Economic Cooperation Telecommunications Working Group, 1997-2000. He is a past member of the Earth Studies Committee, Space Studies Board, National Research Council and the Commercial Activities Subcommittee, NASA Advisory Council. Dr. Pace is a former member of the Board of Trustees, Universities Space Research Association, a Corresponding Member of the International Academy of Astronautics, and a member of the Board of Governors of the National Space Society.