Statement of Stephen Cook,
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Committee on Commerce, Science, and Transportation
Subcommittee on Science and Space
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Mr. Chairman and Members of the Subcommittee, I want to thank you for conducting this hearing into "Challenges and Opportunities for Human Space Exploration," and particularly the synergy between government and the commercial sector, focusing on how a stable, long-term national exploration strategy can provide an environment for commercial ventures to thrive. The timing could not be more critical, as the Deputy Administrator of NASA stated in her response to the recent Government Accountability Office (GAO) assessment of NASA's large-scale projects, "programs are experiencing an uncertain and unstable funding environment, which can drive less than optimal phasing of current and future program work and can result in program cost increases."[1]

This is an exceedingly important discussion. The ramifications of the decisions you make could impact space exploration for the rest of this century.

Since 2009, I have served as the Director of Space Technologies at Dynetics, Inc., an employee-owned business headquartered in Huntsville, Alabama, with over 1,400 employees specializing in Space Systems—propulsion, launch systems, small satellites, and test; Intelligence—foreign materiel exploitation; Aviation—unmanned aircraft systems (UASs) and sensor integration; and Missiles—aerodynamics, avionics, and precision-guided munitions. Founded in 1974, Dynetics has earned a reputation for excellence in analysis and engineering. I have gained first-hand an appreciation for the challenges facing the private sector in the aerospace market, especially in the current political and economic climate.

Prior to my private sector career, however, I spent almost 20 years at NASA. From September 2005 until September 2009, I served as manager of the Ares Projects—the predecessor to NASA's Space Launch System (SLS)—at NASA's Marshall Space Flight Center (MSFC) in Huntsville, Alabama. It was a large, complex, government-funded and -led space launch project. Previously, however, I spent several years in the 1990s with the DC-XA and X-33 flight demonstrators—early attempts to move towards commercial-backed space transportation.[2] I have always been a supporter of both government and commercial space transportation efforts.

Unfortunately, the fissures that have developed within the space community over the past four years have too often pitted the commercial and Government space sectors against each other in an "us vs. them" debate. This is very unfortunate and counterproductive. In what other field do we have such arguments about the roles of government and the commercial sectors? For example, we do not argue about the need

[1] U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-13-276SP, NASA: ASSESSMENTS OF SELECTED LARGE-SCALE PROJECTS, 92 (Apr. 17, 2013) [hereinafter *2013 GAO Report*] (comments of Lori B. Garver, Deputy Administrator for NASA).

[2] *See, e.g.,* Stephen Cook et al., "The Reusable Launch Vehicle Technology Program," AIAA SIXTH INTERNATIONAL AEROSPACE PLANES AND HYPERSONICS TECH. CONF., AIAA-95-6153 (Apr. 1995) *and* Stephen Cook et al., "X-33 Reusable Launch Vehicle Structural Technologies," AIAA 7TH INTERNATIONAL SPACE PLANES AND HYPERSONIC SYSTEMS AND TECHNOLOGIES CONFERENCE, AIAA-96-4563, (Nov. 1996).

for a Navy run by the U.S. Government nor do we want the U.S. Navy transporting cruise passengers. Historically, successful governmental-backed exploration efforts have been linked inextricably with commerce: from the exploration of the new world by Columbus to finding a Western trade route to the Orient; from the exploration of the West by Lewis and Clark to mapping routes for commerce. Government-private sector partnerships have literally expanded the human footprint.

Average Americans are largely unaware of the critical role our space presence plays in the comforts they enjoy in their daily lives, not to mention its critical importance within the defense sector.[3] If the space community continues to circle the wagons and shoot inward, we risk their support and we run the risk of making space more irrelevant to the public.

Role of Government

A fundamental role of the government is to provide for our nation's defense—this is a long-established governmental function, enshrined in our Constitution, and there can be no argument against it. Another crucial role of government, however, is to take on endeavors that have benefit to society, are high-risk in nature, require significant amounts of capital, and have long payback times—in other words, ventures that the private sector cannot take on by itself. These are typically fundamental infrastructure projects—expensive, but which offer long-term societal benefits. For example, the U.S. Government underwrote the development of the maritime system, the transcontinental railroad, and the interstate highway system: these took years to fully mature, but undisputedly opened up our country in palpable, life-altering ways.

