1. Mark your confusion.
2. Show evidence of a close reading.
3. Write a 1+ page reflection.

Does the Moon Mean Mars Is Next?

Roger Handberg, TheSpaceReview.com, November 7, 2022

The American Artemis program and the Chinese lunar program embody the promise that, after reaching the lunar surface, the next logical step for human spaceflight will be proceeding onward to Mars. The time frame for that to occur is likely several decades, not immediate. The Cold War and the Apollo program, which drove space for several generations, are long dead except as historical icons and actual memories for a dwindling number of people. The suggestion here is that the time frame now may prove much longer than currently projected, never mind the dash to Mars by 2029 advocated by Elon Musk. This new date represents a delay from Musk's earlier predictions, the last being 2026. Funding this Mars mission would in fact come from the government; building on the similar process through which SpaceX was able to develop and fly its Falcon 9 launch vehicle while relying on contracts from NASA.

Mars advocates see the future arriving, especially after the three abortive efforts mounted earlier. In 1969, a Space Task Group Report led by Vice President Agnew proposed an ambitious program to follow on the Apollo success in July 1969. This presented a replacement for an earlier cancelled Apollo Applications Program. The Task Force Report considered the question of pushing back to and beyond the Moon because in their judgment, NASA had demonstrated the competence and technology base "to carry out a successful program to land man on Mars within 15 years." Three options were proposed to President Nixon; each option laid out a level of funding tied to specific missions to be accomplished and with differing degrees of speed toward achieving the goal of continued lunar exploration and habitation and subsequent movement toward Mars.

All three proposals assumed that a national commitment equivalent to Apollo existed or could be created. The critical assumption was that the United States was committed to achieving such an endeavor especially after the triumph of Apollo. President Nixon disagreed and only approved the Space Shuttle after an intense debate. The shuttle program's approval was contingent on political calculations in January 1972 that the jobs created by the shuttle program in California would facilitate the president's re-election bid that year. If the president and his advisors had understood the weakness of the George McGovern candidacy in November 1972, the shuttle likely would not have been approved. This would not only have ended the human space exploration program, it may have delayed progress possibly for decades.

Twice, the Bush presidents announced programs aimed at igniting public support for a return to the Moon and on to Mars. George H.W. Bush in July 1989 (20 years after the Eagle landing) announced the Space Exploration Initiative (SEI), a multibillion-dollar effort that died of public and congressional indifference (see "Aiming for the Moon, crashing on Earth: The rise and fall of the 1989 Space Exploration Initiative (part 1)", The Space Review, October 24, 2022). Subsequently, in the aftermath of the shuttle Columbia tragedy, George W. Bush proposed the Constellation program, an effort to partially tame the budget issue that cancelled the SEI earlier. The proposed schema was to complete construction of the International Space Station (ISS). Then, as the space shuttle shut down (too dangerous to fly indefinitely and too costly to upgrade) and the ISS terminated in the mid-2010s, the budget savings would be rolled into the Constellation program. In effect, this new Moon (ultimately Mars) effort would be funded by cannibalizing the foundational programs of the post-Apollo era, the shuttle and ISS. That plan collapsed when the international partners objected to early ISS termination since that unilateral American choice devastated their programs' investment in technology and research modules for the ISS, effectively killing off their research and technology development activities. The Constellation program continued but without the requisite funding flow from ISS cancellation.

The Obama Administration came to office skeptical of the Constellation program, whose funding had already lagged while development of its Ares launch vehicle was already behind schedule. Obama's view was that the United States had been to the Moon already, so why go back? The new proposed path forward was to build the technology for deep space exploration by first going out to an asteroid. The Asteroid Redirect Mission (ARM), moving the asteroid closer to the Moon where missions that combining the factors impacting any deep space mission could be achieved while positioning close enough for immediate intervention in the case adversity occurred.

Regardless, this effort was widely rejected especially as ARM died of political indifference and bureaucratic opposition within NASA. What remained was a congressionally mandated launch vehicle, the Space Launch System (SLS), and the Orion spacecraft. Together, they were defined as NASA's ticket to deep space: the Moon or Mars were both acceptable, but the former was more politically viable. This was spun into the Artemis program symbolized presently by the Artemis 1 launch vehicle lingering on the launch pad until at least mid-November, assuming the leaks in the fuel system have been corrected and no further issues arise.

The Trump administration's initial contribution, besides canceling the ARM program, was to speed up the slow-moving NASA Moon program by changing the arrival date on the lunar surface from 2028 to 20 24. Delays in technology development and funding, though, meant that the Biden Administration accepted the Artemis program but tentatively pushed first landing to at least 2025. The slow-motion Artemis 1 launch could further delay the flight program. Assuming all this is achieved, the next phase will be long-duration habitation on the Moon followed by a mission to Mars.

Success in returning to the Moon will come, but when exactly is still up in the air. Efforts to stimulate a "space race" with China have found limited political traction. However, regardless of who reaches the lunar surface first, establishes a lunar outpost (meaning likely a permanent human presence like Antarctica), gains experience operating in an incredibly harsh environment, and develops the infrastructure to support movement to Mars will still effectively have to contend with the even harsher environment of deep space.

All the above may be accomplished, but the reality is that sending humans to Mars to explore and live is not automatically going to flow from lunar success. The reality is that space is incredibility hazardous for human beings. Having the "right stuff" is no longer sufficient. Outer space is by its nature hostile to fragile human bodies. The effects of microgravity on the body are amply documented from long duration missions on space stations. Long duration missions find astronauts, cosmonauts, and taikonauts or yuhangyans having to recover from the effects of microgravity. When added to the list, the effects from prolonged radiation exposure demonstrate that the more research is conducted, the more hazardous space becomes for humans. Knowledge is power but it also can expose your weaknesses as more is understood. On the lunar surface, additional protection from radiation can be put in place: burrowing under the lunar surface can provide protection. As noted in a recent summary of possible hazards in the journal *Microgravity*, "space radiation, altered gravity fields, isolation and confinement, closed environments, and distance from Earth—are linked with over 30 human health risks as documented by NASA's Human Research Program." Overcoming these hazards is absolutely essential for making outer space exploration more than a one-way trip to oblivion.

There have been suggestions by Roger Launius and Howard McCurdy in *Robots in Space: Technology, Evolution, and Interplanetary Travel* that humans may have to be augmented in some fashion for operating in deep space. Whether that suffices to meet the challenges can only be assessed in time. Others, such as the failed Mars One project, have suggested that the early missions to planets might of necessity be one-way missions. What drives much of the field is the belief that humans should be able to travel to celestial bodies in the solar system, with some envisioning movement out to other stars. The latter is beyond our technological capabilities presently but in time those deficiencies are likely to be overcome. Space remains the final frontier because of the difficulty in reaching there and more critically the hazards encountered while operating beyond Earth.

Moving beyond the geosynchronous arc 36,000 kilometers up permanently will be a dramatic step for humans, but both the known and unknown hazards will make that a more fraught activity than is understood by the public. Such hazards make human activities in outer space long-term endeavors. The biggest test for the United States is whether it can sustain its enthusiasm for such long-duration programs with success to come in another generation. The first generation of space pioneers has left the scene, and the children of Apollo will likely leave the scene before humans arrive on Mars, let alone establishing a long-duration settlement out there

Possible Response Questions

- Should the U.S. spend billions of dollars in an attempt to get to Mars? Explain.
- Did something in the article surprise you? Discuss.
- Pick a word/line/passage from the article and respond to it.
- Discuss a "move" made by the writer in this piece that you think is good/interesting. Explain.