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GUEST ESSAY

# What We Do to the Moon Will Transform It Forever

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The moon stands alone. It is unique in the known cosmos: a solitary rock one-fourth the width of its host planet, the only place life has ever been found. And the moon *is* alone: It is a desolate, sunbaked and crater-pocked wasteland that harbors little except what we bring to it, either with our minds or with our spaceships. But that is about to change.

In the coming weeks, a rocket is expected to burst from Earth's atmosphere and send a spacecraft called Nova-C careening toward the moon's south pole. If all goes as planned, Nova-C, built by the private company Intuitive Machines, under NASA's Commercial Lunar Payload Services program, will touch down on the moon about seven days later, bearing suites of scientific instruments. It will also carry a collection of narratives stored on microfiche disks, several cameras and a series of small sculptures made by the artist Jeff Koons that will be encased in a cube and stay on the moon in perpetuity.

February's expected launch will quickly follow another company's failed lunar landing attempt. Peregrine, built by Astrobotic Technology under another Commercial Lunar Payload Services contract, successfully flew into space on Jan.

8, but its mission was cut short because of a fuel leak. It failed to be the first private mission to land on the moon, but Nova-C could succeed — and so could the one after that, and many more. Though such an outlook may feel like a compelling next step for humanity's cosmic ambitions, it also portends a dismaying future where the moon becomes a hotbed of unregulated human enterprise that will irreversibly transform it.

Humans have not touched the moon since the end of the Apollo program in 1972, and robots touch it only sporadically via expensive, government-funded efforts that often fail. But what is likely to happen in February is new. For the first time, the moon will be occupied by private capital, including small startups whose aims transcend science and exploration, launching landers and capsules. These missions are still heavily subsidized by NASA and other space agencies seeking a return to the moon for good, mostly through NASA's Artemis program, which now aims to land the first woman astronaut on the moon by 2026. The Commercial Lunar Payload Services program, as part of Artemis, encourages private companies to build landers and even rovers that NASA can pay to use, as opposed to the traditional approach of NASA-built equipment. That means even if they are carrying government-sponsored science experiments, the new privately built, commercially funded landers can choose to add other nonscientific payloads purchased by other customers.

The freedom to choose any payload could lead to controversy. Nova-C will use thermal-reflective coatings designed by the sportswear brand Columbia; a company website shows an artist's concept of the Columbia logo prominently displayed on the spacecraft as it sits on the lunar surface. The failed Peregrine lander was carrying small amounts of cremated human remains. In 2019, an Israeli lander carried a few thousand dehydrated tardigrades, microscopic creatures that can survive in the vacuum of space. It's unclear what happened to them when the lander crashed, but the attempt raised new concerns about bringing biological materials to the moon. Future launches will attempt to send more cremated human remains to the moon, as well as time capsules, messages and other materials bound to raise various objections.

This new era of lunar missions is likely to change humanity's relationship to the moon. Before this happens, we owe ourselves — and the moon itself — a more thoughtful consideration of what our planet's only natural satellite represents. Anything we do to it will last forever. We have an enormous responsibility to the moon's future, and to the future of anyone else who lives here beside it.

Earth's inert, spectral companion world shepherds our existence. It protects our planet from climate chaos by moderating Earth's axis. It fostered the evolution of complex life. Through its tide, the moon pulled backboned animals onto land. Early humans used it to mark time, create calendars and forge the first civilizations; later, we used it to consolidate power, develop religion and invent philosophy and science. It has played a pivotal role in our biological and cultural evolution and is a primary feature in everything from the trenches of warfare to our loftiest dreams.

Before this decade is out, if you have a powerful enough telescope, you may be able to see evidence of human construction or even habitation on the moon. In May of 2023, the accounting firm PwC estimated the global space industry was worth $469 billion and will top $1 trillion by 2030, as countries and companies increasingly use satellites for manufacturing, power generation and data. NASA's own estimates show that spending on lunar exploration programs supported more than $20 billion in economic output across the United States in 2022. The agency has already awarded billions of dollars in total in contracts to private companies, including established giants like Lockheed Martin, newer billionaire-backed players like SpaceX and Blue Origin, scrappy startups like the lander makers Astrobotic and Intuitive Machines, and the nuclear-power research firm Zeno Power. "We are now at an inflection point, where ideas previously confined to the pages of science fiction represent attractive investment ventures," PwC's report read.

Some of these ventures will provide lander services for space agencies, universities or private research firms; some will help enable power, wayfinding or mission planning services for other lunar missions, aiming to seed a self-sustaining lunar economy. After hearing about the cremation service Celestis Memorial Spaceflight's plans to send human cremains to the moon aboard Peregrine, the Navajo Nation president, Buu Nygren, wrote to the NASA administrator Bill Nelson and other officials on Dec. 21 asking to delay the launch. The Navajo people revere the moon as a spiritually important object.

"The act of depositing human remains and other materials, which could be perceived as discards in any other location, on the moon is tantamount to desecration of this sacred space," Mr. Nygren wrote.

The Navajo president's protest offers an example of how use of the moon, even for the most well-intentioned purposes, requires a collaborative and deliberate approach. The moon belongs to everyone, which means it belongs to no one; use of the moon by anyone demands consideration of everyone. Lunar landings scheduled for 2024 and 2025 under the Commercial Lunar Payload Services program include a water-hunting robot, a navigation system that works like a GPS device, instruments to probe the moon's interior and sample containers that will collect lunar soil. These private landers will join a flotilla of government-run rovers, landers and science instruments launched by the United States, China, Russia and India. India's space agency safely landed a new rover on the moon in August, becoming only the fourth country to do so. On Friday, after repeated failed attempts, Japan became the fifth country in the world to safely land a spacecraft on the moon.

But space is still hard, as demonstrated by recent lunar landing failures by Russia and the Israeli firm SpaceIL, which carried the tardigrades in 2019. Though the moon looms large in our sky throughout most nights and days, it is roughly a quarter of a million miles away. Lofting rockets off Earth is one thing; getting to the moon is another.

NASA officials have tried since 2020 to forge a more cooperative path for the moon through the agency's Artemis Accords, a nonbinding framework that affirms the 1967 Outer Space Treaty and asks signatories to enhance collaboration between nations by agreeing on international standards for equipment, helping each other in emergencies, sharing scientific data and protecting the Apollo landing sites. But the accords also make plenty of room for extracting and using mined "resources," which could include moon dust, water, rare earth elements or other materials.

There is value in being on the moon as explorers, as scientists, maybe even as prospectors with the goal of helping people back home. But we humans tend to transmute exploration into extraction, and our intentions for the moon seem headed the same way. The moon won't be alone for long. But it is and will forever be quiet. It plays host to no rumbling thunderstorms, no crashing waves, no bird song, no anthems. We must be its voice. We will soon change its surface, and our relationship to it, forever. At the very least, we owe the moon a considered discussion of why and how we will do so.

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