

Using a US government human spaceflight program to support space commerce

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Philip Crume, Chairman
The Moon Society

1. What are the important benefits provided to the United States and other countries by human spaceflight endeavors?

a) *Background.* On October 26, 1957, shortly after the 40th anniversary of the Russian Communist Revolution, the USSR successfully put Sputnik, the world's first satellite, into orbit around the Earth. The Russians boasted their scientific and engineering prowess and ridiculed the inferiority of the entire American way of life before the world community. America would respond on January 31, 1958 with the successful launch of Explorer I. For three months, a Soviet object transgressed American space with impunity and left a profound psychological wound upon our nation. On July 29, 1958, the National Aeronautics and Space Act was passed to convert NACA¹ into NASA.

NASA was not originally founded to achieve any strategic national mission except to provide parity with Soviet rocket research²³. Between 1958-1962 the USSR would use their space program to engage in oneupmanship with the US to symbolize their industrial might with a thinly veiled suggestion of its military potential. Although America would ultimately rise to any challenge it would lag behind until well into the Apollo program. America's response to this day continues to use the space program as a symbol of our industrial and intellectual might.

b) *STEM⁴.* Federal STEM programs are vital for having a scientifically-literate and technologically innovative labor force⁵. What makes NASA unique among all of the world's science agencies is that the HSFP provides personifiable archetypes that incentivizes literacy of or entry into the STEM fields. The ability of the HSFP to offer a real contemporary archetype with the science fiction genre of entertainment provides the most powerful tool in the federal government's arsenal of influence. No other ongoing US government science program even comes close to the level of job applicants the astronaut corps enjoys⁶.

c) *Serendipity.* There are three ways new discoveries are made in science. The first comes from hypothesis-driven research, the second from negations of the first, and the third by accidents. Robot-based research works best with the first and second case, but the imperfection of human beings creates variabilities that allow for the third. Scientific research in space that rely on robotic platforms are often single-purpose designs that seek to validate hypothesis-driven research. Such research designs often excel at improving knowledge depth whereas human variability often excels in expanding knowledge-breadth.

As many in the scientific community likely already know, a cursory overview of serendipity in science gives us: Galileo's pendulum, Mendel's peas, Davy's electrolysis, Bunsen's spectroscope, and Röntgen's x-rays. Many of

1 NACA – National Advisory Committee for Aeronautics

2 Kennedy would not deliver his Moon Race speech for another 4 years.

3 Wolfe, Tom. *The Right Stuff*. Collins. Toronto. 1979.

4 STEM - Science, Technology, Engineering, and Mathematics

5 Cornelia, Ashby M. *Higher Education: Science, Technology, Engineering, and Mathematics Trends and the Role of Federal Programs*. Testimony before the Committee on Education and the Workforce, House of Representatives. GAO-06-702T. U.S. Government Accountability Office, Washington, DC. 2006.

6 There were 6,300 applications for the 2013 Class for 9-15 openings – a 700:1 ratio! <http://www.csmonitor.com/Science/2012/0206/NASA-Record-number-of-astronaut-applicants-but-no-spaceships>

these discoveries are foundational and this small sample only scratches the surface.

A balanced space program would incorporate both AI and telepresence-controlled robots for hypothesis-driven experiments as well as a human element for repairs, biological experiments, and engaging in definitive exploration for any accidental discoveries. This parallel approach would maximize our research potential by leveraging the strengths of both humans and robots.

d) Laying the groundwork for space colonization. The steel gauntlet that space colonization throws down as a challenge to all industrialized nations is to duplicate our industrial economy and ecological support systems in space. It sets such a high bar for achievement that if we reach for it, the journey will likely guide technological innovation for the remainder of this century across a wide spectrum of science. Adaptation to new environmental conditions always stimulates innovation. It is the founding principle of biology with applications in society, economics, and politics.

The emigration of Life into space will be of the same magnitude of importance as the emigration of life out of the oceans onto land. It is not an exaggeration to say that this is of the same scale of historical importance as the human migration out of Africa or Columbus' discovery of the Americas.

