Written Statement of

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"Mars Flyby 2021: The First Deep Space Mission for the Orion and Space Launch System?"

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Chairman Smith, Ranking Member Johnson, and distinguished members, I want to thank you for the opportunity to address you today concerning the future of human spaceflight. Spaceflight and the exploration of space captured my imagination when I was a young girl and steered me toward the study of science and engineering in the hopes of being able to take part in our nation's space program in some way. I have been very fortunate to have had the opportunities to participate in an endeavor in which I so passionately believe and feel is vital to our country. Today I was asked to address the importance of having an exploration architecture and strategic framework to guide NASA's investments in space. In order to understand how important this is, I think we need to examine the trajectory of the human spaceflight program over the previous decades.

We are all well aware of President Kennedy's famous speech to Congress on May 25, 1961, in which he declared that "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth." We all know that declaration caught the imagination of the country, which at the time was fearful of the Soviet Union and its technological success with Sputnik. Kennedy, spurred by realpolitik, committed to a lunar mission as a goal sufficient to illustrate to the world the preeminence of the United States and its way of life. While no one can dismiss the importance of his announcement for the development of the U.S. space program, the trajectory that Kennedy started the U.S. manned space program on still haunts us today.

For even though Kennedy's proposal was a noble goal; it was just that – a goal. Underlying that goal was neither a longer term strategy nor vision – let alone political consensus – for how or what the U.S. should do in space. It was a sprint to the moon for political purposes. And because of this the U.S. space program has since suffered. Those who considered the lunar goal a means to a political end ultimately undermined the long-term interests of the U.S. space program – for once that goal was reached, attention was diverted elsewhere. Others, convinced of the importance of the U.S. continuing to gain experience in space, sought successive goals upon which the U.S. could embark. The end result: we all know what happened to the space program in the early 1970s – only shortly after reaching the moon for the first time, the budget was cut and continued in a decline for the next twenty years. For NASA, it became, to a certain extent, a survival game. There was no committed long-term strategic plan, even though there was a community that was engaged in trying to define and institute one. In the absence of a strategic vision we instead planned and executed short-term tactical goals outside of a larger defined stable framework. This is the operational mode we are still working under today.

So from the beginning of the U.S. involvement in human spaceflight we have been trapped in a paradigm where we have a space program that has been constantly morphed and re-directed, often deployed as a tool for other purposes. I don't mean to imply that nothing positive has come out of this experience, however. The aerospace community in the United States is an amazing community and has been able to achieve some extraordinary things over the years as our space policy and programs have evolved and progressed – in commercial and civil space and in both manned and unmanned exploration as well. In general though, particularly in human spaceflight,

the U.S. has typically lurched from goal to goal lacking a long-term stable strategic vision to tie our collective efforts together into an overarching space architecture.

So what has been at the heart of the problem of identifying and committing to a consistent national long-term strategic plan for the U.S. space program? Unfortunately, I believe that part of the problem is buried in human nature and another aspect can be attributed to our governmental structure. We human beings have a difficult time focusing, in general, on the long term. Space exploration is, by its nature, an enterprise that requires long-term focus and a steadfast commitment. It takes years to design, build, and execute missions. Put those multi-year missions into a larger connected framework that crosses generations and it is hard for humans to maintain a decades-long focus toward realizing the outcomes. Couple our inherent short-term attention spans with a federal government that turns over at least a fraction of its governing structure every two, four, or six years and the barriers to a long-term consistent strategy become painfully apparent. Human nature and the organizational impacts of the U.S. government are factors that are not entirely in our control, but they are real factors that have to be taken into account and addressed as we move forward. It is important to acknowledge these issues and overcome them together as we determine the course for our country in space for the next few decades.

So, how do we do this?

I have had the opportunity to live for four and a half months on the International Space Station, a program that illustrates a model for executing a long-term program in today's environment. The ISS, like Kennedy's lunar program, partially owes its existence to political motivations. The U.S. space station program was struggling (again a symptom of another goal that was created outside of a well-defined strategic plan with an overarching space architecture) in its development stage. A decision was made that the space station could become an instrument of U.S. policy aimed at employing Russian scientists as the Soviet Union began to unravel. This policy, important for reasons of national security, was formed with the intent to minimize the redirection of critical technical and scientific skills from the Soviet Union to less desirable places. As a result the International Space Station program, formulated from the base of the Freedom program with several of our allies, reached across the divide of the Cold War. Unlike the lunar program, however, once the geopolitical situation in Russia stabilized the ISS was not abandoned,

although it came close a few times. I firmly believe that the success of the International Space Station is due to the fact that it was an international program bound with treaties at the highest levels of government. The nature of those treaties were such that each member government (sometimes reluctantly, I will admit, because of short-term pressures) was required to stay the course over the long term to work together on a large, complex program that could not have been accomplished any other way. The strength of these agreements benefitted all of the partner countries at various times. In 1961 Kennedy was able to commit and leverage resources for a decade due to the fear that the Cold War instilled. One wonders if such a commitment is possible today. The history of the space program since Kennedy's time suggests the answer is no – at least not without a substantial change in our approach.

