

# WE ARE OVER THE MOON

Chandrayaan-3 is a brilliant demonstration of Made-in-India landing and roving technologies. The fourth member of the elite lunar club must now aim to be in pole position as global space politics gets fiercely competitive

AS Kiran Kumar



Former Chairman, ISRO

Yesterday India successfully crossed a decisive milestone by accomplishing the demanding task of soft landing a robotic spacecraft on the Moon. Chandrayaan-3's Vikram lander is now firmly sitting in the south polar region of the lunar surface and getting ready to collect valuable data about the Moon, its interior as well as the extremely thin atmosphere surrounding it. And the six-wheeled Pragyan rover, which was cocooned in Vikram till landing, has begun its exploration crisscrossing the landing area at snail's pace.

For its part, the 'propulsion module' of Chandrayaan-3 that carried Vikram from Earth to the 150 km high lunar orbit, continues to circle the Moon there. It has the company of Chandrayaan-2's orbital module, which is circling the Moon for the past four years and has sent copious data on its various facets. We are fortunate indeed to simultaneously witness an Indian lander and an Indian rover on the lunar surface along with two of our spacecraft orbiting the Moon. All this is the result of meticulous planning, perseverance and dedication of thousands of members of India's proud space fraternity, who are understandably jubilant.

Landing on the airless lunar surface is challenging indeed. That is why only four countries – the former USSR/Russia, the US, China and now India – have accomplished this. What is more important for India is that the gentle landing of Chandrayaan-3 has been accomplished in the south polar region of the Moon with its difficult yet alluring terrain. Scientists are captivated by the prospects of water ice in this region. This as well as the supposed presence of relics of the early solar system on this surface are the main reasons for the lunar south polar region becoming the target of spacecraft from India, the US, Russia, China and Japan.

During the days leading up to Chandrayaan-3's soft landing, there was talk of a Russia-India 'race' to reach the lunar south pole. But India has been striving for a soft landing in the south

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four rocket engines of Chandrayaan-3's Vikram lander began, Indians across the country and others across the world held their breath. Notwithstanding the lessons learnt through Chandrayaan-2 and the many subsequent precautions plus design changes plus installation of backup systems, ISRO scientists were apprehensive about the landing. But their perseverance and dedication paid off handsomely, as Vikram made a smooth touchdown in the intended south polar region of the lunar surface.

After making sure that the solar-powered Vikram lander and the Pragyan rover in it were functioning well, the latter was commanded to come down and it faithfully did so after sliding down from an extended ramp. As Pragyan started rolling over the pristine south polar region with its wheel tracks making long lasting impressions of the national emblem and the ISRO logo on the lunar soil, a

Aditya Ramanathan



Research Fellow, Space & Geopolitics, Takshashila

The successful Chandrayaan-3 mission not only marks India's ascension to a tiny club of lunar states, it also marks the first time humans have conducted a controlled landing in the southern polar region of the Moon. Whatever scientific data the Vikram lander and Pragyan rover might collect, their greatest contribution may be to inspire young Indians to take up space exploration.

The success stands in contrast to a string of failures that have preceded it. These include India's own Chandrayaan-2, which lost its lander in a crash near the Moon's south pole. Most recently, Russia's Luna-25 crashed on August 19 as it attempted to reach the same polar region.

Cold War like increasing development aid and bolstering Nato's conventional warfighting capabilities. What remained unsaid were Kennedy's assumptions about Apollo: that it would keep the aerospace industry in good health, spur economic vitality, and demonstrate American technological supremacy. The Moon had simply become another front in the struggle with the Soviets.

In 2019, the US announced the commencement of the Artemis programme, which aims to sustain human presence on the Moon and use it as a springboard for missions to Mars. The inaugural crewed Artemis mission is to land the first woman and person of colour on the Moon, reflecting America's self-image as an inclusive and free society.