The U.S. Government does not operate in a vacuum, however. While the Government *invests* in infrastructure, it has always relied on private companies for the labor required to complete the projects, as well as to set up the support systems along the way—from telegraph offices to gas stations to restaurants and hotels, the private sector has provided goods and services necessary to get the job done.

Commercial programs may, by necessity, move more quickly because businesses must make a profit to keep their doors open. While government programs may move at a more deliberate pace, for those truly difficult tasks—those the private sector will not or cannot take on—a meticulous and measured approach is prudent. It is the price we are willing to pay, and must pay, for innovation and achieving our government's mission and objectives.

It is undisputed that space is a perfect market for a strong, supportive U.S. Government presence—after all, establishing a robust space presence is difficult, both technically and economically. Both sectors can learn from each other, as is clear from NASA's focus today on affordability.[4]

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[3] This subject was also discussed in a recent hearing before this Subcommittee on "Assessing the Risks, Impacts, and Solutions for Space Threats," held on March 20, 2013. *See, e.g.*, *Assessing the Risks, Impacts, and Solutions for Space Threats: Hearing Before the S. Subcomm. On Science and Space*, 113th Cong. (2013) (statement of Dr. Joan Johnson-Freese, Prof. of Nat. Sec. Aff. At Naval War Coll., Newport, R.I.). "[B]ecause of the resounding *success* of NASA and other organizations that have been responsible for putting space infrastructure into orbit, Americans [are] totally oblivious to the role that spaces assets play in [daily activities]. *Id.* at 2 (emphasis in original).

[4] *See, e.g.*, "2011 NASA Strategic Plan," NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (2011), *available at* http://www.nasa.gov/news/budget/index.html.

Commercial–Government Partnerships

At its core, "commercial" means that the private sector bears the burden of the investment, the resultant risk, as well as the subsequent reward. This principle has been a standard of U.S. economic growth since our founding. A corollary is that companies doing business with the Government should be subject to a higher standard to ensure that such business is transparent and auditable, particularly given that public funds are at stake. Private companies can be profitable by providing products and services and by creating new wealth (e.g., opening up new markets like Helium-3 mining in space). However, commercial successes need not be limited to the commercial sector: partnerships between Government and Industry can produce valuable products that can benefit the space sector as a whole. The current landscape is rife with examples of recent commercial-Government program success stories.

For example, Dynetics' first commercial satellite—the Fast, Affordable, Science and Technology SATellite (FASTSAT)—is the culmination of a public-private partnership between Dynetics, Inc., and NASA's Marshall Space Flight Center (MSFC). Dynetics invested its own money, supplying the vast majority of capital for the program, while NASA MSFC supported the project in terms of the conceptual idea, engineering capabilities, and facilities. The result? A spacecraft ready for flight in 16 months from inception at approximately one-third the cost of the competition – all while meeting rigorous NASA and Air Force flight readiness standards. Additionally, the satellite successfully operated for 24 months—100% past its design life. Dynetics now markets this satellite to other users. Dynetics assumed the financial risks and can now reap the rewards of the program's success. NASA was able to spin off its conceptual ideas to commercial industry and put engineers to work on a fast-paced flight project.

Another example of a commercial venture leveraging NASA's investments is Bigelow Aerospace's efforts to develop a commercially backed inflatable space station. Robert Bigelow, with his own funds, leveraged a NASA-developed concept called "TransHab" into a self-supporting space habitat approach, flying two Genesis test modules in space.[5] Bigelow recently announced that it has partnered with NASA to fly a test module on the International Space Station.[6] While leveraging NASA investments, Robert Bigelow has funded the development of the inflatable technology with his own money—taking the risk as well as the resultant reward. Dynetics was pleased to supply the forward propulsion system for his free-flyer module using an innovative hydrogen/oxygen system.[7]

The Government-Industry partnership can work multiple ways—for instance, commercial investments may be further developed in partnership with NASA for space-based applications. For instance, Dynetics' Advanced Materials and Nanosystems (AMN) group is working to partner with NASA to leverage commercial investments in nanomaterials and structures to space-based applications. Dynetics researchers have pioneered a new rapid prototyping method that will revolutionize manufacturing techniques for providing dramatically stronger and lighter structures. This technology will

[5] The Genesis I and II modules were launched in 2006 and 2007, respectively. Tariq Malik and Leonard David, "Bigelow's Second Orbital Module Launches Into Space," SPACE.COM (June 28, 2007, updated 8:08 PM), http://www.space.com/4007-bigelow-orbital-module-launches-space.html.

