COMMENTARY Paul D. Spudis

Moon: the next destination in space

With the new administration and change in leadership at hand, America can correct the strategic direction of our human space program back to the moon. As the body that is both accessible and useful, it is *the* destination capable of returning practical value for investment within the next decade.

The moon is close — three days away by rocket and 1.5 seconds by radio. Because the moon orbits Earth, we can go and return whenever we want. This gift of proximity affords us an open window for launch opportunities, making lunar return safer than any other destination beyond LEO. The significance of being just three days away becomes clear when compared to the other suggested destination — Mars.

Due to orbital mechanics, the window of opportunity for going to and returning from Mars only happens every 26 months. The distance to Mars varies between 55 million and 400 million kilometers. Even at the speed of light, it takes seven to 40 minutes for radio messages to reach and return from Mars, resulting in no real-time system support from Earth and many months away from any resupply or rescue.

Since ending our missions to the moon nearly 50 years ago, the United States has been seeking a practicable, strategic human space program. Despite claims that America is on a "Journey to Mars," we have neither the technology nor the money (*at least* half-a-trillion dollars) to send humans to Mars. In contrast, by using existing technology and space assets, we can develop a permanent human outpost on the moon and do it within the existing NASA budget.

Orbiting robotic probes to the moon have discovered large deposits of water near both poles. Water supports life — to drink, for food reconstitution, sanitation, and radiation shielding. When water is cracked into hydrogen and oxygen, it creates air to breathe and (when frozen into liquids) is a powerful rocket propellant. This last use makes available water the most valuable resource in space. By returning to the moon and harvesting water, we will gain the technology and tools necessary to build a completely reusable, refuelable space transportation system, which will enable access >

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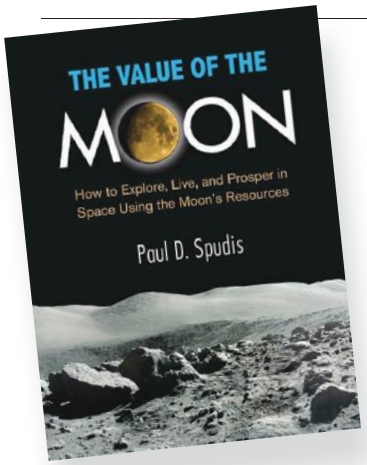

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< > to all the space between and around Earth and the moon — a region called cislunar space.

The closeness of the moon enables robots, under remote control by operators on Earth, to construct the lunar outpost. The use of robotic assets reduces the amount of mass initially needed and delivered to the surface — as opposed to what is required for a human spaceflight system — meaning fewer launches and lower costs. As we learn vital lessons in how to emplace and build systems on the moon, and how to provision ourselves in space using local resources, we will bring down the cost of human access to all destinations. A similar telerobotic approach is not possible for Mars due to distance and time.

Modern society has become dependent on the large and growing fleet of satellites stationed in extremely high orbits in cislunar space — orbits as high as 40,000 kilometers above Earth. These systems create wealth (worldwide communications) and provide protection (weather monitoring, security and surveillance). Satellites, like everything else, are subject to breakdown due to technical failure, lifespan, or from overt hostile actions. With no ability to access these high orbits, the United States cannot service and protect satellites at distances much higher than low Earth orbit, or LEO — the 400-kilometer orbital distance of the International Space Station. The way to make such access affordable and routine is to develop a permanent, space-based transportation system. The moon then serves as a logistics depot — with its water (vital raw material available outside Earth's deep gravity well) converted to propellant and fueling the space transportation system of the future.

Other nations are actively pursuing or planning for a presence on and around the moon. The European Space Agency is planning a "village" on the moon and Russia has announced plans to fly robotic and human and lunar missions. Most significantly, China has a very active program of lunar missions; they put a lander and a rover on the moon in 2013 and have more missions scheduled for the near future. China declares that their space activities are peaceful and devoted to science, but they have already established and demonstrated capabilities necessary for space control (moving and using space assets at will throughout cislunar space). Satellites and situational awareness are critical for military command, control, communications and intelligence. During some future geopolitical crisis, the denial of satellite services could render our military vulnerable. The United States must prepare, create and maintain the ability to respond to any future situation that threatens our national security.

While some continue to advance the idea that a human mission to Mars must be America's "next step" in space, for now, Mars remains a goal too far away — in distance, in available technology, in political rationale, and in fiscal capability. Our focus and planning should be on establishing a presence on the moon, with the goal of using its material and energy resources to supply a permanent cislunar transportation system — a "transcontinental railroad" in space. Once such a system is established, journeys beyond cislunar space become feasible. A return to the moon begins our journey to the stars. **SN**

PAUL D. SPUDIS IS A PLANETARY SCIENTIST WHO HAS SERVED ON TWO WHITE HOUSE PANELS STUDYING LUNAR RETURN ARCHITECTURES. HE HAS PUBLISHED OVER 120 TECHNICAL PAPERS AND SEVEN BOOKS, MOST RECENTLY, "THE VALUE OF THE MOON," PUBLISHED BY THE SMITHSONIAN INSTITUTION PRESS. HIS WEBSITE CAN BE FOUND AT WWW.SPUDISLUNARRESOURCES.COM.