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The views expressed in this paper are my own and do not reflect the views of my employer or any other organization with which I am affiliated.

I thank you for the opportunity to present your committee with my ideas for developing a robust and sustainable spacefaring capability. I bring to this brief presentation my background of a career of nearly thirty years in the space industry which reached one of its climatic moments last month with my participation in support of the STS-125 Hubble Servicing Mission. I also bring my personal involvement in several space public interest groups where I have gained a familiarity with the major space policy issues and with some of the players and developments in the entrepreneurial New Space industry.

In the early 21st Century, there is clearly a growing awareness of the importance of space for security, economic development, scientific discovery and providing for the well being of future generations. The growing space initiatives by China, India, Europe, Japan and other nations and the renewed initiatives by Russia are concrete evidence that the world is moving into space. It is definitely in our national interest to undertake a robust and sustainable spacefaring effort so as to maintain a leading role in space for the United States.

Developing this spacefaring capability requires that we think of NASA not as a set of programs that accomplish everything we can accomplish in space, but as a catalyst to initiate various efforts that also engage the private sector, multiplying the return on our investment in NASA and creating a sustainable and ever expanding presence in space.

I will be discussing several areas related to human spaceflight (HSF) and how to restore, maintain and expand our capabilities in space. These include launch capabilities and architectures, in-space servicing and assembly, and exploration and infrastructure development on and around the Moon, Near Earth Objects (NEOs) and Mars and other destinations beyond.

Launch Capabilities and Architectures

The primary focus of implementing NASA's future human spaceflight plan centers on development of the post-Shuttle launch vehicles and infrastructure to carry out the exploration of the Moon and other destinations while maintaining our commitments to the International Space Station (ISS). The challenge is how to carry out these objectives in a sustainable way within a constrained budget situation. While I am not in a position to provide a detailed and definitive analysis of the capabilities and issues related to the current Constellation architecture versus the proposed alternatives developed in great detail by others, I am presenting my input on some of the issues and directions that need to be considered.

The greatest concerns raised about the current Constellation architecture with its Ares I and Ares V launch vehicles are that it started out as a fairly straightforward Shuttle Derived Vehicle (SDV) system of two vehicles that have since undergone significant design modifications. These modifications included going from a four-segment solid booster to a five-segment booster for the Ares I and to a 5.5-segment strap on booster for the Ares V. The additional segment for the Ares I has raised serious technical issues including thrust oscillation that would generate vibrations that, if not sufficiently dampened, could endanger the crew and their vehicle. Also, the expansion of the liquid fueled core booster diameter from 8.4 m (the current diameter of the Shuttle External Tank on which it is based) to 10 m has added increased cost and schedule issues to the Ares V which is in the critical path to exploration of the Moon and beyond.

Alternative approaches have primarily focused on use of existing rockets (Atlas V and Delta IV Evolved Expendable Launch Vehicles EELVs) currently used for military and commercial purposes, bringing new commercial vehicles now under development (Falcon IX, Taurus II, etc.) into use in support of NASA's missions, and use of more straightforward development of Shuttle Derived Vehicles (Direct v3.0) to meet requirements for heavy lift that those other systems may not yet be able to meet within the schedule of the nation's goals.

Going forward, US policy should harness the best combination of solutions from the commercial sector and the capabilities that NASA has already developed to accomplish the nation's exploration goals on schedule and within budget. While continuing to partner with and use the services of Russia and the other international partners, NASA should press its Commercial Resupply Services program to utilize commercially supplied transportation of cargo and eventually crew to the ISS. If necessary to complement commercial and foreign human spaceflight services, heavy lift EELV launch of the Orion crew vehicle to ISS can be carried out at lower cost than the current architecture, according to a recent study by the Aerospace Corporation.

To carry out missions beyond Earth Orbit may require that more powerful heavy lift vehicles be developed in the near term. In that case, serious consideration should be given to the Direct v3.0 proposal for the Jupiter rocket family. This proposal is really an updated version of NASA and industry studies done in previous decades to make maximum use of launch hardware already developed and in use for the Space Shuttle Program. The Jupiter rocket would use the same 4-segment Solid Rocket Boosters that are currently used on the Space Shuttle and would use a liquid hydrogen/liquid oxygen powered core stage derived directly from the current Shuttle External Tank, with no change to its 8.4 m diameter. Various engine configurations in this core stage and the upper stage would provide various capabilities to support operations beyond Earth Orbit, including lifting of the fully capable six-crewmember Orion spacecraft.

A combination of the EELV and Jupiter architectures might best serve our future orbital and deep space human spaceflight goals. However, independent study of the technical and financial profiles of these architectures should be carried out to verify whether or not it is really advantageous to replace the current Constellation architecture at this time. In the mean time, decisive action must be taken quickly to ensure existing infrastructure and manufacturing capabilities are not prematurely or unnecessarily destroyed while architecture alternatives are being considered.

In-Space Servicing and Assembly

The recently completed STS-125 final servicing mission (and its predecessors) which executed essential repairs and upgrades to the capabilities of the Hubble Space Telescope (HST), along with the nearly completed assembly of the ISS, demonstrate capabilities developed by NASA and industry over the past few decades. These capabilities were developed incrementally through intense analysis, preparation, practice and lessons learned from prior experience. For example, over a hundred new specialized tools were developed just to carry out the tasks on this last Hubble servicing mission.

