



Response to:

National Research Council (NRC) Committee on Human Spaceflight

July 2013

The National Space Society (NSS) is a space advocacy organization with over 8000 members throughout the United States and around the world. We have been working for over 25 years to support the expansion of our civilization into the solar system. Our vision statement presents a clear picture of our desired future in space, and highlights the importance of human spaceflight: “People living and working in thriving communities beyond the Earth, and the use of the vast resources of space for the dramatic betterment of humanity.” Those two themes are central to NSS: using the resources of the solar system to enable peaceful commerce and settlement, while also improving life here on Earth. The knowledge that we gather in learning to live, work and thrive in space is exactly the same knowledge that is desperately required to provide long term sustainability back here on Earth. However, the technology and infrastructure required to enable the fulfillment of this vision does not yet exist. Furthermore, government funding is shrinking and the goal(s) for US human exploration has been a moving target for the last several decades.

The US stands at a turning point in our exploration and development of the space frontier. With the retirement of the Space Shuttle and with the International Space Station now fully operational the question of how we move forward in human spaceflight needs to be addressed. We believe that there are several guiding principles that should shape our human spaceflight strategy:

1. Develop a long-term sustainable human exploration and settlement strategy that defines not only what we want to do but also why.
2. Make the maximum use of the public/private and international partnerships.
3. Lower the cost and increase access to space not only for human exploration but also for other commercial and scientific endeavors.
4. Develop the capabilities and infrastructure to enable on orbit assembly, maintenance and repair of large structures and complex systems
5. Develop the technology to make use of the resources available on the Moon, Mars and Near Earth Asteroids (NEAs)

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

In addition to the many subjective benefits that resulted from the success of the Apollo program there has also been a significant science and technology return from human spaceflight. Some of these benefits include data gathered by the Skylab missions, the Hubble Space Telescope, and a variety of investigations on Shuttle and the ISS, all supported by humans in space. Recent experiments on the ISS have been shown exciting results which could revolutionize medicine, biotechnology, material science and manufacturing. Aging is a particularly interesting phenomenon to study in space. Future human spaceflight programs promise equally significant results. For example, the zero gravity deconditioning that astronauts experience in microgravity in many ways resembles the signs of aging here on Earth but, unlike aging, when the astronauts return to Earth these conditions reverse. By studying these changes it may be possible to unlock the riddle of the human aging process for the benefit of all mankind.

The development of a new commercial space economy that brings the resources of the solar system into the Earth's economic sphere was a choice that Dr. John Marberger, President George W. Bush's science advisor, offered in his famous Goddard Memorial speech in 2006. It is a choice we support, and which depends on having a vibrant human spaceflight capability. Every imaginable resource that is valuable on this planet is available in nearly unlimited quantities in our solar system. It is a matter of developing the infrastructure and economics that are required to enable the practical retrieval of these resources. If the proper reusable space infrastructure were put in place, how long would it be before it was cheaper and more sustainable to provide these resources from space than it is to tear them from the Earth? The internet economy that the world enjoys today was the result of wise US government investment and the opening up of government-developed technology and infrastructure for commercial use. The size of this new commercial space economy could dwarf the internet economy within 1-2 decades if similar wise choices are made. Human operations in space will be essential to realizing this potential.

The meteor blast that took place over Russia on February 15th of 2013 should have been a startling wake up call for the entire planet. This was a fairly small and relatively benign call; it could have been far worse. Without space capabilities to identify and deflect these objects it is just a matter of time until our luck runs out and the human race goes the way of the dinosaurs. No one knows when this will happen but as of 2012 NASA had identified 842 asteroids of 1 km or larger that will come close to or cross the orbit of the Earth. Any one of these could destroy our civilization in a heartbeat but with the appropriate technology these threats could be the source of unlimited resources for generations to come; the choice is ours. Prepositioned human and robotic assets in strategic space locations could make the

difference between life and death. The proper role of humans in space in addressing this threat has not yet been determined, but must be explored.

The experience gained from the operation of the many robotic and tele-operated systems on the ISS and our planetary probes could enable us to construct, repair and refurbish satellites that, in turn, could radically decrease the cost of developing and operating the required space infrastructure. Development of human/robot cooperative capabilities in space would be an essential first step in enabling lunar and asteroid mining and the development and deployment of very large space structures for a range of uses including communication, remote sensing, planetary defense and, even, space solar power. As our experience has demonstrated, human space operations will be a vital technology in realizing these capabilities.

The inspirational value of human space flight must also be recognized. Just as the Apollo program inspired a generation of scientists and technologists in the 1960's and 70's, the current generation is also being inspired by the today's human spaceflight programs in both the government and commercial sectors. The importance of this vision lies not in short-term benefits, but in the inspiration of a new generation of dreamers and doers for the long-term sustenance of humanity.