2. What are the greatest challenges to sustaining a U.S. government program in human spaceflight?

a) Congress. Above and beyond everything else, the tendency of Congress to think short-term as it relates to their own job security and getting re-elected. If any government program, not just the space program, cannot in some way benefit their state (if a senator) or district (if a representative), then they'll rate its importance with lower priority than one that will do so *even if such a program would measurably improve the economic well-being of the United States*. In the current class of Congress, "benefiting one's district" has come to be defined as eliminating government programs so as to reduce tax burdens. Thus for any government program to survive in this legislative climate, it must provide a measurable return on tax payers' investment. Overcoming this redefining process will not be easy given the growing trend of Internet-driven filter bubbles⁷.

Close to this problem is the desire for Congress to avoid investing in expensive programs that offer no or poorly defined exit strategies. The greatest reason the US government has avoided expanding our human presence in space is because of Congress' desire to avoid locking up a sizable portion of our discretionary budget on expeditions that don't provide short-term geopolitical advantages⁸. When considering how Congress views the space program as optional and of lesser importance as any military expedition, any mistakes made by NASA that result in the loss of life carry with it an existential risk for the whole space program

b) Mission Directorates that are misaligned with public support constituencies. After an exhaustive search of the NASA website and TRS⁹, there are no publicly available political science or market research studies on NASA's support constituencies. Based on anecdotal experience and a brief overview provided by the *Mars Wars*, the rough breakdown of NASA's support groups come from the unorganized public which might be further divided into those that advocate for astronomical science detached from any human focus and those that advocate for space colonization while viewing astronomical and planetary science in supportive roles. Aligned to this rough schism, organized members of the public can be divided into space advocacy organizations, academic and research institutions, and the aerospace industry.

Each faction views the space program very differently. The ontology of the science faction is shaped by natural philosophy and empiricism, while remaining firmly grounded in reality. The science faction tends to ascribe to the view of terms of pushing the boundaries of knowledge relative to existing science. Missions are based on forecasts of previously acquired knowledge of what might be learned and mission priorities are assigned based on its value-added contribution to a particular field of science. Since progress is viewed relative to itself, this

7 Ridout, Travis. *New Directions in Media and Politics*. Routledge. 2013.

8 Hogan, Thor. *Mars Wars, The Rise and Fall of the Space Exploration Initiative*. NASA. 2007.

9 NASA TRS – NASA Technical Reports Server

faction is often satisfied with any motion so long as it is measurable. The strategy works well within the constrained budgetary environment established by Congress.

The space colonization faction stands in stark contrast. It ascribes to an ontology shaped by science fiction which influences desirable end states. It often maintains one foot in reality and the other in an idealized future. Missions would ideally be backcasted trajectories that nudge technological development and operations towards interim goals. Since progress is viewed relative to science fiction, which often leaps beyond existing capabilities, the space colonization faction remains discontented despite the reality of living in the most technologically advanced period in human history. This faction ascribes to the view that NASA *hasn't gone far enough* with its mission foci, and that everything that NASA does is underwhelming progress at best and stagnation at worst. The constraints that Congress placed on space colonization is viewed by many in this community as an abject failure of political will since we never built upon the success of the Apollo Program.

The space colonization faction should not be cursorily dismissed considering that both Wernher von Braun and Sergei Korolev, the founding fathers of both the US and Russian space programs, come from this school of thought¹⁰. The new commercial space industry has likewise emerged out of this faction¹¹. The challenge in sustaining a government HSFP is in maintaining the balance between engaging in research and development, and stepping aside to facilitate economic development once technologies mature to the point that private investors are willing to participate. The HEOMD¹² could serve an important role in this area.

c) Improve mission directorate collaboration. Since the HSFP retired the Space Shuttle and is stepping aside to facilitate space commerce, the HEOMD can still function in as it has since the end of the Apollo era as facilitators of research in the space environment, only it needs to develop a closer relationship with the STMD¹³, which is already structured with a DARPA-like project management structure. Research guidance needs to come from the full spectrum of support constituencies and not just a narrow list of contractors or former personnel. The usage of the HSFP should not constrain research options. It should work in partnership with a robust teleoperations platform that enable greater direct participation by lead investigators. Astronauts would ideally be used in this environment for biological research, serendipitous research, or maintenance.

d) Funding. Instead of viewing the retirement of the Space Shuttle as a disaster, it should be looked upon as an opportunity. The US is a partner of the ISS and the HSFP can be based out of it much like other nations, only instead of relying on transportation from a government-owned vehicle, it depends on a commercial one. The HSFP can still do what it does best in micro-g. Only the US space program should expand its mission to incorporate a larger share of teleoperations-based robotic research, which can either take place in a module or on a separate platform. If the research load is divided equitably between public and private projects, the private projects could be charged usage fees that could generate additional income for the space program.

