

**Witness Statement for the Hearing**

**Step by Step: The Artemis Program and NASA's Path to Human Exploration of the Moon, Mars, and Beyond**

**U.S. House of Representatives  
Committee on Science, Space and Technology  
Space and Aeronautics Subcommittee**

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Room 2318**

**Daniel L. Dumbacher  
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Thank you Chairman Haridopolos and Ranking Member Foushee, and all Committee Members for the opportunity to discuss the need for the United States to retain and grow its leadership in space by Mastering the Moon and then on to Mars.

My background: I am a proud former civil servant to the Constitution – a long-term NASA Senior Executive in human space exploration, most recently the CEO of the American Institute of Aeronautics and Astronautics (AIAA), and currently a professor of engineering practice in Aeronautics and Astronautics at Purdue University. During my experience over more than four (4) decades in the profession of space engineering, I have learned it's about doing the right thing at the right time. Therefore, the discussion is not Moon or Mars, rather, timing dictates that we must master the moon and then proceed to Mars.

I say this because we are at a key crossroads for US leadership in space. The challenge facing us is immediate, growing, and extremely capable. Our global competitors, primarily China and its allies, are out planning and outpacing us in their drive to become dominant in space. This is a critical national security and economic concern, as was discussed at the Full Committee Hearing on February 5 – The State of U.S. Science and Technology: Ensuring U.S. Global Leadership, and at a hearing of this Subcommittee in 2016, entitled "Are We Losing the Space Race to China?"

These times are not akin to the space race of the 1960's – "who can get there first." This is the long-term drive to be present, to lead and become the first to establish the "rules of the road" in space position, navigation and tracking, communications, power generation and distribution, resource ownership and allocation – in effect, mastering the cislunar domain for the purposes of science, exploration, and commercial development. Today's race is about continuous presence, values and technical leadership. The nation that leads is the nation that benefits. That nation will establish the norms of behavior which will dictate how sovereign countries will

interact in deep space for decades to come. And that nation, and its citizens, explorers, scientists and investors, will attract powerful partners and allies in accelerating their influence at the Moon - and as a result, on the hearts, minds, and economies back on Earth.

What we know: The Chinese have very deliberately plotted a course, with clear milestone dates, to demonstrate that China is the dominant power in space. Their intent is to catch and surpass the United States by 2030. China strives to be present across all facets of the space enterprise so that they lead the implementation and development of the infrastructure, thereby reaping the economic benefit and retaining the “high ground.”

**We are in a global competition, every single day.**

The Chinese are serious competitors. In 1992 China announced plans to develop human spaceflight capability by 2002, Shenzhou 5 launched with humans in October 2003. In 2011 China announced the Tiangong space station would be assembled from 2020-2022, modules were launched in 2021, and two in 2022. Robotically China has returned samples from the far side of the moon in 2024 - no other nation has accomplished this feat. They plan to arrive at the south pole of the moon in both 2026 and 2028.

The key takeaway is China does what it says it's going to do, +/- a year. This is all part of the published China Space Strategy<sup>i</sup>. China plans to land humans on the moon “before 2030”, leading to a permanent lunar base by the mid-2030's. China's aim is to be the dominant leader by being present and establishing the critical infrastructure. China publicly is developing the partnerships, even with our allies, to achieve their goals.

China is not the only nation working on furthering its ambitions in space. Russia is now partnering with China<sup>ii</sup>. China is building partnerships with nations, including some of our allies, to develop requisite capabilities. For example, Chang'e - 6 included instruments from France, Italy and ESA. It is absolutely critical that the United States reinforce existing international partnerships and build new partnerships. We have weakened our US / International partnerships in the past by dramatically changing our plans. We must be seen as reliable for the long-term leadership in space. The International Space Station and the James Webb Space Telescope serve as very successful models for building on our international commitments.

The large number of commercial, national security satellites and assets between earth and the moon, and the capabilities that will be installed on the moon over time, will provide space faring nations with the capability to access, capture and/or destroy assets between the earth and the moon. This is the proverbial “high ground.” Additionally, resources on the Moon such as water ice, helium 3 and possible rare earth elements, will be critical to our lunar presence, our ability to expand to Mars, and even to life on earth.

Retaining U.S. leadership in space demands that we be actively present from the earth to the moon for the foreseeable future. This establishes our credibility and credentials. The United States must protect potential economic opportunity, protect our National Security, lead the

building of the necessary infrastructure, and importantly lead chartering the “rules of the road.” We must continue to lead the coalition from the earth to the moon, and we must bring international and commercial partners along with us. The Artemis Accords are a key step in establishing these critical partnerships. We can then proceed to Mars when the time is right.

### **Where is the United States?**

The United States (NASA) last put people on the moon in 1972. We have mapped the moon since 2009, and attempted commercial, cargo landings on the moon in 2024, with additional cargo landings coming in 2025. We have test flown our spacecraft and rockets around the moon in 2022, with our international partners, the European Space Agency.

