

## *If No One Owns the Moon, Can Anyone Make Money Up There?*

Ambiguities in the 50-year-old Outer Space Treaty may be getting in the way of entrepreneurs seeking opportunities elsewhere in our solar system.

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By **Kenneth Chang**

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CAPE CANAVERAL, Fla. — From Launch Complex 17 here at the Cape Canaveral Air Force Station, many of NASA's robotic planetary missions blasted off. Soon, the two massive towers that once cradled Delta 2 rockets will be torn down. A new tenant — Moon Express, a tiny company with far-out ambitions — is moving in.

Next year, the company, with just 30 employees, aims to be the first private entity to put a small robotic lander on the moon and perhaps win \$20 million in the Google Lunar X Prize competition. It is investing at least \$1.85 million to renovate decades-old buildings here. The company is transforming a parking lot into a miniature moonscape, and will also set up an engineering laboratory, a mission operations room and a test stand for spacecraft engine firings.

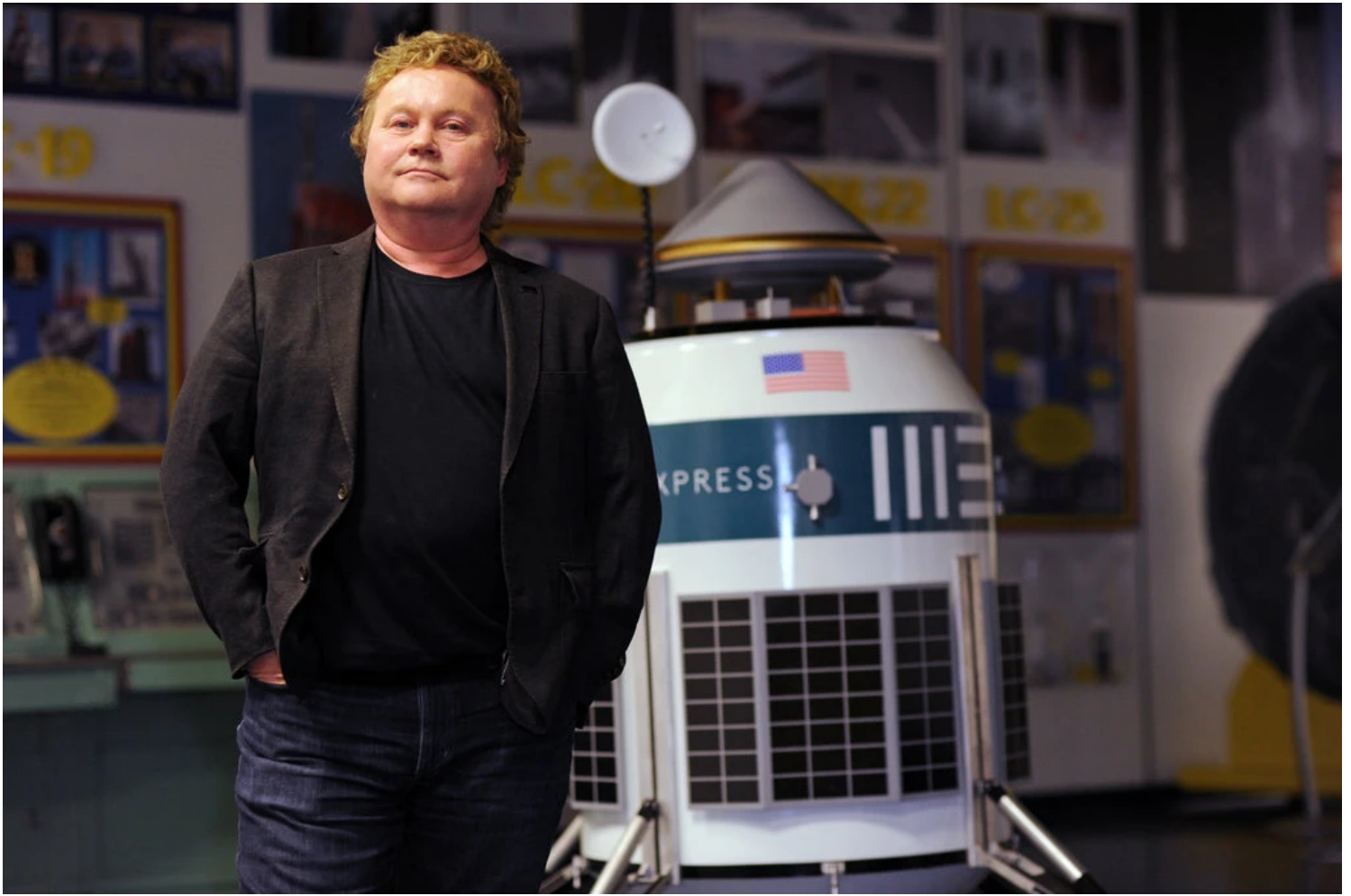
Moon Express would not need all of these facilities if its only goal were to win the Lunar X Prize.

