Hearing of the House Committee on Science, Space, and Technology

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

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Thank you Mr. Chairman and members of the Committee for this unique opportunity to discuss with you the exceptionally important need for a Human Space Exploration roadmap, and specifically how a human Mars flyby mission in 2021 contributes to long term exploration goals. I have dedicated much of my life and career to understanding the important objectives in exploring space, determining the capabilities and technologies needed to send people to destinations in our solar system, laying out architectures for these missions, and leading efforts to make them a reality. I fully appreciate the interest and leadership of this committee in support of our Nation's Space Program and for focusing on these topics. On May 21 of last year I testified to the House Science Subcommittee on Space about the need for a human space exploration roadmap and described a method for developing one that is sustainable. It is a good reference and background for today's discussion.

At a time when there is so much potential to make significant progress, I have never been more concerned about the future of human space exploration, primarily because of the current void in long-term direction. Human space exploration is in dire need of a strategic plan consisting of logical objectives and goals which are connected in sequence and in parallel, as appropriate, with tactically placed specific missions. Human space flight can return to an exciting path that inspires the people of the world as explorers venture far from Earth. It promises adventure and important national benefits from astounding achievements, international collaboration, technical leadership, new scientific discoveries, and potential space commerce. I will propose my view of a logical course; a starting point for discussion among advocates for various objectives and destinations to develop the best possible long-term plan. I am offering this based on my years of leading space exploration planning at NASA as the Exploration Systems Mission Directorate Associate Administrator, through NASA Agency-wide planning activities, similar efforts with international agencies while at NASA, participating in related industry discussions, and through active participation in recent related activities. These include the Inspiration Mars Foundation, the Target NEO (Near Earth Object) Workshop, the Humans 2 Mars conference, Affording Mars Workshop, and others.

Guidelines for a Long-term Human Space Exploration Plan

There are basic guidelines that should be followed in developing a plan.

- Missions should address science, exploration, commerce, geopolitical and other objectives to maximize the potential for great achievements and discoveries. It is not enough to describe vehicles and how we are technically going to perform missions. Well-vetted objectives provide the important rationale for the exploration plan and help guide specific missions.
- International collaboration is essential in planning, development of hardware, and participation in missions and operations. We have learned through the International Space Station (ISS) Program, and science missions the value of international collaboration on many levels. Collaboration provides the opportunity for pooling resources to accomplish more than any one country can on its own. Collaboration is a rewarding experience among nations and is a positive influence in international relationships. The International Space Exploration Coordination Group (ISECG) continues to work on exploration objectives, roadmaps and planning for future human space exploration. NASA has provided the leadership in these relationships and I believe must continue to do so. The critical geopolitical considerations of our time strongly mandate that the United States step up to the responsibilities of that leadership role and guide the proper use of space. What's more, these nations look to the U.S. and NASA for this leadership.
- The needed capabilities and technologies should be developed incrementally, paced with available budgets. A long-term plan will help define the specific capabilities that are needed and will provide the priorities and phasing of these developments. Without a plan, capabilities developed can miss the mark and fall short of what will be needed. Other NASA programs, international agencies and companies, industry, academia, DOD, and other agencies and their programs can be leveraged to maximize progress.
- Every mission and capability developed should contribute to long-term exploration needs and objectives. To the degree possible, each flight element, including in-space habitat modules, landers, rovers, space suits, power systems, and others should be developed for multiple use. This begins with the foundation of International Space Station (ISS) testing and research, routine transportation to Low Earth Orbit, and the development of the Space Launch System (SLS) heavy lift rocket and Orion Multi-Purpose Crew Vehicle (MPCV).
- Exploration capabilities should be made available for commercial and other interests to further the utilization of space. As NASA develops capabilities to explore farther and farther from Earth, other interested parties may find advantage in using these capabilities at destinations in space, where NASA has paved the way.
- The long-term plan should be adaptable based on discoveries and budget realities. With it we can envision a logical sequence of missions based on known objectives. However, by the nature of exploration, missions will lead to discoveries that may change priorities. The plan should be adaptable based on these discoveries. A perfect example of this idea in practice is the NASA Mars Science Program. Roadmaps with specific sets of objectives and missions have been developed for the last two decades. Discoveries have been prevalent in this program, and the plan has been adjusted to make the most of every upcoming mission.