The United States approach to space exploration has evolved over time. In the mid-2000’s The Vision for Space Exploration set a course eventually manifested in NASA’s Constellation Program to return to the moon and then go to Mars. In the 2009-2011 timeframe, the Constellation Program was cancelled and NASA adjusted, resulting in establishment of the Space Launch System and the Orion spacecraft. The Artemis Program was established in 2017, with the Human Lander System announced in 2021. Throughout this history, NASA has been working per NASA Authorization Acts of 2008, 2010, 2017, and 2022 to return to the moon and then take humans to Mars.

Today, I admit, however, that the current plan to return people to the moon is very suspect. The Aerospace Safety Advisory Panel (ASAP) in their recent 2024 report<sup>iii</sup>, described NASA’s Artemis 3 first human flight as high risk, “...aggregated risk associated with accomplishing so many “first-time” milestones, including several critical prerequisite demonstrations, may be too high.”

The ASAP assessment highlights 14 critical “first-time” milestones, including the development of the poorly understood and under-researched cryogenic rocket fuel storage and transfer technology. By NASA’s own plan, approximately 40 large Starship Launches are necessary to first demonstrate the capability on an uncrewed mission, and then execute the first human mission currently planned for Artemis 3. The question becomes: Can 40 launches, development and demonstration of the undeveloped and undemonstrated on-orbit rocket fuel station, and integration of a complex operational scenario across multiple systems, all successfully occur by 2030? Any objective assessment, including my own view, concludes that our approach today has a very low probability to match the “before 2030” milestone for landing humans on the moon. In other words, the probability of the United States safely landing humans on the moon by 2030, with the current plan, is remote at best.

Further, the United States does not have a sustainable plan for 2030 **and** beyond. We need to recognize the competitive environment, admit our true technical status and capability, provide the needed effort for success, and engage our international partners. This includes the European Space Agency, the Japanese Space Agency (JAXA), the Canadian Space Agency (CSA), and others. NASA currently has a process for addressing objectives, but no timeline, no sense of

needed resources. To be a great nation that leads in space, we need a flexible, sustainable approach, adjusting as we learn. This is the definition of “exploration”. We must adjust as new capabilities and technologies come to fruition, and achieve our national objectives on the necessary timeline. We can take advantage of the on-going efforts on the Human Lander Systems, lunar systems, and technology development and build these into the sustainable program we need to retain our leadership in space.

From a technical and human point of view, going to Mars is orders of magnitude more difficult than returning to the moon, 36 million miles versus 240,000. Furthering the technology, developing the systems and demonstrating at scale the needed capabilities, along with how humans live and work in the microgravity and radiation environments and the long-term psychological impacts, continue to be open questions. While Congress has repeatedly endorsed Mars as an eventual destination, it has also recognized in law for almost 20 years the importance of a consistent space policy that captures both the nearer-term scientific, international and commercial value of returning to the moon on a permanent basis while continuing development toward Mars. The bipartisan and bicameral agreement on continuity of purpose thus underpins our national effort to date and spurs it forward.

At the same time, we cannot continue to do “business as usual”. Dr. Griffin stated it very well in his testimony of January 17, 2024 to this Subcommittee<sup>iv</sup>. “The Artemis Program should not be “kept on track”; it should be fixed and then prosecuted with all deliberate speed.” Dr. Griffin’s suggested “lower risk” approach is precisely what we need to be doing, with all deliberate speed.

### **Current Realities**

Private enterprise space capabilities, driving today’s innovation and progress, have grown tremendously in the last decade. Over the past 10 years, nearly 700 start-up companies focused on space and satellite applications/markets have raised over \$66B (~200 start-up companies raised \$8.2B in 2024). We have reached the time where the United States private enterprise competitiveness and innovation is driving our progress with government and private investment. We must continue to grow this competitive power. This is how a sustainable future is built. Initially, government investment moved us through the early challenges. Today’s combination of private investment and government support provides the United States with unmatched capability. Our efforts on human landers, commercial cargo landers, lunar space suits, lunar surface systems and associated technology provide a starting point. We must utilize, foster and grow this capability, it is our super power along with our people.

The United States has made investments, and the results are clear. For example, the current growth and efficiencies in launch systems, particularly the return and landing of rocket stages, is partially attributable to NASA investments in the mid-1990’s and early 2000’s. Air Force and NASA investments in vertical landing and launch system technologies have supported the reduction of the cost of access to space. These investments provided the initial technical capabilities and skilled workforce that has now grown to the capabilities of SpaceX, Blue Origin,

and others. These investments by the United States taxpayer, are key stepping stones to the observed success of today.

Our workforce, across industry, government and academia, will make our dreams real. We must explicitly support and grow our national asset, our workforce. We must nurture and grow our people. Stability, real objectives to be accomplished, and real problems to be solved will keep this workforce engaged and learning, all to accomplish the future. These people will be inventing the technologies, applying existing capabilities in new ways, creating the technology for future markets, and building the future marketplace. Our strength is tapping into the talent across our society, clearly showing people the opportunity for their own lives.