The completion of Shuttle Hubble servicing missions and the completion of ISS assembly within the next two years put at risk these hard won capabilities. While some servicing and upgrading of the ISS will continue, much of the experienced workforce that supported the Hubble servicing efforts is already dispersing and this capability will atrophy with no near term missions requiring these skills and capabilities.

We should act now to maintain continuity of this national capability for in-space servicing which will be needed to accomplish future goals. A study is now being conducted by the NASA Goddard Space Flight Center at the request of Congress to analyze how the human spaceflight architecture can be utilized for servicing future large space observatories and other satellites. And when serious planning is needed for missions to the lunar surface, NEOs, Mars and other destinations, the kind of tools and procedures development that supported the Hubble servicing missions will be a vital requirement.

Another consideration for in-space servicing is the continuing advancement of robotics that will allow for the planning of robotic servicing for routine tasks and robotic assistance to human servicing crews for more complex servicing where human intervention is required.

While there may always be a role for NASA in developing servicing capabilities for one of a kind national assets such as HST, development of a commercial in-orbit servicing industry will be vital to meet the needs of future constellations of increasingly sophisticated communications satellites and possibly large spaced based solar power systems designed to help meet Earth's future energy needs.

Exploration and Infrastructure Development on and around the Moon and Beyond

This summer, we are celebrating the 40th anniversary of the first lunar landing in 1969. This occasion will be an inspiring observance, but it is also a reminder of the capacity for exploration we gave up after the final lunar expedition in 1972. The Vision for Space Exploration (VSE) announced in 2004 provides a challenge to not only regain the lost exploration capabilities of the Apollo era, but to develop a truly robust and sustainable capability to open up the inner solar system and eventually beyond.

The first step toward this goal is to see that the fleet of launch vehicles available can carry out the incremental test program and progressively more sophisticated exploration missions within a reasonably rapid but sustainable schedule given budget constraints. These missions might develop from an Apollo 8 style lunar orbital mission to an Apollo 17 style lunar landing expedition continuing rapidly toward more extensive long duration expeditions and the establishment of one or more bases on the Moon. Likewise, exploration of Near Earth Objects, which hold both potential peril of collision with our home planet and the promise of abundant resources for future generations, can progress in sophistication as experience is gained.

To achieve these goals, it is vital that serious consideration be given to the merits of the current Constellation architecture versus those of the alternatives discussed earlier and of any other serious innovative approach that may emerge.

With an effective launch capability, our exploration capabilities can be enhanced by application of in-space operations and services. One area that has received significant attention is the development of propellant depots in Earth orbit and possibly the Earth-Moon-1 Lagrange point. There is a two-fold benefit from employing these kinds of facilities. First, the ability to refuel in orbit would give a propulsion vehicle of a given size and performance the payload capability of a larger, more powerful (and more expensive) vehicle. Second, seeking commercial provision of in-space refueling services would enable the growth of a new commercial space industry while providing a new market for the growing commercial launch industry.

The procurement of commercial space services can be extended from commercial resupply and crew exchange for ISS to in-space refueling and servicing to the provision of facilities and services at a lunar base, including the utilization of local resources. Engaging the commercial sector in this manner would free up NASA from the details of operating facilities in Earth orbit and on the Moon to be able to focus on exploration of NEOs, Mars and other destination. This line between cutting edge exploration and commercial support and development should naturally follow the explorers outward into the Solar System.

There is another way of enabling the growth of commercial human spaceflight that may not seem directly relevant to human exploration beyond Earth orbit but that can have near term and long term payoff. NASA has already expressed interest in flying researchers' experiments on commercial suborbital "tourist" flights. This initiative should be pursued aggressively and in fact be extended to sponsoring passengers to fly on these commercial vehicles for purposes of research, in-space training or education. Nurturing of the fledgling suborbital human spaceflight industry now can help enable it to grow into a robust industry that will provide large scale public access to orbit and beyond.

Developing a True Spacefaring Capability

The challenge for our nation is to develop and sustain a truly spacefaring capability, that is, the capability to carry out various tasks in space to explore, develop and eventually settle an increasing array of destinations in our Solar System. To do this will challenge some usual ways of thinking and doing business.

There is an understandable and legitimate interest by public officials in securing industries and jobs for their local constituents. Up to a point, this has a positive effect of broadening legislative support for space initiatives. However, it has taken on a potentially serious detrimental effect when efforts to defend parochial interests go so far as to stifle innovative alternative approaches and initiatives to engage the commercial sector. Legislative efforts to block funding for procuring commercial services should be lifted or overridden.

Divisions within the space community should not be allowed to hinder creative initiatives to make spacefaring an affordable enterprise. Opening this frontier will call on the best from government and from “traditional” and “new” space companies. The debate about human versus robotic exploration ignores the obvious case that human and robotic and combined efforts are all vital. Likewise, arguing over whether the most important destination is the Moon, Mars or NEOs also misses the point. What is needed is a robust spacefaring capability that makes all of these destinations accessible.

Achieving a true spacefaring capability will not be measured by programmatic milestones on a management chart. We will only know we are there when large numbers of people routinely travel into space on business or pleasure, trade routes are flowing among locations in the Solar System, resources and energy from space are being used to benefit people on Earth, and human settlements are beginning to flourish in places beyond Earth. It is not within the charter or realistic timeframe of this Human Spaceflight Plans Committee to make all of these things happen. However, it is incumbent on this committee to consider how the decisions to be made for the near term will enable those vital developments to occur for the benefit of present and future generations.