- Constant progress should be made towards the long term goal of landing people on Mars to explore this planet. Mars is globally accepted as an ultimate human space flight goal based on the fact that it is the planet most like our own and may hold evidence of past or present life. It is habitable with known systems, and can be reached within foreseeable technological capabilities.

A Foundation for Human Space Exploration

Investments in current NASA human space flight programs are important in providing a balanced and solid foundation for human space exploration. The ISS is an operational facility for research and testing. U.S. Space Policy and NASA budgets currently support Commercial Cargo and Crew system development to provide routine travel between Earth and Low Earth Orbit(LEO); in particular to the ISS. U. S. policy also recognizes and supports human exploration beyond Low Earth Orbit as the long-term future for human space flight. The SLS and the MPCV are the first crucial development steps for NASA to focus its resources in achieving this human space exploration strategy. I will point out where I believe these programs could be improved to better support long-term human space flight needs.

International Space Station (ISS)

The ISS is a unique operational capability that is utilized for research needed to better understand human health and safety on long space missions in zero or partial gravity. It is also a valuable facility to demonstrate needed technologies and reliability of systems in the space environment for long duration exploration missions. I believe the ISS program needs to produce an integrated research and test plan with important milestones for prioritizing research and testing as well as for measuring progress. The ISS program needs to provide more crew time for the research and testing than it does now. This is another metric that should be reported. Reporting achievements against these metrics will demonstrate the value of the work that is done there. Programs also tend to be more productive when reporting regularly against metrics such as these.

Commercial Cargo and Crew

Cargo transportation to ISS has been developed and demonstrated, and a services contract is now in place. Crew launch capabilities to ISS are in development and competition for a contract is underway. The U.S. pays for and relies on crew transportation to ISS from the Russians until the U.S. capability can be completed.

NASA has taken the position that it needs to have at least two crew transportation providers competing to drive down transportation costs. NASA managers have stated that because of current budget limitations, they will slip the schedule significantly for bringing this capability on-line in order to maintain these parallel developments. I believe that the value of using the available budget to accelerate schedule for crew transportation with a single provider far outweighs the need to carry multiple companies through development. These are the rationale:

- The cost of multiple (2 or 3) redundant developments is going to far outweigh any savings from the continued competition in transportation pricing. Unnecessary costs also include flying Astronauts on Russian Soyuz flights at $70M per seat, for the extended time that the development schedule is slipped.

- In my opinion the only certain market for Commercial Crew transportation is to and from the ISS. Other speculative markets are currently on the margin in terms of revenue for transportation providers. Markets will possibly develop over time, but it does not appear to be on the horizon. ISS needs will really only support one provider. If two companies are carried for ISS transportation, it will wipe out any savings from competitive pricing. ISS only needs a limited number of flights each year to transport crews. If those limited opportunities are split between two providers, it will be more expensive per flight than if one provider supplied the transportation. This is because there are fixed costs for each to carry the overhead of a workforce and facilities. In this case, NASA would likely end up carrying both of them even if there is a price disparity between the two. Bottom line; the cost of carrying two is more than carrying one provider, and it makes it harder for each to cover their costs with low flight rates.
- Companies are competing through the current Commercial Crew solicitation, which will already result in the lowest price each company can live with.
- For whatever non-ISS market that exists, the U. S. company(s) will likely have to compete with Russian Soyuz costs. That will provide pricing competition.
- Parallel competing developments would be nice in other programs such as SLS and Orion MPCV. This is a luxury that is not possible in available budgets. I believe this is a luxury that is not a good trade in the Commercial Crew program when traded for schedule.
- A feature of the Commercial Crew Program has been and will continue to be shared investments between the companies and the government through the development period. This is a benefit to the government during this period of time. When NASA has to down-select, companies that are not selected will have lost their investment if they cannot continue development on their own. Companies not selected will have to consider the fact that they will not benefit from the only certain market (ISS) for their services. The longer this parallel investment goes on, the more harm it will cause to companies not selected.