A long-term, committed, and stable strategic plan for the U.S. space program is vital to the country's interests. A long-term plan accompanied by a stable, deterministic budget can leverage U.S. investments wisely and fruitfully. The ability to make decisions based on a long-term view will always allow for better outcomes rather than being forced to deal with the uncertainty of a plan and budget situation that morphs every year or every few years based on unpredictable forces such as elections and the changing nature of global geopolitics.

We live in interesting times. After 50 years of accumulating experience with humans in space and the resultant transfer of that technology and know-how to the private sector, we exist in a moment of our country's history where space has started to become accessible to an increasingly wider swath of the business community and general public. I must mention my visit to Cornell University last fall, where the students proudly showed me the CubeSat they were building to launch sometime this year. They had already launched a small satellite as a piggyback on a commercial launch the previous year and the CubeSat under construction was their second endeavor. They also showed me the mission control room they assembled and proudly talked about the ground stations they built, something that would not have been possible when I was in college 30 years ago! Could we have ever predicted such an outcome in Kennedy's time?

We find ourselves at a pivotal point where private enterprise, again leveraging off of the foundational and groundbreaking work that the government has been conducting for the last five decades, feels that they understand the risk/reward equation enough to start engaging in activities

in low Earth orbit. Government is prepared to foster this engagement. But in what context? What is the long-term plan? What are the outcomes we are trying to encourage as a nation?

Government has a role that it must continue to play in space exploration and utilization. The role of government is to do the "hard" things; invest in the research and development that industry cannot, and to take on the tasks and push the boundaries that the private sector will not. Our strategy should encompass not only exploration but what we hope to accomplish in low Earth orbit and to encourage an economically viable industry there. We should consider how we want the U.S. to be leveraged for future roles in space, both in commercial and civil, in low Earth orbit and beyond. It should not be an "or," it should be an "and." Our plan – our vision – needs to be long term and stable in nature and comprehensive in scope, well thought out and well articulated, and, most importantly, fully resourced and executable. And finally we need to maintain our long-term focus and steadfast commitment to our strategy on the order of a decade or so at a minimum.

So the question being addressed today is "Can the Mars Flyby mission be a candidate for a deep space mission for the SLS system?" I would say that it is certainly one of many possible missions that could result. But once again, let me caution you. Let us not return to the misguided lessons of the past; any mission chosen cannot be done merely with the mindset of accomplishing a "goal" without clearly being tied to an overarching strategy.

A mission such as the Mars Flyby, or an asteroid retrieval or a lunar base, should be put in the context of the required longer term strategy to which I have been referring to. In the context of a coherent strategy and framework the appropriate missions will be defined logically, based on requirements developed within the strategic framework and then developed into a variety of mission and operational scenarios. The Mars Flyby thus can only be discussed in the context of that larger strategy and the associated missions and operational goals. I would also like to underscore that any plan, whether its goals are to retrieve an asteroid, establish a lunar base, or send people to Mars (or any combination thereof) is doomed to failure without the resources to support it – resources provided in a sustained and sustainable manner based on realistic projections.

Because it is not only the delineation of a strategic plan that is important but also the continuing commitment of the proper resources and necessary husbandry to that plan that will make it successful. Any strategic plan for any enterprise must be appropriately funded. So let me take a moment and talk about resources. NASA has found itself often in a position where it is given tasks to perform but then provided inadequate resources to fulfill them. Put in an impossible situation, nonetheless efforts are made to fulfill expectations that inevitably fall short. Failure to adequately source such large-scale endeavors from the outset inevitably leads to higher costs and inefficiencies that derive from the need to "rob Peter to pay Paul." These are hard things to address, but yet they are important, and understanding them requires comprehension and acceptance of some fundamental facts.

