

Destination Moon **FREE**

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On 26 March the National Space Council met at the US Space and Rocket Center in Huntsville, Alabama. There, the council's chair, Vice President Mike Pence, announced the administration's new goal of returning American astronauts to the Moon by 2024. Seven weeks later the Trump administration added an extra \$1.6 billion to its FY 2020 NASA budget request to fund the mission, which NASA has named Artemis after the twin sister of the Greek Sun god, Apollo. Far more funding will be needed in the next four annual budgets.

Five years is unlikely to be enough time. On 30 May the US Government Accountability Office (GAO) issued its 11th annual assessment of NASA's biggest projects. Three of them—the Space Launch System, the Orion Multi-Purpose Crew Vehicle, and Exploration Ground Systems—are essential to landing astronauts on the Moon. The GAO auditors found that, together, the systems are \$1.8 billion over budget and 38 months late. NASA's average launch delay, at 13 months, was the longest the office had found since 2009, when it first started reviewing the space agency's performance.

Whereas the GAO is skeptical of NASA's ability to meet its own deadlines, Pence repeatedly stressed the need to revisit the Moon soon. "Urgency must be our watchword," he told his Huntsville audience. "Failure to achieve our goal to return an American astronaut to the Moon in the next five years is not an option." NASA, he said, had to become leaner, more accountable, and more agile.

Given what it will take to return astronauts to the Moon by 2024, it's worth examining just how urgent the goal really is. The scientific case is perhaps the easiest one to assess. In 2011 the National Research Council published its most recent decadal survey of planetary science. When the committee members evaluated scientific opportunities, returning astronauts to the Moon was not White House policy. Without the prospect of piggybacking on a manned mission, the Moon was considered a potential destination for robotic missions along with all the other bodies in our solar system.

The decadal survey made recommendations for two classes of missions, flagship and the smaller yet still ambitious New Frontiers. Retrieving samples from the surface of Mars was the highest priority among flagship missions, followed by visits to Jupiter's moon Europa and the planet Uranus.

Lunar science was the goal of one of five recommended candidates for the next New Frontiers mission: Specifically, retrieving samples from the ice-rich,



deeply impacted Aitken basin at the Moon's south pole. The scientific payoff would be great. Indeed, the south pole is the intended destination of the 2024 Moon shot. But the next New Frontiers mission, to be announced later this month, will be either to Saturn's moon Titan or to comet 67P/Churyumov-Gerasimenko.

What of other, nonscientific cases to return astronauts to the Moon by 2024? To his credit, Pence did not equivocate. The US must remain first in space, he said, because the rules and values of space will be written by those who get there first and commit to staying. He's likely correct. In 1979 the United Nations Office for Outer Space Affairs promulgated a treaty to establish regulations for the use of the Moon and other celestial bodies and to grant the UN jurisdiction over them. Eighteen countries have acceded to or ratified the treaty; China, Russia, and the US are not among them. Mining oxygen from lunar rocks and using nuclear power to extract water from permanently shadowed craters—two activities that Pence mentioned in his Huntsville address—contravene Article 11 of the Moon Treaty, which forbids the appropriation of lunar resources by states and companies.

Who might reach the Moon before the US? On 28 November 2018, Dmitry Rogozin, head of Russia's national space agency, announced Russia's intention land a human on the Moon by 2030. Two years earlier, Zhang Yulin, the deputy commander of the China's manned space program, announced the country's intention to land a human on the Moon by 2036.

Does it matter if NASA goes all out to return to the Moon by 2024? Yes, I think it does. In its report, the GAO noted that the combination of NASA's existing overruns and the addition of Artemis will strain NASA's budget: "NASA will have to either increase its annual funding request or make tradeoffs between projects." Those tradeoffs could include the scientifically fruitful robotic missions that the decadal survey identified. I favor returning American astronauts to the Moon, just not at any cost. **PT**

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