For these reasons, I believe NASA should down-select to one provider during the current competition. This will save unnecessary expenditures and accelerate deployment of the crew transportation capability as early as possible. It will end reliance and the parallel cost of the Russian launch of U.S. and international partner crews.

Space Launch System (SLS)

While some advocate agendas in opposition to the heavy lift SLS, the Congress and Administration approved development of a heavy lift vehicle for human exploration needs through the 2010 Authorization Act, based on sound rationale. The Chinese and Russians recognize the requirement and have stated their intentions to pursue heavy lift for exploration missions as reflected in recent announcements they have made. The specific SLS design was driven by human exploration requirements for lunar and Mars missions, the advanced U.S. state of propulsion technology, U.S. industrial capabilities, the necessity of making progress to sustain the program, existing programmatic opportunities, and the significant constraint of the near-term budget outlook. Extensive technical trade studies in 2011 objectively compared all possible launch scenarios, launch vehicle sizes, their relative efficiencies, relative mission risks, and other programmatic considerations, including severe budget constraints. Decisions on the overall design were made by the NASA administrator in conjunction with senior management across all of NASA. The resulting SLS design is made up of the most advanced and reliable U.S. propulsion technology available, evolved continuously over the last 40 years.

Why choose a heavy lift vehicle? Launch mass for a single human mission to the Mars surface and back is at least the equivalent weight of the ISS launched from Earth. That mass would be much more without taking advantage of new technologies, such as advanced in-space propulsion, cryogenic fuel management, closed loop life support, aero-braking at Mars, lightweight materials and others. Using these technologies to reduce launched mass and therefore the number of launches is much more effective in reducing cost than the marginal efficiency improvements that might be made in launch vehicle technology, which by the way, is also being improved upon. Assuming use of these technologies, this mission would still require 6 to 7 SLS vehicles with 130 metric ton (Mt) lift capability. In contrast, considering only mass requirements, this same mission would require on the order of 30 EELV-class launch vehicles, assuming 23 Mt lift capability. The cumulative risk of mission failure from that many launches and the accompanying assembly operations compared to the number of SLS launches is about a factor of 2 higher. Mass is not the only important consideration. What the rockets launch, such as landers and large in-space vehicles require the diameter and volume of a large payload shroud provided only by a heavy lift vehicle. These facts are why the Russians, Chinese, U.S. aerospace companies, the Inspiration Mars Foundation, and others who study and understand the facts also recognize the requirement for heavy lift. SLS was designed based on these considerations.

Exceptional progress has continuously been made on SLS, since design decisions were made in 2011. The SLS design and development, managed from the Marshall Space Flight Center (MSFC) in Huntsville Alabama, is currently ahead of schedule according to recent reports and demonstrated milestones. The SLS Program will conduct the detailed Critical Design Review for the booster and core stage this year. The program is employing advanced manufacturing/welding technologies and techniques for the core stage. These are much simpler and efficient when compared to the Space Shuttle External Tank manufacturing. Manufacturing of the core stage is being done at the Michoud Assembly Facility (MAF) in Louisiana. The program is currently producing pathfinder and flight hardware for the large core stage fuel tanks. At the Stennis Space Center (SSC) in Mississippi the B-2 engine test stand is being refurbished for testing the full SLS core stage, and is doing so on schedule and under budget. Modifications are also being made to the A-1 Test Stand at the SSC for testing of the RS-25 Core Stage engines. The five segment boosters have undergone exceptionally successful test motor firings in Utah. The program will test fire its first qualification motor this year, build the second qualification motor and begin building flight hardware. The full SLS avionics package had its first power-up in January. Testing of the booster thrust vector control assembly at ATK's facility in Utah was also recently accomplished.