For example, the United States Hispanic population is 19% of the total population. According to the American Society of Engineering Education (ASEE) 10.7% of our engineering graduates are Hispanic. Similar examples exist for other groups in our society. The Honorable Heather Wilson, in the full Committee Hearing of February 5, 2025 made a similar point. We must include all of our talented people that want to be part of this enterprise, and help the United States in the global competition. Estimates show that the US annually graduates 10-20%<sup>vi</sup> of the number of engineers that China graduates. We need everyone, from all backgrounds.

### **Why Does it Matter?**

Human progress and economic opportunity are born out of curiosity, exploration and ultimately utilization of new technologies within new markets. The growth of the United States from 13 colonies to ultimately 50 states is one example.

Expansion to the west in the 1800's developed the economic infrastructure, railroads, supply chain and economic opportunity of the United States to the point where today, one state - California, is the fifth largest gross domestic product in the world - comparable to all of India.

Similarly, being present and developing the necessary infrastructure between the earth and the moon to build and grow the economic opportunity for both today and future generations is at the heart of the United States value system. The United States must lead so that our principles and values drive the benefit for the United States citizens and all the global citizens.

In today's world, our future as the global leader depends on being seen as a leader in space. Being present at the moon, building the infrastructure from the earth to the moon, importantly results in economic opportunity and growth for our citizens. We must also recognize that economic security is protected via our own national security.

Therefore, our continuous engagement in space exploration, space utilization, and our national security in space is essential for the protection and growth for our citizens.

### **Recommendations**

Assuming the United States wants to retain its leadership in space, the following recommendations are provided:

1. Return humans to the moon as expeditiously as possible by utilizing existing systems such as the Space Launch System, Orion spacecraft, ground systems and existing international partnerships. This will require extreme focus by the NASA / industry Artemis team for the goal of returning to the moon by 2030, assuring the most efficient and technically rigorous efforts are accomplished;
2. In parallel, utilizing the growing private space capabilities, government and academia, immediately initiate the architecting and implementation of the **sustainable** and **efficient** approach to retain the United States presence on the moon, assuring our National Security and future economic opportunity, consistent with National priorities and policy, and the science priorities from the National Academies Decadal Surveys;
3. Focus the NASA / industry workforce on accomplishing the national objectives, with real timelines, and incentives to incorporate new capabilities from across industry, academic labs and government labs;
4. Congress must assure the policy and funding stability along with the program sustainability, to encourage the best and brightest of our people, across our society, to lead and implement this critical enterprise, for our national security and economic opportunity.

## Summary

In summary, our Nation, faces a very clear question. Do we want China to be the dominant space nation, or do we, the United States, want to retain and expand the leadership we have built across decades through investment and sacrifice?

From my perspective, the United States must be present, retain the lunar high ground, remain the key leaders in the development of the space economy for our citizens and future generations. We must not allow our global competition to have the high ground and the benefits.

To achieve the near-term milestones, we should use the existing capabilities that have successfully been flight tested for the lunar mission, the Space Launch System, Orion and the Exploration Ground Systems. AND, we must do it with much greater urgency than we have today.

In parallel, we must develop the long-term, sustainable approach for the United States to retain its leadership in space, establish the “rules of the road,” and build the infrastructure for the economic benefit of the US citizens.

Congress must put forward the policy and the appropriations to master the Moon. The United States can extend humans to Mars when it makes sense.

Thank you Chairman Haridopolos and Ranking Member Foushee for the opportunity to discuss this critical issue facing our Country. I look forward to your questions.

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<sup>i</sup> Baturin, M. (2024, October 23). *China space plan highlights commitment to space exploration, analysts say*. Voice of America News. Retrieved February 20, 2025, from China space plan highlights commitment to space exploration, analysts say, <https://www.voanews.com/a/china-space-plan-highlights-commitment-to-space-exploration-analysts-say/7836873.html>

<sup>ii</sup> <https://www.newsweek.com/russia-approves-plan-establish-lunar-base-china-1848731>

<sup>iii</sup> Aerospace Safety Advisory Panel 2024 Report, <https://www.nasa.gov/asap-reports/>

<sup>iv</sup> <https://republicans-science.house.gov/cache/files/2/d/2dc97bb6-040b-4d15-ae69-6b8de637174d/448A0B95841995613C9A9B19135C104C.2024-01-17-griffin---testimony.pdf>

<sup>v</sup> <https://ira.asee.org/wp-content/uploads/2024/12/Engineering-Engineering-Technology-By-the-Numbers-2023-1-combined.pdf>

<sup>vi</sup> <https://www.linkedin.com/pulse/chinas-engineering-capabilities-workforce-2024-munkholm-%E5%AD%9F%E5%8F%AF%E5%92%8C-fxrnf/>