Finally, the future and even the survival of our civilization may rest in space, and the continued development of our ability to live and work in space is an important target for our exploration. The US government should lead in developing and demonstrating these vital long term capabilities.

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

One of the key challenges for human space exploration in the US today is demonstrating its relevance. How does this exploration impact the lives of average Americans? Certainly the pictures of astronauts floating effortlessly in space is inspiring but at what cost? To gain long-term support for human exploration beyond LEO it will be necessary to provide a clear explanation of its value to people in their everyday lives. If all we have to offer for a rationale is glossy pictures and faded footprints then this will be a very hard case to make. Instead we need to communicate more tangible benefits such as the potential role of humans for accessing new resources, creating new industries on Earth as well as in space, and using remote sensing to help us better understand the Earth ecosystem, while developing new methods of sustainability both on Earth and in space.

With the current budget situation, the US government cannot and should not have to carry the entire financial burden. That is why it is so important to develop a reusable human/robotic space infrastructure that commercial and international partners can invest in and utilize along with NASA to help spread the cost and amortize the investment. This investment will help to build the technological and

economic foundation for this new space economy. Maintaining the right level of investment to build and operate this infrastructure will be a major challenge

There are also key physiological challenges to human spaceflight. Only 16 humans have traveled outside of Earth's protective Van Allen radiation belt with the last returning in 1972 with the longest mission lasting less than two weeks. If long term human exploration of the inner Solar System is to be possible, humans must learn to live and work in the harsh radiation environment of deep space. The question of the gravity requirements for humans over timescales of years must also be addressed.

Space Solar Power (SSP) is one possible example of how human space exploration can provide the technological foundation to help solve problems here on Earth. The technology and infrastructure for space exploration can also be used to build and SSP stations that can beam clean, cost effective energy to almost any spot on the globe 24 hours a day, and can help answer the President's call for new green energy sources. Reusable space transportation systems that are currently being commercially developed could support not only exploration but also construction of SSP facilities. The flight rates that this would demand could drive the cost of access to space to as low as \$10/lb to LEO. This would represent a true paradigm shift for space exploration, development and settlement similar to the one that occurred in commercial aviation in the last century. This would allow NASA's current budget to support a much larger and more aggressive human exploration program. However, achieving these capabilities is a significant challenge

NASA can help develop and support transportation and sustainment capabilities just as its predecessor, the National Advisory Committee for Aeronautics (NACA), helped develop and support the commercial aviation industry in the last century. If our human exploration programs could be initiated from Earth orbit from vehicles assembled and fueled on orbit, this could provide dramatic benefits in both cost savings and in safety. NASA needs to expand on its successful programs to leverage and stimulate the commercial sector such as the COTS and the Commercial Crew programs to achieve these capabilities. Another good example is the NASA Transhab technology License to Bigelow Aerospace and the subsequent agreement to demonstrate the resulting commercial capability on the ISS. These public/private partnerships have produced reliable flight hardware at a cost that is 8-10 times less than the conventional procurement procedures that the government typically utilizes. We should leverage off of this experience and utilize these partnerships whenever they are appropriate. However, maintaining an appropriate budget for these programs will be a significant challenge.

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

Abandoning the ISS would be a major breach of faith by the U.S. The international repercussions would be significant as the U.S. would correctly be seen as an

unreliable partner. The American people would rightly wonder why they spent \$100 billion on a facility that was barely used, and be reluctant to pour more money into the organization that made such poor choices. Also, abandonment of human spaceflight would be perceived as a major retreat, loss of will, and sign of American weakness.

A termination of our efforts to develop human capabilities to operate in Earth orbit and to expand human space exploration beyond LEO would cede this new frontier to others to conquer and prosper from. This would be a betrayal of all the blood, sweat and tears that have been shed and the billions of dollars spent by previous generations in order to give us this unique opportunity. It would also be a betrayal of future generations who will have to live with the profound consequences of the lost opportunities that will result from such a decision.

As James Michener so eloquently stated, “My own life has been spent chronicling the rise and fall of human systems, and I am convinced that we are terribly vulnerable.... We should be reluctant to turn back upon the frontier of this epoch. Space is indifferent to what we do; it has no feeling, no design, no interest in whether or not we grapple with it. But we cannot be indifferent to space, because the grand, slow march of intelligence has brought us, in our generation, to a point from which we can explore and understand and utilize it. To turn our back now would be to deny our history and our capability.”

Respectfully submitted,
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About the National Space Society (NSS): NSS is an independent non-profit educational membership organization dedicated to the creation of a spacefaring civilization. NSS is widely acknowledged as the preeminent citizen's voice on space, with over 50 chapters in the United States and around the world. The Society publishes *Ad Astra* magazine, an award-winning periodical chronicling the most important developments in space. To learn more, visit www.nss.org.