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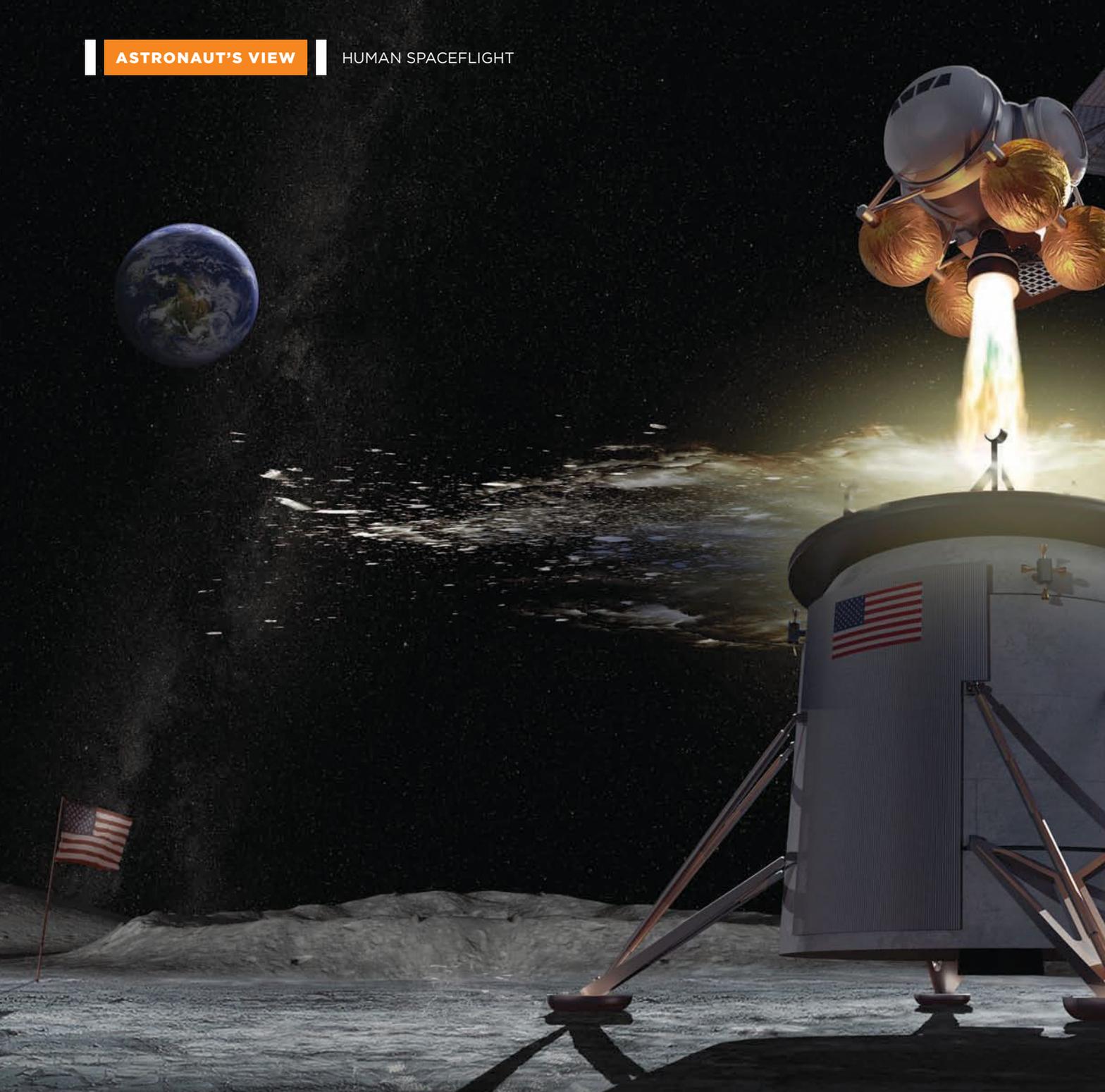


## TOMORROW'S BLACK BOXES

Should they be the same, ejectable or virtual?  
We take you inside the debate.

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# The necessity of returning to the moon



A spacecraft lifts off from the moon with astronauts returning to the Gateway space station (not shown in this artist's rendering).  
NASA

**For 50 years, Americans have taken the moon for granted. Planetary scientist and former astronaut Tom Jones argues that returning there soon is an essential step toward other worlds, and continued leadership on this one.**

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**T**he moon won't wait for us. Last January, China delivered its second probe, Chang'e-4, to the lunar surface — this time to the moon's far side. The fact that the spacecraft carried a rover to the surface reveals the design as an evolutionary step toward a lander that one day will carry taikonauts.

Given China's publicly stated lunar plans and all the moon has to teach us about traveling to more distant destinations, the U.S. Congress should approve the Trump administration's request for supplemental 2020 funding for NASA's proposed 2024 lunar return program, called Artemis.