The first SLS test flight will use an "interim" upper stage, an adapted Delta IV upper stage. I believe that this "interim" upper stage should be used as-is to the degree possible for use only on this first test flight. Work should begin immediately to replace it with the NASA/industry Dual Use Upper Stage (DUUS) concept. This will provide exploration-class SLS performance (100+

metric tons) for the first flight after the 2017 test flight, and will provide the earliest deployment of the performance needed for human exploration missions. Developing it now will take advantage of synergies in design with the SLS core stage, realizing considerable savings.

Orion Multi-Purpose Crew Vehicle (MPCV)

The Orion MPCV was conceived to be the crew vehicle for Beyond Earth Orbit exploration missions. It was designed for a crew of six for eventual Mars missions. While it might look like other capsule designs, there are requirements for distinct differences in capabilities, including systems and consumables for longer duration missions, a heat shield designed for much higher entry speeds from destinations Beyond Earth Orbit, and a service module with performance that exceeds what is necessary for Earth orbit operations. The Orion design went through a decision process equivalent to the SLS process, and decisions were made at the NASA Administrator level.

The Orion MPCV Program, managed at the Johnson Space Center in Houston, Texas has made progress towards the first test flight of the EFT-1 Crew Module (CM) and service module that are due to be launched in September of this year. These are nearing completion at the Operations and Checkout Building at the Kennedy Space Center (KSC). The spacecraft flight avionics were powered up in November for the first time. The Delta IV-Heavy rocket that will be used for this launch is due to be shipped to Florida in March. The Orion Program will begin work this year on the spacecraft for the first SLS flight in 2017.

Ground Systems

NASA, Kennedy Space Center and its contractors are working to reduce eventual production and operations costs for SLS and Orion, making modifications to previous Space Shuttle processing facilities and the new mobile launcher. The Launch Complex 39-B is being refurbished to efficiently support SLS and Orion flights. Modifications have begun on the Mobile Launcher, the Multi-Payload Processing Facility, and the Rotation Processing Surge Facility. Construction in the Vehicle Assembly Building at KSC for SLS and Orion stacking and preflight processing is planned for this year.

The progress for all these capabilities is reassuring as a foundation or future human space exploration and can be enhanced as I have noted. The NASA human space flight work force and the corresponding industry work force deserve tremendous credit for finding efficiencies and making excellent progress on these programs within difficult budgetary constraints.

Needed Technologies and Capabilities for the Long-term Human Exploration Missions

In addition to the LEO transportation capabilities, ISS research and testing, the heavy lift SLS vehicle, the Orion MPCV and supporting ground systems; certain key capabilities, technologies and research are needed over time. Some are enabling to mission success, while other technologies offer efficiencies that reduce the number of launches. These are some of the more important of these capabilities:

- Advanced In-Space Propulsion**:** Enabling low-cost and rapid transport of cargo and crew beyond LEO
- Radiation Research and Protection: To protect crews from in-space solar proton events and galactic cosmic radiation
- Cryogenic Propellant Storage and Transfer: To reduce fuel loss from boil-off of cryogenic fuels and manage fuels
- Closed Loop Life Support and Habitation Systems: Enabling humans to live for long periods in deep-space environments and reduce consumables through recycling them
- Lightweight Spacecraft Materials and Structures**:** Enabling lightweight systems to reduce mission mass and costs
- High-Efficiency Space Power Systems**:** Providing adequate efficient power
- EVA Technology: Enabling humans to effectively conduct surface exploration in partial gravity and conduct in-space operations outside the protection of habitats and vehicles.
- Human-Robotic Systems: Amplifying human productivity and reducing mission risk by extending human capabilities with machines and robots.
- Aerobraking, Entry, Descent, and Landing Technology: Landing large payloads safely and precisely on extra-terrestrial surfaces
- Autonomous Systems and Avionics: Extending human exploration capability by reducing workload and dependence on support from Earth
- Automated Rendezvous and Docking: To automatically assemble components for missions
- Rovers/Mobility: Efficient rover technology, developed synergistically with EVA capabilities to transport crews to exploration sites

A Point of Departure for a Human Exploration Long-Term Plan

In the absence of an existing long-term plan for human exploration, perhaps it is of value to describe a plan with proposed missions, objectives and rationale for debate in the space community among stakeholders and advocates of the various approaches. It is important to find common ground with compromise in providing a plan that represents the visions of many, while being efficient and cost effective. The following is a plan and top level rationale that I propose as a point of departure based on my experience:

