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Back to the Moon

As the world sets its sights on the Moon, patent attorneys **MICHAEL JAEGER** and Dr **PETER HEINS** from European intellectual property firm, Withers & Rogers look at how space tech companies can protect their innovations.

Since the launch of NASA's Artemis 1 mission last year, public interest in space travel and, in particular, journeying to the Moon, has been rejuvenated. In 2023 the UK space industry is looking forward to its first ever vertical rocket launch of the Skyrora XL which is due to take place in Scotland later this year.

Unlike the Apollo missions of the 1960s and 1970s, it is no longer just a matter of getting astronauts to the Moon and back. The latest missions aim to find out whether it is possible to sustain human life in space for an indefinite period of time. It is hoped that scientific experiments carried out during these modern-day missions will one day allow people to set up camp and live on Mars – a planet that has long been of interest to astrobiologists, due to its proximity and similarities to Earth.

In recent times, the global space industry has attracted significant private sector investment, leading to a 'billionaire space race'. The main players include Elon Musk's SpaceX, which is planning a Moon flyby with its Starship and Jeff Bezos' Blue Origin, with its aims to industrialise space.

While high-profile rocket launches paid for by some of the richest individuals on Earth are bound to get significant public attention, a considerable amount of private and public sector funding is also being invested in the development of smaller-scale rocket launch systems which are primarily focused on sending small satellites into Low Earth Orbit (LEO). To demonstrate this, the UK Space Agency announced over £50m of funding for UK companies to develop communications and navigation services for missions to the Moon, as part of the Moonlight Programme. Fuelled by the flow of investment into the sector, 2022 was a record year for space activity globally with 180 successful rocket launches to orbit – 44 more than in 2021.

Mining lunar minerals

As well as paving the way for space travel and sending small satellites into orbit, the space industry is developing technologies to facilitate the extraction of rare earth minerals from the Moon's surface. The regolith found on the surface of the Moon is known to contain deposits of rare earth minerals, including neodymium, titanium, beryllium, lithium, zirconium, niobium and tantalum, which could be mined for use in the production of batteries for electric vehicles and solar energy installations.

It is also envisaged that one day the Moon could be used as a launch pad for missions to Mars and beyond, as well as providing a test bed for technologies that might be required to support human life on Mars. However, there are many problems to overcome, as space is not a hospitable place for humans to live for a variety of reasons.

▲ A NASA artist's depiction of astronauts taking rock samples on the Moon. Industrial mining would be on a much larger scale.

> ANY INVENTION MADE, USED, OR SOLD IN OUTER SPACE ON BOARD A US-CONTROLLED SPACECRAFT IS CONSIDERED TO BE MADE, USED OR SOLD ON US TERRITORY

Life support in space

Space radiation is a major barrier when it comes to finding ways for humans to live on the Moon, as there is no atmosphere or magnetic field to shield astronauts from these harmful effects. Therefore, Moon bases would need to be shielded in other ways – for example, by wrapping them in water or lunar soil. One proposed solution is for humans to live in the network of lunar lava tubes that exist just below the Moon's surface. Up to 40m in diameter, these 'tubes' are a natural phenomenon, formed as a result of basaltic lava eruptions.

Low gravity is another barrier to human settlement on the Moon since long-term exposure to a micro-g or zero-g environment may have detrimental effects on the human body. Other key barriers to overcome include finding a source of breathable air and portable water supplies, and how to grow food.

Innovative space companies around the world are experimenting to find technologies that could enable human beings to live on the Moon and, potentially, Mars too. In the US, The Aerospace Corporation has recently obtained a granted patent for a method of constructing a lightweight inflatable lunar habitat which can be made rigid by using a combination of lunar soil, lunar rocks and a binder. A consortium, led by NASA, has secured a US patent covering a method of manufacturing a new impact-resistant material for protecting astronauts and spacecraft from micrometeoroids.

Meanwhile, an Israeli start-up, Helios, is developing a patented molten regolith reactor, capable of separating the oxides found in lunar soil into oxygen which can be stored in high-pressure tanks, providing fuel for onward missions and, potentially, for breathing too. This solution could avoid the significant expense of transporting oxygen from Earth.

In the UK, Earth Rover is developing techniques that use satellite monitoring, and trialling the use of robots to monitor the growth of food crops, such as broccoli and other organic vegetables. Supported by the Science and Technology Facilities Council (STFC), the Earth Rover team has been sharing information with RAL Space UK's autonomous systems group, who have previously been involved in field-testing Mars rover technology.

Communicating with Earth

Ever since the earliest missions to outer space, astronauts have relied on Earth-Moon-Earth (EME) communication systems to exchange messages with terrestrial mission control teams. Today, communication links with the International Space Station are reliable and excellent quality, with a telemetry latency of just 2-6 seconds, depending on its position *vis-à-vis* the Earth.

As space scientists set their sights on sending astronauts to Mars, signal delays will become more of a problem. It currently takes about 5-10 minutes for a radio signal to travel between Mars and Earth, depending on the respective position of the planets, and this is sufficient to disrupt voice and video transmissions significantly.

A number of potential technological solutions to this communications problem are emerging. UK-based Braided Communications has secured a patent from the US Patent and Trademark Office, covering a system for exchanging communications via a communication channel linking a user on Earth with a user in space. Using "cyclically ordered conversation threads," the system mitigates the communication latency that exists between the two users, due to their distance from each other.

A project run by NASA is currently testing a two-way infrared relay system, to find out more about the capabilities of optical communications. Infrared laser beams are able to carry large volumes of data in much tighter waves than would be possible using radio waves so more information can be transmitted in one go. The downside is that optical communications systems require a high degree of precision when it comes to positioning the telescopic transmitter antenna and receiver. NASA is expected to publish the findings of its trial this year.

Intellectual property strategies

Innovative space companies will be familiar with the benefits of intellectual property rights and the importance of submitting patent applications to avoid the risk associated with early disclosure. However, some potential issues are less well known and could take innovators by surprise.

According to Article VIII of the *Outer Space Treaty,* a state retains jurisdiction and control over objects sent into outer space from its territory, including objects that exist on a celestial body, such as the Moon. Therefore, it is possible for companies to enforce their IP rights in space as long as they have a patent covering the launch jurisdiction. Interestingly, the US has gone one step further by amending their patent law to state that any invention made, used, or sold in outer space on board a US-controlled spacecraft is considered to be made, used or sold on US territory. Germany has similar provisions.

To protect against potential infringement action, it is important for space-tech innovators to respect earthly IP rights where they are held. In general, broad brush protection is also advisable to optimise the commercial potential of an innovation both in space and in wider applications on Earth.