Its second spacecraft aims to land in 2019 near the moon's south pole. A third, larger spacecraft in 2020 is to gather samples and then bring them back to Earth, the first haul of moon rocks since a Soviet robotic probe's return in 1976.

But these plans almost came to a halt a couple of years ago — not because of technological challenges or financial shortfalls, but because of an international agreement known as the Outer Space Treaty, which is marking its 50th anniversary this year.

The treaty spells out what countries are and are not allowed to do in space. Its crowning achievement was stopping the nuclear arms race between the United States and the Soviet Union from expanding into space.

But the agreement may now be getting in the way of entrepreneurs with plans to push farther and faster into space than national agencies like NASA.



Robert D. Richards, co-founder and C.E.O. of Moon Express, at the Sands Space History Center in Cape Canaveral, Fla., where his company is headquartered. Behind him is a model of the MX-1 lander that Moon Express hopes to launch in 2018. Sarah Beth Glickstein for The New York Times

“Before it was something really, really hypothetical,” said Fabio Tronchetti, a law professor at Harbin Institute of Technology in China. “But now there are groups that are really serious. It changes everything.”

Robert D. Richards, Moon Express’s chief executive — whose business plan is “to expand Earth’s economic sphere to the moon and beyond” — is far from the only entrepreneur looking for business opportunities beyond our planet.

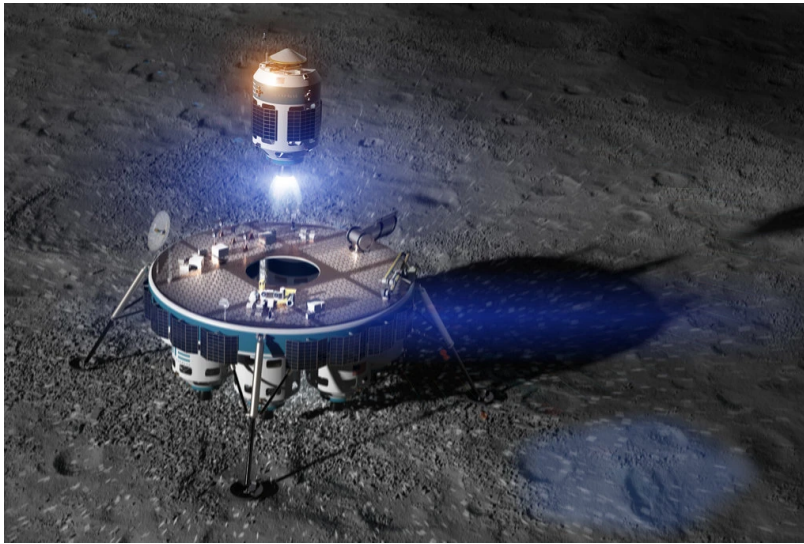
Elon Musk, the billionaire founder of SpaceX, boldly proclaims that his company will begin sending colonists to Mars in a decade. Jeffrey P. Bezos, the founder of Amazon, is using part of his fortune to finance his rocket company Blue Origin, and predicts millions of people will be living and working in space.

As these companies go where no businesses have gone before, they raise questions only fuzzily addressed by the Outer Space Treaty: What are private companies allowed to do in space? Can a company mine the moon or an asteroid and then sell what it has pulled out? How are countries to regulate these businesses?

Internationally, countries have been discussing how to answer these questions. In the United States, Congress has begun tackling regulatory issues. Some warn that if the United States does not set up business-friendly policies, then the start-ups could move elsewhere — including such seemingly unlikely places as Luxembourg.

## A Quick Fix Before Launch

The Outer Space Treaty — officially it is the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space — declares that “the moon and other celestial bodies shall be used by all states parties to the treaty exclusively for peaceful purposes.”



A rendering of Moon Express's proposed MX-9 return vehicle, which would return from the moon to Earth with samples of rock and soil. Moon Express

The treaty also prohibited nations from making any claim of sovereignty over any part of the rest of the solar system.