Begin with a human Mars/Venus flyby mission in 2021, a unique mission opportunity with a free return trajectory made possible by the exact Earth-Venus-Mars planetary alignment. A flyby with a free return is the least complex mission profile for reaching the Mars vicinity. The next comparable flyby opportunity is not until 2033. This opportunity in 2021 exists only because Venus will be in the right place to assist from a swing-by of the spacecraft and thus offers the opportunity for a two-planet flyby. The Mars free return mission was first proposed last year by Dennis Tito and was extensively analyzed through the Inspiration Mars Foundation for a 2018 mission. Mobilizing the programs to achieve the 2018 date was not achievable, but the 2021 date is within reach. The mission provides an opportunity for an incredible first step in future human space exploration, demonstrating the excitement, reality and potential of human missions to Mars, as these explorers would be the first in history to travel the distance and fly past Venus and Mars. A mission in 2021 would provide a near-term goal, achievable with a clearly focused effort to motivate and measure our progress in the most cost effective way. In discussing Mars exploration it is generally seen as a distant possibility. This flyby mission will make travel to Mars more real to the people of the world, by demonstrating previously unimaginable possibilities in the span of a few short years. The crew will observe and relay their experiences as they view and describe a partially illuminated Mars for more than 40 hours.
Such a bold and audacious expedition will demonstrate American resolve around the world, while inspiring young people to pursue new dreams and higher education.

Capabilities flown are a single SLS vehicle with a fully capable (DUUS) upper stage, a habitat with an advanced life support system, and an Orion capsule with an advanced heat shield. Once developed, these incremental steps in necessary exploration capabilities would contribute to human exploration missions that follow. The Mars flyby mission is an inspiring near-term achievement that will energize the human space programs worldwide, creating anxious anticipation for missions that follow. The next logical Mars mission will be years away, most likely 2033 or later. The important point is that in the interim, meaningful and exciting missions are possible, incrementally developing capabilities for the more complex Mars missions in the years downstream. These downstream missions will include travel to the Mars moons, Phobos and Deimos, and Astronauts landing on Mars.

After the initial Mars flyby mission, the most logical next step in exploration for the 2020's are missions to our own Moon which is only days away in travel time. Spacefaring nations are highly interested, including China and Russia. The Mars flyby mission capabilities would support a possible cislunar space facility and landed missions. An extensive list of lunar exploration objectives have been refined between NASA and thirteen international space agencies over the last few years. Incredible new information has been provided by recent robotic missions, including the Lunar Robotic Orbiter (LRO) (still orbiting the Moon), the Lunar Crater Observation and Sensing Satellite (LCROSS), and the Gravity Recovery and Interior Laboratory (GRAIL). LRO instruments have revealed detailed high fidelity images of the Moon with striking, dramatic landscapes not seen during Apollo missions. These rugged terrains are now accessible with precision landing technology. LRO instruments have provided data for accurate three dimensional maps. Lunar resources are globally mapped and available to commercial interests. Data from GRAIL will help understand the structure of the lunar interior, providing information on how lunar orbits are affected by the non-uniform density of the Moon. LRO and LCROSS were missions specifically formulated to inform future human missions to the Moon as they now have. Scientists are interested in the Moon to learn about the history of the Sun, Earth and the inner solar system through its impact crater history and deposition of solar wind particles. Astronauts will collect samples in high priority locations already identified by scientists, photographed in high resolution and mapped by LRO. Astronauts will employ surface operational techniques in the hostile lunar environment that will prepare for future Mars surface operations. They will use, test, and further the maturity of planetary systems that will benefit Mars exploration. Pressurized rovers combined with a new surface space suit design will be advanced synergistically to maximize the productivity of crews on the lunar surface. These will provide the opportunity to widely explore the Moon, with Astronauts investigating many interesting sites over a series of potential missions. Based on the pace of achievements and interests, these missions can continue, interspersed between future Mars mission opportunities.

