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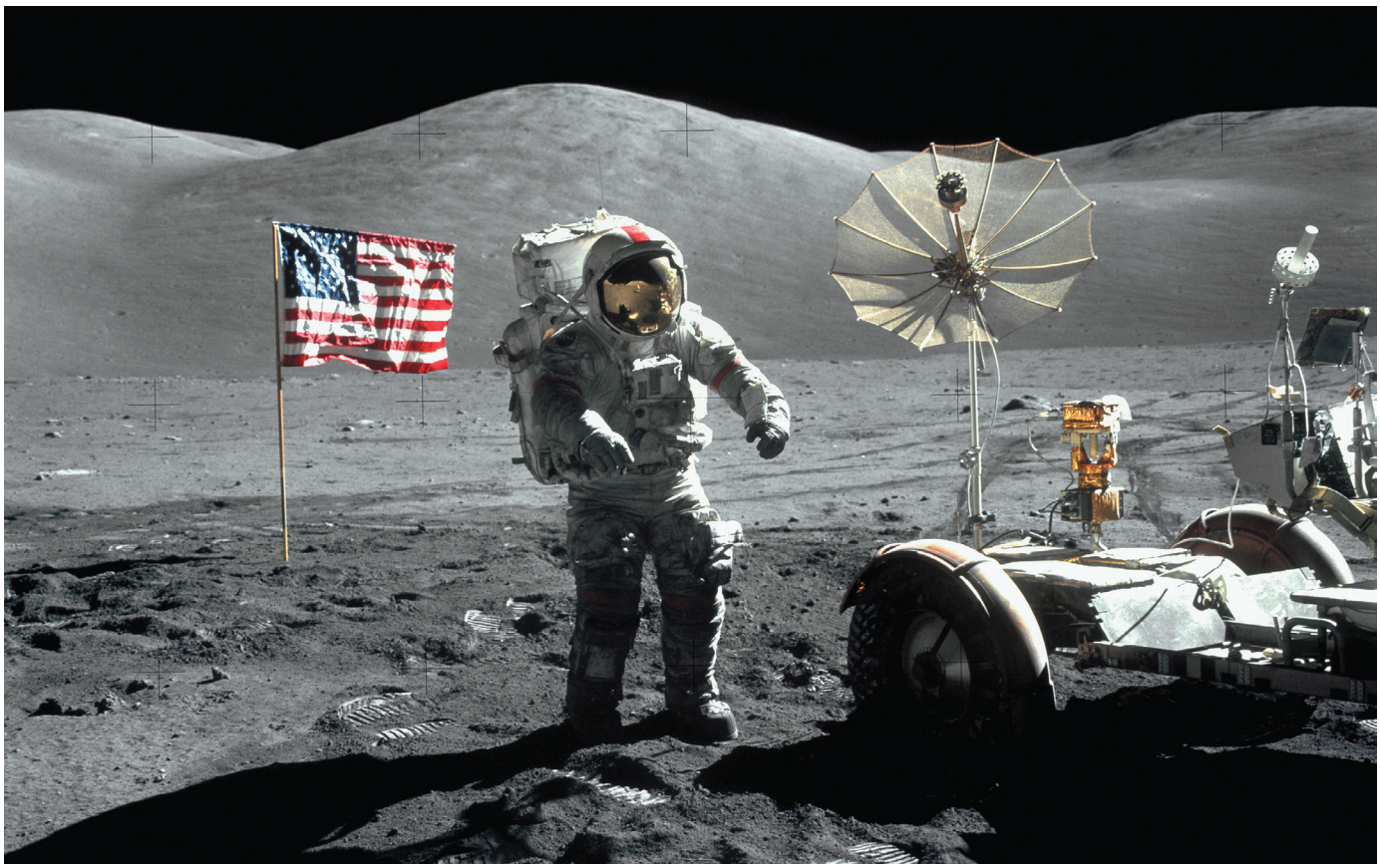

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SPACE

Can NASA return people to the Moon by 2024?

Donald Trump's ambitious plan faces formidable political and technical challenges.

BY ALEXANDRA WITZE

Five decades after sending humans to the Moon, NASA is tasked with repeating the feat — and doing it by 2024, the ambitious deadline set by US President Donald Trump's team. But it is unclear how the space agency will surmount some formidable technical, political and financial challenges to pull off a lunar landing in just four and a half years.

"If the pieces come together in the right way they can pull it off," says Ryan Watkins, a lunar scientist at the Planetary Science Institute who is based in St Louis, Missouri. "But they have to come together."

NASA's leaders have yet to make key decisions about how the Moon effort, called Artemis after Apollo's twin sister, will proceed. The agency does not have a rocket ready to fly humans into deep space, and it has not developed a lunar lander since the Apollo programme ended in 1972. Then there is Congress, which controls NASA's budget and seems increasingly uninterested in paying for the Moon mission.

Even as NASA scrambles to meet its ambitious goal, China is making steady progress towards landing astronauts on the Moon by the mid-2030s. The country has launched a series of uncrewed lunar missions over the past decade, and in January its Chang'e-4 probe ▶

▶ became the first spacecraft from any nation to land on the Moon's far side. Chinese officials say that four more robotic missions will follow, starting with Chang'e-5, which could launch as early as December and bring back Moon rock and soil. Lunar researchers expect that these missions will carry out scientific experiments and lay the groundwork for a future Moon base.