[6] *See* Brian Vastag, "International Space Station to Receive Inflatable Module," WASH. POST, Jan. 16, 2013, http://www.washingtonpost.com/national/health-science/international-space-station-to-receive-inflatable-module/2013/01/16/8a102712-5ffc-11e2-9940-6fc488f3fecd_story.html (last visited April 17, 2013).

[7] BIGELOW AEROSPACE SUNDANCER FORWARD PROPULSION SYSTEM, http://www.dynetics.com/services/space/bigelow-aerospace-sundancer-forward-propulsion-system (last visited April 17, 2013).

enable game-changing leaps forward in areas such as reduced vehicle mass and improved functionality and durability of spacecraft components, including electronics and radiation shielding. In partnership with NASA, this groundbreaking method of producing strong, lightweight structures—in effect reducing mass properties while increasing strength—will revolutionize the space industry.

Finally, private industry can take systems developed under contract to NASA and leverage these for other purposes. This has been done successfully in aerospace projects for decades, and could be especially useful for NASA projects—for example, NASA's Space Launch System (SLS). In a full and open competitive process, NASA recently selected several SLS advanced booster risk reduction projects. Dynetics is partnered with Pratt and Whitney Rocketdyne in developing a liquid booster concept based on the Apollo-Saturn V's F-1 main engine to give NASA the most affordable, reliable, and highest performance booster possible. Our team is taking a flight-proven design—originally developed by NASA—and is merging it with the best of modern, commercial manufacturing techniques, such as additive manufacturing. In addition, we have a Letter of Agreement with NASA MSFC, which allows us to engage experts in propulsion, test, and manufacturing and utilize state-of-the-art weld tooling on a cost-reimbursable basis. Under this agreement, we are able to tap into NASA expertise, facilities, and equipment, while NASA is able to offset its own costs and work hand-in-hand with Industry on a rapid schedule project—a win-win for both Government and Industry. While the prime focus is for NASA boosters, such a system has direct commercial application in the expendable launch market. Dynetics is pleased to support NASA and looks forward to the next phase of the competitive process—slated for 2015—which will select one advanced booster provider for the SLS.

The bottom line is this: when we keep things simple using models proven in other markets over time, the commercial sector and the U.S. Government can work in harmony—not against each other.

Key to Commercial–Government Success: A Steady, Long-Term Space Policy

For this public-private partnership to succeed, a stable space policy is necessary—a space policy that transcends politics, administrations, and congressional terms. The cancellation of Constellation caused issues in the space sector that are still being felt today across many industries. Another major policy shift now would be even more damaging to U.S. leadership in space. Establishing a steady, long-term policy, grounded in the principles of the 2010 NASA Authorization Act,[8] will allow both commercial and Government endeavors to thrive. Laying out clear goals, destinations, and dates will provide an environment in which the market can and will respond.

First, there has been much discussion around the International Space Station (ISS) cargo and crew market, but I believe pursuing this market alone is too limiting for a space-faring nation, especially given our untapped potential. In fact, recent published studies[9] have shown that the ISS cargo and crew market is not large enough to support

[8] NASA Authorization Act of 2010, Pub. L. No. 111-267, (2010).

[9] *See, e.g.,* Michael D. Griffin, "Enabling Complementary Commercial and Government Enterprises in Space," IAC-11.E3.4.6, 62nd International Astronautical Congress, Cape Town, South Africa, (Oct. 2011). "The NASA Commercial Resupply Services (CRS) contracts for ISS cargo delivery offer a working example of a guaranteed market. However, [the] ISS market, whether for cargo or crew or both, is too small and likely too short-lived to bring about the robust commercial space industry that most space development advocates

a robust commercial market. However, if we expand the space market to include destinations with untapped economic potential—for example, a lunar outpost that may support mining of minerals emplaced from asteroids over thousands of years—the wealth creation potential is virtually unlimited. In addition to new wealth creation, such an outpost would require the routine resupply of cargo and crew. The moon could be an ideal market for new space companies: penalty for failure is manageable, enterprise risk is reduced, and there is ample opportunity to refine designs through repeated utilization. Furthermore, the Government could guarantee a market for lunar outpost cargo prior to human return, serving as the anchor tenant.