With Mars flyby mission capabilities, a human mission to a large asteroid in its own orbit will be achievable with the same capabilities. It would make for an interesting interim destination if a compelling target is identified by scientists. Travel to a large heterogeneous asteroid would be more scientifically interesting than the currently proposed mission to retrieve a very small asteroid and transport it back to the vicinity of the Moon, by the way, with capture hardware that is single use. Scientific data shows that small asteroids tend to be spinning if not tumbling, probably making the retrieval spacecraft capture capability complex and expensive, if it is to be successful. Scientists have also raised questions about the scientific value of such a relatively small rock. The asteroid would be too small to be considered dangerous, smaller than the asteroid that exploded over Chelyabinsk Russia in February, 2013. Therefore the mission probably doesn't provide much information relative to planetary protection.

After initial lunar missions, Mars' moons Phobos and Deimos are very promising destinations for exploration, when capabilities become available for Mars orbital missions. This is a big step beyond a flyby with advances, including highly efficient in-space propulsion necessary to reduce fuel mass. The crew must brake into Mars orbit and then propulsively return to Earth. This advanced propulsion could include an evolution of solar electric propulsion technology in use today, nuclear electric propulsion, electric plasma engines, or nuclear thermal propulsion. Because of the efficiencies of advanced propulsion, the amount of mass launched into space for a Mars mission can be reduced by a factor of about two over the mass associated with conventional chemical propulsion technology. Orbital missions will still require multiple SLS launches. Crews will be in close proximity to Mars for a period of weeks, observing and studying the planet Mars. They will be able to tele-operate robots on the surface with short communication delays when compared to long time delays associated with control of rovers from Earth. Astronauts will explore the moons Phobos and/or Deimos, harvesting samples, including those ejected from asteroid collisions with Mars and possibly Mars samples emplaced by robotic science missions. This is believed to be achievable in the early 2030s within reasonable budgets. A mission to Phobos or Deimos will be an incredible experience inspiring the ultimate step of landing a crew on the Martian surface.

A Mars human landing would be another big incremental step in human exploration, beyond the Mars orbital missions. A large lander capable of an atmospheric entry, a surface habitat, nuclear surface power, a lightweight surface space suit, a surface rover, and other surface assets will be needed. Human missions to Mars will be tremendously momentous, as Astronauts explore the planet most like our own. Mars once had running water and a more substantial atmosphere. Astronauts will gather information to learn about the evolution of the Martian atmosphere and environment, so scientists can evaluate its relevance to the evolution of the Earth's environment. Astronauts will drill for subsurface water, looking for signs of past or present life, and processing water for fuel and consumables. Crews will use their unique observational skills to locate the most precious samples leading to unsurpassed discoveries. They will encounter vistas never before seen by any other person and will share the excitement of the experience with the civilization 10's of millions of miles away, back on Earth.

As in the case of the LRO and LCROSS lunar missions, robotic precursors will be interspersed with human missions to gain important knowledge and test technologies needed for upcoming exploration flights. Examples are testing of higher lift or inflatable heat shields at Mars, demonstrating precision landing, and performing in-situ resource production experiments. These objectives can be combined with science objectives to plan collaborative missions. There are precedents for this, including the collaboration between human space flight and science in planning, instrumentation selection, and operations for LRO and LCROSS. Additionally there was collaboration on the Mars Science Lab (MSL) mission in flying a radiation experiment for the first time to the Mars surface, and in instrumenting the MSL heat shield to obtain entry aerodynamic and heating data during Mars entry. This is the first such Mars entry data measured since Mars Viking missions in 1976.

Budgets

Upcoming and future budgets need to be commensurate with the value of the long-term plan with its envisioned achievements and the work needed to accomplish it. Human space flight budgets are well below 2010 Authorization Act numbers. The budgets have tended to be flat with no adjustments for inflation. That means buying power of appropriated funding continues to decline. On the other hand the investments made human space flight provide incredible potential for the future through spectacular peaceful endeavors. Leveraging other domestic and international investments will contribute to the pace of progress. Reasonable budgets over time will open the door for great technological achievements to be expected of a great Nation.