### **The benefits of Artemis are many**

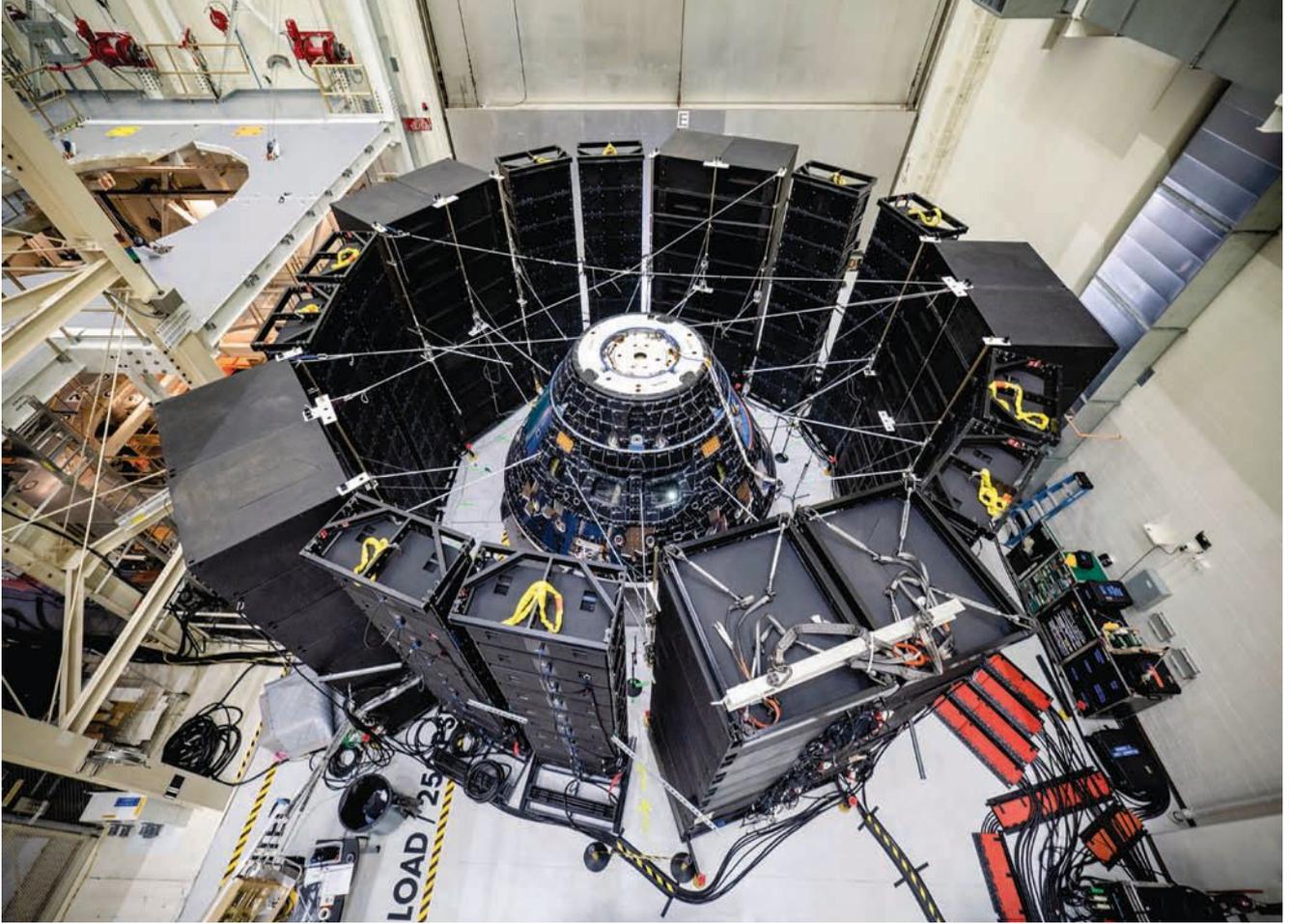
This NASA-led effort is long overdue. That Americans have not returned to the moon's surface or even orbited it since 1972 is a national embarrassment. Returning to this resource-rich training ground is a vital stepping stone toward interplanetary space — toward the nearby asteroids and Mars. If America can lead a public-private partnership operating on the moon and beyond, we will benefit from new technologies, help protect our national security, boost our economic competitiveness, and inspire millions of young people toward careers in science, technology, engineering and math. We also will rebuild confidence in our society's ability to meet its most difficult challenges.

When Apollo 11 reached the moon 50 years ago, it gave the nation a long-lasting technological edge that contributed directly to winning the Cold War. It's a lead we have never relinquished but one now in jeopardy as China expands its space ambitions. Revitalizing our human exploration of deep space, to the moon and beyond, will stand as evidence of America's commitment to technological leadership.

### **Staying ahead**

Today our leading position in space is precarious at best. The International Space Station, our current symbol of American-led space achievement, has only a decade of life remaining. Meanwhile, China plans to launch its next space station in 2020, and European Space Agency astronauts are learning Chinese with an eye toward joint missions aboard that outpost. China has announced plans to send human explorers to the moon by about 2030. When taikonauts do plant their flag there — and Chang'e-4 shows they are certainly on track to do it — the U.S. had better be there, too. Our absence on the moon will demonstrate to the world that America's technological and military abilities are second-rate, with observant nations aligning themselves with an autocratic yet confident superpower.