In fact, the commercial sector has already shown interest in the moon. For example, the Google Lunar X PRIZE was established in 2007 in part to incentivize the market to enable a commercially funded mission to the lunar surface, working to jump-start a lunar-based economic model. Dynetics is a member of one of 23 teams competing for the $30M prize—again, we have taken a risk, but we will also reap the reward. We have reduced some key risks, such as propulsion, by developing and testing a new thruster system leveraged from propulsion systems we developed for NASA and testing out key elements of a rover. This is not a technical problem, however, but rather a market issue.

A core market conundrum in this case lies in the fact that since a return to and exploration of the moon was eliminated as the primary mission by the United States in 2010,[10] many international teams planning missions to the moon have been eliminated, cut back, or made less of a priority.

Here is a case where a change in policy has had a direct effect on a commercial business case: if we change directions every few years, the market will not invest—and why should it? Like it or not, the Constellation Program was designed to implement civil space policy articulated by President Bush in the aftermath of the *Columbia* accident. It was modified, extended, and enhanced by both Republican and Democratic Congresses in the NASA Authorization Acts of 2005 and 2008. While the program transcended multiple Congresses, it did not do so with the last change in Administration.

Some lament the difficulty of explaining Space Policy, but I fundamentally disagree. While space is a complex endeavor, explaining it to our stakeholders—both the public and Congress—need not be complex. For example, I can explain the previous policy in a single sentence:

> "The United States will meet domestic and international commitments by using the Space Shuttle to finish the International Space Station (ISS), after which the Shuttle fleet will be retired and replaced by a new system to support space station crew transfer and logistics, enable human lunar return and sustained lunar presence, and pave the way for future voyages to Mars and the near-Earth asteroids."

Other important points are captured in both policy and law, including especially the intent to foster commercial development of space—but this one sentence captures the essence of the policy and legal direction for NASA's human spaceflight program for over five years. While I *am* a rocket scientist, it does not take one to write or understand a clear space policy.

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would like to see. The ISS is simply not a program having the strategic scope to provide the required market incentives. Something more is needed." *Id.*

[10] Including the NASA Authorization Act of 2010, *supra* note 8.

Finally, it is clear that if we want to continue the successful model of international cooperation from ISS—a model that brought together nations from around the globe in a great peaceful enterprise—the United States must pick a course and stick with it. Constantly changing our policy makes us an unreliable partner, and as a result, will naturally push our friends and allies away to others. First, the United States does not want to become known as a country that breaks commitments. Second, it is *not* in the long-term strategic interest of the United States—from either an economic or national security standpoint—to encourage our friends to look elsewhere for partners in space.

Conclusion

In closing, public policy decisions *can* effectively spur collateral private development—the key lies in recognizing how the Government and Commercial sectors best work together.

We must recognize the need to work as a community and realize that—as in many other exploration efforts of mankind—commerce and exploration go hand-in-hand. We must recognize that the U.S. Government plays a critical role in undertaking projects that have no business case—high-risk, high-capital, and long-payoff endeavors—often in the form of infrastructure projects. We must recognize the value of international partnerships and show that we value and will keep our long-term commitments to our friends as a key part of our economic and national security. We must recognize that "commercial" means that the private sector bears the burden of the investment, the resultant risk, as well as the subsequent reward.

A stable, long-term space policy and supporting programs *can and will* allow the commercial space sector to flourish. A key element of this is picking destinations that can have long-term scientific and economic value. As one example, the establishment of a lunar outpost could align important strategic goals: it facilitates U.S. preeminence in cis-lunar space and provides the "anchor market" for expanding commercial space enterprises. While fundamental capabilities are necessary, dates and commitments have always been critical to enabling the commercial sector to plan and invest accordingly.

Never before has a robust Government-Commercial partnership been more critical. As the GAO report stated in its April 2013 assessment of NASA's large-scale projects, "Given the current fiscal environment, our findings underscore the importance of NASA remaining committed to its initiatives to reduce acquisition risk, especially with regard to management of its larger and more complex missions."[11] Continuing to develop a strong partnership between the Government and Commercial sectors will certainly "help NASA continue the improvements it has made to reduce cost and schedule growth in its portfolio and improve its ability to successfully manage the fiscal uncertainty that is likely to continue for many years."[12]

Thank you for the opportunity to testify today. I am excited and optimistic about the future in space and look forward to enabling it for generations to come.

[11] *2013 GAO Report*, *supra* note 1, at 70.
[12] *Id.*