Moon Express ran into a bureaucratic wall because the treaty declares that activities of nongovernmental entities — a classification that includes commercial companies — “require authorization and continuing supervision” of the government. (The United States had insisted on the clause, rejecting the Soviet view that space exploration should be limited to governments.)

“We had a mission planned, we had investors invested, but didn’t have a way forward at the end of 2015,” Dr. Richards testified during a Senate committee hearing in May. “There wasn’t anybody that didn’t want to say yes. There was just no mechanism to do so.”

The Federal Aviation Administration licenses rocket launches and re-entry of commercial spacecraft from orbit in order to ensure the safety of people on the ground. The Federal Communications Commission regulates communications satellites, and the Department of Commerce regulates commercial remote sensing satellites.

But the United States does not as yet have a process for authorizing or supervising novel endeavors like a private company landing on the moon.

Moon Express spent about a year working with the F.A.A., the State Department and other agencies to jerry-rig what Dr. Richards called a “temporary patch,” using the F.A.A.’s existing authority to review rocket payloads in order to gain the approval Moon Express was seeking.



President Lyndon Johnson, right, shook hands with Soviet Ambassador Anatoly Dobrynin at a signing ceremony for the Outer Space Treaty at the White House on Oct. 10, 1967. Though the treaty was intended to limit the Cold War nuclear arms race, it has created obstacles to private space exploration. Harvey Georges/Associated Press

In announcing the decision, however, the F.A.A. said the approval applied only to this one Moon Express launch, and that not even Moon Express could count on a favorable outcome in the future.

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Moon Express has begun discussions with the F.A.A. for the second trip to the lunar south pole, and Dr. Richards is confident that the company could successfully pull off its first three flights via the current regulatory patchwork.

But if Congress and the president do not come up with a better solution, Moon Express, SpaceX, Blue Origin and the rest of the emerging industry could run into more bureaucratic walls, and companies might start looking for other places to set up shop.

Dr. Richards said he remained optimistic.

“Each company is moving forward with some assumption of risk but a presumption of the U.S. government coming through with frameworks that allow that to happen,” Dr. Richards said in October during a visit at his company’s Florida headquarters.

## Smoothing a Path to Space Rocks

Another space upstart is Planetary Resources, a small company located in an unremarkable office park outside Seattle. Its early investors included Larry Page, co-founder of Google, and Charles Simonyi, a former chief software architect at Microsoft. The company is also taking advantage of an investment from the Grand Duchy of Luxembourg.

Planetary Resources’s goal is to mine the solar system’s asteroids. Luxembourg, a nation smaller than Rhode Island with a long history in mining, has bet 200 million euros — more than \$225 million — on this industry that does not exist. That includes \$28 million invested in Planetary Resources. In return, Luxembourg owns a 10 percent share of the company, said Etienne Schneider, the country’s deputy prime



minister.

Back in April, Luxembourg's crown prince, his wife and government officials paid a visit to Planetary Resources, putting on white gowns, gloves, wispy caps and baby blue booties — a distinctly unroyal outfit sometimes called a “bunny suit” — to take a close look at where the company is assembling small satellites.

In June, Mr. Schneider returned to the United States to host a symposium with a roomful of bankers and venture capitalists, a vivid demonstration that private space investment has reached a tipping point of credibility.

A Goldman Sachs report about innovative space businesses that came out in the spring seemed to agree. “Space mining could be more realistic than perceived,” the report said. “While the psychological barrier to mining asteroids is high, the actual financial and technological barriers are far lower.”

At the Manhattan presentation, Mr. Schneider readily acknowledged that the notion of asteroid mining sounds like science fiction and that he often gets quizzical questions about why Luxembourg is spending money chasing this.

Mr. Schneider recalled that during a visit to Silicon Valley in 2012, he met S. Pete Worden, then the director of the NASA Ames Research Center in Mountain View, Calif., who suggested that Luxembourg look into asteroid mining.

“At the time, I listened to him and wondered what this guy might have smoked,” Mr. Schneider said.

But more discussions and research convinced Mr. Schneider this was a promising possibility.



In Colorado Springs, Colo., in April, Jeff Bezos announced he would sell Amazon stock to finance his Blue Origin rocket company. Nick Cote for The New York Times

For Planetary Resources, the first wave of development is to culminate in a doughnut-shape spacecraft heading on a prospecting mission to a near-Earth asteroid in 2020.