3. What are the ramifications and what would the nation and world lose if the United States terminated NASA's human spaceflight program?

Before answering this question, the first people that should be given the opportunity to respond to this inquiry

10 Cadbury, Deborah. *Space Race, The epic battle between America and the Soviet Union for dominion of space.* HarperCollins Publishers. New York. 2006.

11 Huge Mars colony eyed by Space-X founder Elon Musk <http://www.space.com/18596-mars-colony-spacex-elon-musk.html>

12 HEOMD – Human Exploration and Operations Mission Directorate

13 STMD – Space Technology Mission Directorate

should be partner nations with whom the US has MOUs¹⁴, IGAs¹⁵, and MLAs¹⁶ related to its HSFP activities.

a) *Jumping the gun.*

i) *A private commercial space launch industry still in its infancy.* Considering that the majority, if not all, of the new entrants into the space commercial industry come from the space colonization camp, we are likely to see an increased, not decreased, demand for space medical and industrial research. The loss of the HSFP, which can underwrite this research, will impede space colonization by shifting the burden of pure research onto the initial entrants who would have no incentive to share scientific knowledge with the rest of humanity.

ii) *Poorly defined and out-dated space law.* The Outer Space Treaty of 1967 served primarily as an agreement between the USA and USSR to avoid going to war over a space territory grab at a time when neither was in a position to fully develop space resources. Any redefinition of space law that involves resource acquisition or exploitation, which is highly likely given the desired development trajectory of the space colonization faction, will also likely involve a redefinition of the international order. Although the US government can use space commerce to increase its bargaining position, it still needs to work with its international partners to redefine space treaties so that they won't compromise other US interests or undermine international security. Since the reframing of the space legal regime will likely be on the international agenda within the next decade, the premature termination of the HSFP will likely compromise America's ability to manage the agenda of these talks.

b) *Blowback.*

i) *Symbols.* Recalling the original political environment in which the US space program was born, symbols are two-sided coins. Advertising a symbol of strength implies strength. Abandoning that symbol, without another symbol that implies greater strength, will imply weakness. The US should not terminate the HSFP without ensuring a smooth transition of any alternatives. A day will come when it makes sense to terminate the HSFP but that day has not yet arrived. The US HSFP is still the platinum standard for the world's STEM community.

ii) *International partners.* As mentioned at the beginning of this section, the US needs to keep our international partners in the loop *before* considering major changes to our programs. They may offer solutions we have yet to consider. Keeping them in the loop shows respect and it builds trust. Consistently failing to do so conveys unreliability and untrustworthiness. Such behaviors can affect future agreements, create delays, increase costs, and result in less robust and possibly less effective international relations. If our partners were not consulted, it is likely that the damage in some measure has already been done.

iii.) *Domestic constituencies.* We are abandoning an energy inefficient transportation system and replacing it with a more efficient and less costly one. Let's not throw out the baby with the bathwater simply because we're changing transportation platforms. The HSFP still has a large network of expertise it can tap into that it could use to mentor a budding new industry. Terminating the HSFP will result in a loss of political support from the space colonization community. This would translate in a gradual erosion of the space program's budget and worse for the long term, the loss of the STEM community's most valuable archetype.

The US space program continues to remain America's pre-eminent symbol of science and technological advancement. It's had many successes, a few failures, and even setbacks. It will likely always remain somewhat schizoid as a result of its supportive constituencies. Each play a critical role in helping America maintain its leadership. It still faces challenges from Congress, which must constantly balance national priorities, structural and cultural rivalries from within, and in keeping our international partners engaged from without. We will triumph and rise stronger than ever before. We can and we will shape a better future.

14 MOU – Memorandum of Understanding

15 IGA – Inter-governmental Agreement

16 MLA – Multi-lateral Agreement