First, the development cycle for large, complex space projects, as we have already discussed, are very long term – from several years to as long as a decade or more. It is difficult to make intelligent and cost-effective decisions relating to the life-cycle costs of multiyear programs when you don't have control, let alone knowledge, of what your budget is more than a year out. Second, many state that NASA can no longer be cost effective. In these exceptionally lean budget times NASA has been experimenting with new approaches to program management and funding models and is learning to be more efficient but that is not enough. If you examine how they are constrained to run the agency, then one can easily see some adjustments that can help achieve even more efficiency and enable better financial decisions. Along with the uncertainty of budgets from year to year, NASA has little or no control over their expense side of the budget; the politics of the situation make it difficult for them to adjust overhead, either facilities or workforce or the management of task assignments around the agency. Addressing both these issues at some level will improves NASA's ability to perform more cost effectively.

Today there are a lot of discussions constantly taking place about the U.S. budget; clearly we live in some fiscally challenging times. NASA currently gets about 0.5% of the U.S. budget – a figure I am certain you are all well aware of. You are probably also aware that this is the lowest relative amount of the federal budget that the agency has been allocated since before the Apollo program started. This is not enough, and we all know it. If we are going to be a nation that has a future in space, a nation with a strong strategic plan and the will to execute it, 0.5% of the national budget is simply not adequate. The nation has some major budgetary issues to address –

I will not deny that. But the heart of our budget problems does not lie in the increasingly small fraction of the budget available to discretionary programs like NASA. Reducing NASA's budget will not solve the bigger problems we face. Reducing NASA's budget is a choice to not invest in our future.

Expanding our presence and continuing our exploration in space is important to our future. We are all aware of the long-term economic benefits of a healthy, robust space industry – you see that all around you today as we reap the harvest of our previous investments. But there is an intangible benefit as well. Space is "cool" and a strong motivating factor for our youth, a point of pride for our citizens. In my many years of being out and about discussing the activities of our country in space I have yet to find an audience that is not interested, and that does not get excited, about what we are doing. When we, the STS-135 crew, engaged with the public after our mission there were many people who expressed dismay when the shuttles were retired at what they thought was the end of the U.S. space program. Highlighting all of the exciting things occurring on the International Space Station and explaining that the U.S. was poised to expand our exploration efforts beyond low Earth orbit reassured them that the U.S. was not walking away from an enterprise that was important to them and in which we have lead for decades.

I thank you for inviting me to address you here today. I believe a strong, stable, strategically directed space program is vitally important to our country. A sustained national commitment to such a space program will not only benefit our country economically (in ways we cannot imagine) but also will serve as a strong motivation for our young generations to pursue challenging and exciting careers in science, math, and engineering – an intangible benefit but an important one – a benefit that Congress and the administration have declared as national priorities. Again thank you for the opportunity to address this committee and thank you as well for your continued support of the United States Space Program. I look forward to discussing this issue with you further, and to answering any questions you may have for me in this regard.

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Dr. Sandra H. "Sandy" Magnus is the Executive Director of the American Institute of Aeronautics and Astronautics (AIAA), the world's largest technical society dedicated to the global aerospace profession, with more than 35,000 individual members in 79 countries.

Born and raised in Belleville, Ill., Dr. Magnus attended the Missouri University of Science and Technology, graduating in 1986 with a degree in physics and in 1990 with a master's degree in electrical engineering. She also holds a Ph.D. from the School of Materials Science and Engineering at Georgia Tech (1996).

Selected to the NASA Astronaut Corps in April, 1996, Dr. Magnus flew in space on the STS-112 shuttle mission in 2002, and on the final shuttle flight, STS-135, in 2011. In addition, she flew to the International Space Station on STS-126 in November 2008, served as flight engineer and science officer on Expedition 18, and returned home on STS-119 after four and a half months on board. Following her assignment on Station, she served at NASA Headquarters in the Exploration Systems Mission Directorate. Her last duty at NASA, after STS-135, was as the deputy chief of the Astronaut Office.

While at NASA, Dr. Magnus worked extensively with the international community, including the European Space Agency (ESA) and the National Space Development Agency of Japan (NASDA), as well as with Brazil on facility-type payloads. She also spent time in Russia developing and integrating operational products and procedures for the International Space Station.

Before joining NASA, Dr. Magnus worked for McDonnell Douglas Aircraft Company from 1986 to 1991, as a stealth engineer. While at McDonnell Douglas, she worked on internal research and development and on the Navy's A-12 Attack Aircraft program, studying the effectiveness of radar signature reduction techniques.

Dr. Magnus has received numerous awards, including the NASA Space Flight Medal, the NASA Distinguished Service Medal, the NASA Exceptional Service Medal, and the 40 at 40 Award (given to former collegiate women athletes to recognize the impact of Title IX).