Conclusions and Recommendations

This is a brief description of what I consider a promising future for human space exploration based on exploration and science objectives, and an incremental approach to development of exploration capabilities. This proposal is an example of what should be debated and refined by the space community and stakeholders to reach consensus on a long-term plan. We must not prolong this debate, because timing is critical for making progress. With this overall plan and further definition of exciting exploration objectives, I believe stakeholders will be motivated to support with appropriate but reasonable budgets. This will assure that we regain and further U.S. leadership in space exploration with a cadence of achievements.

Within this framework immediate focus is needed to define details and initiate steps towards the Mars flyby mission in 2021. It is an inspiring mission and provides a time constraint, driving efficiencies in development by NASA and industry. We have the significant foundation of programs underway. These programs can be refined to be better aligned with long-term exploration needs as I have described.

NASA should seriously consider the ideas and suggestions put forth here and objectively examine how it could be accomplished.

With such a long-term plan and inspired United States leadership, we can provide our youth and the rest of the world a future that will make technological progress and inspire all to higher aspirations. This is a uniquely powerful, peaceful, positive initiative for our country and the world.

Once again, thank you for inviting me to give my personal views. I also want to thank this committee and your staff for your continued bipartisan support for human space flight, even through difficult times.

I welcome your questions.

Douglas R. Cooke

Douglas R. Cooke is an aerospace consultant for Cooke Concepts and Solutions with over 40 years of experience in human space flight programs. In 2011, he retired from NASA after a 38-year career at Johnson Space Center and NASA Headquarters. He advises on company strategies, program management, proposal development, program strategies, strategic planning, and technical matters. His experience at NASA was in engineering and senior level program management positions in the Space Shuttle, the International Space Station, and Human Exploration Programs. During his career, Mr. Cooke has held major leadership responsibilities and had achievements during critical periods of each of these human space flight programs. These responsibilities have included leading entry aerodynamic flight testing of the Space Shuttle in the Approach and Landing flight tests and the early orbital flights, leading the design studies for the Space Station in the first program office, systems engineering management positions in the Space Shuttle Program Office during the post-Challenger return to flight period, Program Manager of the Exploration Programs Office, overall lead of engineering and technical analysis and design during the 1993 Space Station Redesign and Transition to the International Space Station, first Vehicle Manager of ISS, ISS Deputy Program Manager-Technical, Manager of a JSC office for human space exploration planning, and NASA technical advisor to the Columbia Accident Investigation Board in 2003. He has been in leadership positions for most of NASA's advanced studies in human space exploration since 1989, including the White House studies "The 90 Day Study" in 1989 and the "Synthesis Group Report, America at the Threshold" in 1990. While at Johnson Space Center he also had several high priority detail assignments to other NASA centers and NASA Headquarters. During Mr. Cooke's last three years at NASA, he served as the Associate Administrator (AA) of the Exploration Systems Mission Directorate at NASA Headquarters. In his last year at NASA, he led efforts within NASA to adopt the current vehicle designs for the Orion and the SLS. As Associate Administrator, Mr. Cooke was also responsible for the Constellation Program, Lunar Reconnaissance Orbiter, Lunar Crater Observation and Sensing Satellite, Commercial Cargo and Crew, Human Research and Exploration Technology Programs. Prior to being AA he was Deputy Associate Administrator of the same directorate, since its formation in 2004. Mr. Cooke has also been a member of the ISS Advisory Committee and on the Advisory Board of the Inspiration Mars Foundation.

Mr. Cooke has received the Presidential Distinguished Rank Award, Presidential Meritorious Rank Award, NASA Distinguished Service Medal, three NASA Exceptional Achievement Medals, NASA Outstanding Leadership Medal, NASA Exceptional Service Medal, two JSC Certificates of Commendation, a number of NASA Group Achievement Awards, and the Space Transportation Association Lifetime Achievement Award. He was awarded the Texas A&M Outstanding Aerospace Engineer Alumni Award in 2013. Mr. Cooke received a B.S. in Aerospace Engineering from Texas A&M University in 1973.