"In the next one to two decades, we will definitely see a Chinese astronaut landing on the Moon," says Christoph Beischl, a researcher at the London Institute of Space Policy and Law.

OFF-THE-SHELF HELP

NASA is gambling that commercial partners can help it to reach the Moon again by taking over some crucial tasks that it handled during the Apollo era. These include flying scientific and technical experiments to the lunar surface to lay the groundwork for an eventual crewed mission. In May, the space agency announced that it had signed contracts with three companies that will each carry as many as 14 experiments to the Moon aboard robotic landers.

One of the firms, Orbit Beyond in Edison, New Jersey, intends to send a lander to the Mare Imbrium lava plain on the Moon as early as the third quarter of 2020. The probe will carry NASA instruments, including one to monitor the level of cosmic radiation to which astronauts would be exposed, said Jon Morse, Orbit Beyond's chief science officer, at a space-resources conference in Golden, Colorado, in June. Radiation-monitoring experiments have previously gone to the Moon, including one delivered by Chang'e-4.

Over the next few years, NASA envisages that private companies will continue to fly lunar probes that grow progressively more complex. These might culminate in a robotic mission to collect Moon rocks and scout landing sites for a crewed mission.

Meanwhile, the agency plans to keep developing its heavy-lift rocket and Orion crew capsule, which would carry astronauts into deep space. Both the rocket and Orion have been repurposed from earlier versions that NASA had been working on to send astronauts to visit an asteroid and later Mars. The first uncrewed test of the rocket–capsule combo is scheduled for no earlier than mid-2020, with the first crewed test no earlier than 2022.

STICKING THE LANDING

NASA's biggest challenge in attempting a return to the Moon might be acquiring a large lander that, after launching with Orion on the heavy-lift rocket, could carry astronauts all the way to the lunar surface. Commercial companies have designed such landers on paper; these include the Blue Moon craft from Blue Origin in Kent, Washington, the rocket company founded by billionaire Jeff Bezos, and one from Lockheed Martin in Denver, Colorado, that would be based on the Phoenix lander that touched down on Mars in 2008. But none of these has been built, tested or flown in space.

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Also uncertain is the ultimate design of the Gateway, a Moon-orbiting outpost that NASA envisages Artemis using as a docking station and stepping stone to the lunar surface. It, too, is a relic of an abandoned NASA programme, and was originally proposed, in a more complicated form, as part of a 2013 plan to send astronauts to hover close to and study a near-Earth asteroid.

In May, the agency announced plans to buy the first part of the outpost, a spacecraft to deliver power and propulsion, from Maxar Technologies in Westminster, Colorado. But where the rest of the Gateway will come from, and how complex it will be, is unknown.

The agency has released only notional details about how the uncrewed landers, the crewed flights and the Gateway would work together, and how it would all be crammed into the next four and a half years. Pulling it off "will require everyone to work at high speed — and multiple stakeholders control that speed", says Thomas Zurbuchen, head of NASA's science division. "There are many failure modes that one could imagine."

DOWN TO EARTH

The response from Congress, which controls NASA's budget, has been tepid. On 25 June, the Democrat-controlled House of Representatives approved a 2020 spending bill for NASA that ignored the Artemis request. The Republican-controlled Senate has yet to act on NASA's proposed budget for 2020, including the agency's request for Artemis funding.

Protracted battles with Congress over funding helped to kill two attempts by Trump's predecessors to return to the Moon. A plan that George H. W. Bush proposed in 1989 never won over Congress. And George W. Bush's Moon programme, announced in 2004, was cancelled by Barack Obama in 2010 — but not before it kicked off the development of the heavy-lift rocket that Trump now wants to use.

Trump first proposed the idea of sending astronauts to the Moon in 2017, and within months NASA said it would aim to do so by 2028. But earlier this year, the Trump administration accelerated the deadline for Artemis to 2024. NASA administrator Jim Bridenstine has indicated that this was to limit how long politicians can argue over it. If Trump is re-elected he would be in office until January 2025, meaning a lunar landing could theoretically take place during his presidency.

So far, nearly everything about Artemis is different from Apollo, says Teasel Muir-Harmony, a curator and space historian at the Smithsonian National Air and Space Museum in Washington DC. In 1961, President John F. Kennedy called for a Moon landing as a way to highlight the United States' position as a global superpower, and both chambers of Congress supported that goal from the beginning.

"These types of programmes are extremely expensive and rely on political will, and there was bipartisan support and interest in Apollo," she says. Whether or not Trump can muster that level of backing "is going to be really critical to the outcome of Artemis".

China, meanwhile, faces different hurdles to putting people on the Moon. It has sent astronauts to space laboratories in low-Earth orbit, and plans to complete a space station in 2022, but has no experience in ferrying people farther afield, which requires more advanced spacecraft and landing technology. The country's biggest challenge is likely to be developing a rocket that is up to the job, says Beischl. "Everything else, you can build on what you've already got." ■

Additional reporting by Elizabeth Gibney.

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Companies including Blue Origin have designed Moon landers but none has yet been flown in space.