Living on the Moon: Real-World Case Studies

Lunar Elevator

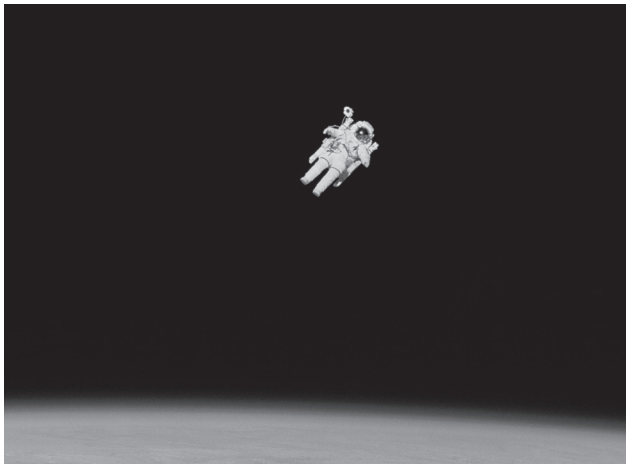
There are abundant resources on the Moon, but their types are limited and none are organic (carbon-based). So, a lunar city could benefit with supplies from the Earth and there are also some lunar resources or products that could be valuable and useful on Earth. How could we make transport trips between the Earth and Moon without using the massive resources and fuel needed to build, maintain, and fly a fleet of cargo rockets?

Two astronomy students at Columbia University have come up with an idea that is being seriously considered: building a lunar spaceline that is anchored on the Moon and stretches about 200,000 miles until it ends at Earth's orbit. It stays taut from its own weight and because it is pointed towards Earth's gravitational field. By anchoring the spaceline on the Moon, where gravitational force is only 1/6th of Earth's, and by dangling the other end at the edge of Earth's atmosphere, the Earth's gravity is no longer a problem. Not only that, but the Moon always shows the same side to Earth, so the spaceline wouldn't be subjected to the twisting it would have to endure if it were anchored to Earth.

The spaceline would be a cable thinner than a pencil! Supply pods would be flown in a rocket and then transferred to a robotic vehicle that would climb the cable until it reached the Moon. The robotic vehicle would not need any fuel; it would rely on solar power and friction to ascend or descend. A rocket still has to get the supplies to the spaceline, but it would use a fraction of the fuel and resources needed to fly all the way to the Moon.

The spaceline could be built and maintained using resources from the Moon. For example, the cable could be made from titanium, which exists in abundance on the Moon. Other materials being considered could also be fabricated from precious metals found on the Moon. Lunar silicon could be refined into semi-conductors that create the solar panels used on the robotic vehicles traveling up and down the spaceline.

The cable elevator design still has some challenges to address, such as how to prevent the cable from breaking or collapsing, which could happen from the many stresses that it would experience. There is also the problem of debris flying around in space that could crash into the cable or the robotic vehicles. Nevertheless, this bold idea has engineers working hard to design a prototype and test its feasibility.



Martian Bricks

Lugging heavy, cumbersome construction materials to the Moon or Mars has proven to be so expensive and difficult that it is not considered an option. It's hard enough just getting astronauts to these places! The alternative is to use the materials that are already there, and that's what scientists and engineers have been figuring out how to do.

Fourteen-year-old Sidor Clare from Utah has made a major contribution to this effort. She and her partner Kassie Holt learned about what the soil on Mars is made out of and replicated it here on Earth. They used a mix called Mars Global Simulant MGS-1 because its chemical and mechanical properties are similar to the soil on Mars. They mixed this simulant with different binders to see which ones held the soil together best and then tested their bricks with equipment at a community college. Of the ones they tried, the soil mixed with polyester resin held together really well. This resin plus Martian soil makes extremely durable bricks—they are even stronger than concrete! "Our resin brick was so strong that we had to move to a concrete crusher to test it," Clare said.

Lunar Greenhouse

We can't plant crops on the Moon like we do on Earth. Soil and pollinators like bees don't exist, the atmosphere and temperatures are unlivable, and the available water is frozen inside craters. If we built regular greenhouses, plants couldn't survive the radiation coming through the glass and the plants would die during the two weeks of darkness every month. But without solving the problem of food—nutritious food that can be grown there, using local resources—there can't be any lunar residents.

Engineers and scientists are devising ways around these obstacles. They gleaned some ideas from The South Pole Growth Chamber. It grows food for researchers in Antarctica, who can be cut off from the rest of the world for up to eight months a year. Lunar scientists repurposed successes in this environment to the much harsher conditions on the Moon. They have constructed prototypes for a lunar greenhouse that would exist underground, protected from solar flares, cosmic rays, and micrometeorites. It is tube-shaped,18 feet long and 8 feet in diameter. These greenhouses can be folded into crates while traveling to the Moon. They'd arrive equipped with seeds that can sprout hydroponically, meaning that they only need water (no soil) in order to grow. Water can be brought from Earth to start the greenhouses, but then provided from frozen lunar deposits as well as water extracted from residents' urine.

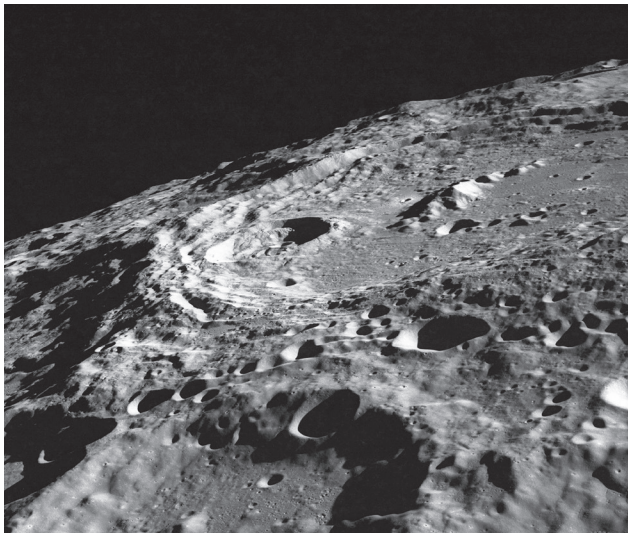
Light pipes using fiber-optic cables would channel sunlight from the Moon's surface to the plants. Once the greenhouses are set up, the settlers' own breath would provide the CO2 that the plants need, and settlers could breathe the oxygen that the plants create during the process of photosynthesis. Engineers call these greenhouses bioregenerative life support systems: everything they need will exist within them, and they will create habitats where humans can flourish.

Plastic Refabricator

Waste is a serious problem on Earth. Plastics in particular are a monumental issue because they take up to a thousand years to decompose. Plastic waste would also be a problem on the Moon, unless engineers figure out a way to turn it into a renewable resource for lunar residents.

The Refabricator does this brilliantly. It is part plastics recycler, part 3D printer. It melts plastic waste into a 3D printing filament, which transforms it into new tools for astronauts to use. NASA engineers tested the Refabricator's ability to work on the Moon by simulating microgravity. They found that the objects had similar thickness, strength, and flexibility as objects created on Earth.

In November 2018, the Refabricator was installed on the International Space Station. As Niki Werkheiser, the project manager for NASA's in-space manufacturing arm explains, "The Refabricator is key in demonstrating a sustainable model to fabricate, recycle, and reuse parts and waste materials on extended space exploration missions."



Engineers see other applications for the Refabricator that would help make life on the Moon self-sustaining. For example, it could enable the 3D printing of skin, bone, and body parts to treat injured residents! This technology is already being used here on Earth, in the field of regenerative medicine, to bioprint ligaments and tendons from stem cells.