Sometime after that, the company hopes to mine in earnest — for seemingly mundane water ice. But water, in addition to potentially providing something to drink for astronauts, can be split into hydrogen and oxygen. Both can be used as rocket propellant; the oxygen, of course, also can provide air to breathe.

As a business, Planetary Resources is betting that by the time it extracts water from an asteroid, there will be a customer like NASA interested in buying water, hydrogen and oxygen.

Eventually, the company aims to extract platinum, currently worth more than \$900 an ounce, and other precious metals.

To make these pursuits easier, Luxembourg passed a space law that took effect this summer. Planetary Resources has set up its European office there. Moves like this one are in part motivating policymakers in the United States to devote more attention to American laws that currently govern commercial space activities.

## Revising Space Law

Ambiguities in the Outer Space Treaty currently create uncertainty over whether anyone can profit from such business ventures. Article II in particular states, “Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.”



From left, Chris Lewicki, Planetary Resources's chief executive and president; Étienne Schneider, deputy prime minister of Luxembourg; and the Hereditary Grand Duke and Duchess of Luxembourg on a tour of Planetary Resources in Washington State. Jean-Christophe Verhaegen/Service Information et Presse

If the United States is prohibited from appropriating a celestial body, is a private company allowed to appropriate a mineral mined out of a celestial body? The Moon Treaty, finalized in 1979, declared that any resources from space should be shared among all nations, but most countries, including the United States, never signed or ratified it.

Two years ago, Congress passed and President Obama signed a law that said private companies can own and sell what they extract, although, abiding by the language of the Outer Space Treaty, the companies cannot claim ownership of the celestial body itself.

This year, Congress is revisiting the Outer Space Treaty again, hoping to boost nascent space companies looking to push outward into the solar system.

Republicans in Congress have said they want the new space ventures to thrive in “permissionless innovation,” similar to the ethos that nourished new enterprises on the internet. This spring, the House science committee packed those ideas into a bill that has been sent to the full House.

It would put the regulatory power in an Office of Space Commerce, which would have 60 days to decide whether to approve or deny a company’s application. The full House has not yet taken up the bill, and the Senate is still working on its version.

Officials at Moon Express and Planetary Resources say they do not want unfettered freedom in space, nor do they seek withdrawal from the Outer Space Treaty.



Left, the Apollo 17, NASA's last expedition to the moon, during launch countdown in 1972. Right, Harrison H. Schmitt, an Apollo 17 astronaut, working beside a large lunar boulder on one of three moonwalks during that mission. NASA

“Our goal is to have a space environment that is populated by people acting responsibly,” said Peter Marquez, vice president for global engagement at Planetary Resources. “If there aren’t any adults in the room, it concerns me. If it turns into the wild, wild West of just do whatever you want, then that kind of runs against concepts and precepts of Outer Space Treaty.”

These companies do want the regulations to be “light-touch” and hope that the default inclination of the U.S. government will be to say yes.

Once the price of transportation comes down, more business opportunities will open up, Dr. Richards said.

The moon, peppered with the impacts of asteroids over the eons, should also possess dollops of platinum and other precious metals. Helium-3, embedded in the lunar crust by the solar wind, could be fuel for future fusion power plants.

Moon Express’s family of spacecraft could be a boon to scientists, sending low-cost probes not just to the moon but to other planets. Its second spacecraft is to carry a shoebox-size experimental telescope for the International Lunar Observatory Association. Some locations near the lunar south pole, offering a continuous view of the universe, could be ideal for an astronomical observatory.

Patches of eternal sunshine on the moon could be limited, valuable resources that nations and companies will someday squabble over.

Dr. Richards compared this moment he sees coming to the 19th century California Gold Rush, when gold diggers jostled over the most lucrative places to sift ore. But he was confident that the new competitors would reach compromises.

“I don’t think there’s going to be bad players per se, but there could be arguments over areas of operation overlap,” he said. “But those are problems for the future, and that’ll be a great problem to have.”

**Correction: Nov. 26, 2017**

*An earlier version of this article misstated the last time a spacecraft brought moon rocks back to Earth. It was a Soviet probe in 1976, not the last of NASA’s Apollo missions. Additionally a picture used in an earlier version of this article misidentified the location of a visit by the Hereditary Grand Duke and Duchess of Luxembourg. It was from their visit of SSL in California, not an earlier stop at Planetary Resources in Washington State.*