Given the usual lead time to develop and test rockets and spacecraft capable of reaching the moon,



we must decide now whether to lead an international and commercial partnership to return there or become an also-ran, a footnote in the still-unfolding saga of space exploration.

The White House recognizes this urgency. Its March announcement of a lunar return was followed by a May request for additional NASA funding for the program. NASA has since published its first technical outline of how to accomplish the goal by 2024.

To make that deadline, NASA must have its Orion deep space transport ready when its powerful but long-delayed booster, the Space Launch System, flies for the first time in early 2021. In parallel, NASA has already begun procurement of the power and propulsion element of the lunar-orbiting Gateway, which will be launched in 2022-2023 on a NASA-purchased commercial launch vehicle. This element, along with a small Northrop Grumman-built habitat, will form the minimalist Gateway that, with Orion and SLS, will support a lunar return. The final piece of the 2024 puzzle will be an industry-designed lunar lander, with NASA choosing among at least two competitive bidders, which are expected to contribute at least 10% of the development costs.

### It's up to Congress

The 2024 goal will be a difficult challenge for NASA and industry, but it can be met, if the agency and industry receive the necessary resources. The numbers show that NASA's budget has steadily lost buying

▲ **The Orion crew module** for the Artemis-1 mission undergoes an acoustics test at Kennedy Space Center. Artemis-1 will send an uncrewed Orion into lunar orbit and return it to Earth.

NASA

power for at least 20 years, with the agency's share of the federal budget similarly dropping from 0.8% to 0.47% (it peaked at 4.4% during Apollo). Yet that eroding budget had to operate the space shuttle, construct the ISS, and engineer new deep space vehicles and technologies. The deep space task has suffered for too long, repeatedly postponing human exploration beyond Earth.

Bold plans must be matched by necessary resources, a task that now falls squarely on the shoulders of Congress. With a 10% increase in NASA's budget — about \$2 billion sustained for five years — we will not merely repeat Apollo's brief lunar visits, but build instead a sustainable, reusable lunar transportation system. That hardware will enable us to stay and explore the moon longer, harness its resources and, through reuse, prove the machines and skills we will need for Mars.

### Clear goal

The 2024 deadline is key to our return to the moon. The challenge is not developing the technologies of getting to the moon and back — the Apollo team conquered those. The difficulty has been a lack of urgency — space funding and operating as usual. For example, Orion and its SLS booster have been under development since 2005, yet Orion has flown just a single test flight, in 2014. The Constellation program of the 2000s, never funded as promised, slipped, shrank and never came close to its lunar target date of 2019. The Obama administration

canceled it in 2010. Dawdling by stretching out the return to 2028 or beyond as discussed in Congress would be a recipe for failure.

To get on track, we must first enlist our space station partners and commercial space firms in committing to a 2024 return to the moon. The fast-paced challenge will try all of them.

Second, we must advance the testing and flight schedule for Orion and SLS, launching a first crewed mission by late 2021 or early 2022. The 2024 deadline leaves almost no margin for further delays in Orion crewed flights. After the lunar return, we'll need to launch at least one crewed SLS per year.

Third, we must launch the first elements of the lunar Gateway into orbit around the moon by 2022. Commercial space firms can help build and deliver this small outpost in time for the landing deadline.

Fourth, NASA must follow up its July "Human Landing System" kickoff with a fast-paced industry lander development program, competing several designs to create the machine that will deliver Americans to the moon's surface.

Fifth, we must obtain advance information on polar landing sites, sending small, commercially developed landers to search for safe landing zones and prospect for ice.

Hitting these marks will enable NASA and its international partners to construct a lunar outpost near the moon's south pole by 2028. There we will plumb the scientific mysteries of the moon and prove the landers, spacesuits, mining gear, water and rocket fuel plants, and nuclear generators needed for travel to Mars and beyond.

## Bold plans must be matched by necessary resources, a task that now falls squarely on the shoulders of Congress.

### End the endless false starts

Since 1990, NASA has failed at two attempts to organize and sustain an American return to the moon. The 2024 deadline is ambitious, but speed is a galvanizing force. The tight timeline has energized the agency and will enlist public and international support. However, if Congress defaults to the cash-strapped pace of the past 15 years, by 2030 we will watch a competing space power land its explorers on the moon. Without a sense of urgency, we will surely lose our technological edge in space and on Earth.

Reigniting the competitive spirit that served us so well during Apollo, we will return to the moon for technology, science and commerce. We will ensure that Earth-moon space will be open to liberty-loving peoples, their democratic legal structures and free markets. Leading a partnership of free, space-faring nations back to the moon is a vital step on an exciting American journey. Let's again make that "giant leap" we took first in 1969 — and keep on going. ★



◀ Flight controllers practice for Artemis 1, Orion's uncrewed flight 64,000 kilometers beyond the moon and back to Earth, at Johnson Space Center in Houston. NASA