Challenges to Lunar Explorers

The Moon is very different from Earth! Understanding the lunar environment and its hazards, combined with innovative engineering and technology, will prepare the way for future astronauts to live and work there.

Imagine working on the nearside of the Moon — the side facing Earth. Due to the lack of atmosphere, the sky is black, even during the day when the Sun shines. The distant Earth in the sky appears smaller than a quarter held at arm's length. The Moon's day is 29.5 Earth-days long. On much of the Moon's surface daylight lasts a little over 14 Earth days, followed by 14 days of darkness. The long-term impact of living in remote, small communities with prolonged light and darkness is unknown, so NASA is learning more by studying people living in remote communities near Earth's poles.

The Moon's poles have areas of permanent light and permanent darkness. Because the Moon's axis of spin is tilted at a very small 1.5 degrees to its orbit around the Sun, sunlight reaches the north and south polar regions at low angles of incidence. Explorers at the Moon's poles will see a Sun that stays near the horizon. Deep craters at the poles never receive sunlight. They are permanently shadowed and permanently cold! In contrast, elevated polar regions, such as crater rims, receive light for extended periods, making them valuable locations for solar energy to power polar bases.

Without an atmosphere to temper the differences, the lunar surface is either very hot or very cold. Average temperatures range from 225°F (107°c) in sunlight to –243°F (–153°C) in the dark. Astronauts will need protection from these extremes through suits and shelters. Equipment will also need to be sheltered and shaded as it operates best at a consistent, typically cold, temperature.

The Moon's gravity is approximately one-sixth of Earth's, so objects weigh one-sixth of their Earth weight. Building materials and structures will bear less weight than on Earth. While lunar Olympians will leap higher and throw farther, the reduced gravity can have a negative effect on human bodies. Well-designed for Earth, our sturdy bones and strong muscles are not necessary in the lower lunar gravity, and they begin to deteriorate, putting astronauts at risk for broken bones and weak muscles when they are back on Earth.

On Earth, our magnetosphere and atmosphere protect us from much of the dangerous incoming solar and cosmic radiation — very-high-energy radiation that can cause damage to living tissue and DNA. The Moon has no magnetosphere or atmosphere. Travelers must provide their own protection from dangerous space radiation. Solar flares can be detected and warnings sent to outposts to ensure astronauts are protected during these events. NASA's medical researchers and engineers are investigating the effects of radiation on the human body and different types of protective materials for suits, stations, and spacecraft.

The Moon is a very dry place! No liquid water exists on its surface, so water will have to be transported or produced on location on the Moon. However, this valuable commodity may exist — in frozen form — in permanently shadowed craters near the lunar poles.

Billions of years of asteroid and comet impacts — still ongoing — have pulverized the surface of the Moon, leaving behind a layer of "soil" — regolith — that can reach up to 50 feet (15 meters) in thickness. About half of the regolith is made of dust-sized particles. Lunar "dust" poses a significant challenge as it can become engrained in delicate equipment such as astronaut life-support systems, computers, and rover instruments. NASA currently is working to understand the properties of lunar dust, the effects of long-term exposure on humans, and ways to minimize its effects.

In facing these challenges on the Moon, we will learn how to live off the land, advancing our use of available resources, as we start the next chapter in human exploration of the solar system. The Moon is our testing ground for engineering approaches and new technologies, allowing us to build and sustain living and working environments beyond Earth.