However, Artemis is about much more than public relations. The programme involves close collaborations with a wide spectrum of private space companies. It is also a multinational effort involving the space agencies of the EU and Japan among others. Finally, Artemis is heavily focused on practical logistics. These include a planned lunar space station, a Moon-based satellite constellation for navigation and communication, and large transport spacecraft such as the European Large Logistics Lander.

Unsurprisingly, in 2021, Russia and China unveiled plans for an International Lunar Research Station with goals similar to those of the Artemis programme. While Russia's capabilities are constrained by Western sanctions, China has not slowed down its lunar exploration programme.

Where does India figure in this international rivalry? It's clear that the US and China are making assumptions similar to Kennedy's. In the long term, they believe space exploration and settlement will build national power and morale. In the short term, they expect large-scale space programmes will increase the competitiveness of a range of high-technology industries.

India symbolically opened itself to much greater space cooperation with the US earlier this year when it signed the Artemis Accords. It must leverage this concession to American interests by pushing for greater opportunities for both ISRO and the private space industry.

Programmes like Artemis require



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polar region from the time of Chandrayaan-2, which could not accomplish the task. And Russia has its own reasons for taking up lunar exploration after a gap of 47 years.

A careful look at the 3,900 kg weighing Chandrayaan-3's long journey of about 40 days to its destination, reveals the clockwork precision with which the planned events took place – from its launch by our own LVM3 vehicle to its placement on the path to encounter the Moon, to insertion into the lunar orbit, to separation and then smooth landing of Vikram. It also points to both the analytical and managerial skills of ISRO, its ability to rise to the occasion.

Since all these operations barring the soft landing had been successfully performed by Chandrayaan-2, the event that aroused suspense among millions of Indians was the landing task itself. Any spacecraft operation of this sort also brings butterflies to the stomach of those who endeavor it seriously. As the live broadcast of the 'retro burn' of the

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With the indigenous technologies essential for landing and roving on the Moon now successfully demonstrated, ISRO shall focus on in situ exploration using the three scientific payloads of Vikram and the two of Pragyan for the next 14 Earth days. This is a period during which the Sun will be continuously shining over the landing spot, thereby illuminating Vikram and Pragyan's solar panels. Until now, ISRO could study the Moon only via remote sensing.

The three payloads of Vikram – RAMBHA-IP, ChaSTE and ILSA – shall study three different aspects of the Moon: density and variation of its extremely thin atmosphere; thermal conductive properties of the lunar surface; and what lunar quakes reveal about the Moon's internal structure. Pragyan's two spectrometers shall help us understand the chemical, mineralogical and elemental composition of the lunar surface.

In the past, the Moon has been very beneficial to humans in the navigation of the high seas as well as in the measurement of time. In today's space age, it is considered as a key to understanding the evolution of the Earth and the solar system. It's not just its precious water, mineral and fuel resources that are enticing humans, but one day the Earth's only natural satellite could be the natural springboard for a crewed exploration of the worlds lying far beyond. The success of Chandrayaan-3 will definitely build a strong foundation for India's futuristic endeavours.

If Luna-25 had its origins in the Cold War-era space race, two other recent failures represent something altogether new. One was the 2019 Beresheet lander funded by an Israeli non-profit organisation, SpaceIL. The other was a mission by Japanese company Hakuto-R, which crashed in April 2023. Significantly, both the Beresheet and Hakuto-R missions were launched by US-based private company SpaceX. Soon, more missions are headed to the Moon.

Humanity's renewed interest in the Moon is driven by both new players and new objectives. The new players include major spacefarers like India and China (which has conducted successful soft landings with the Chang'e 4 and Chang'e 5) as well as private companies and smaller states. The new objectives are all about sustaining human presence on the Moon.

The Moon has periodically loomed large in international relations for more than six decades. The era of lunar politics began soon after the Soviet Union's 1957 launch of the first artificial satellite, Sputnik. Alarmed by this development, US officials developed multiple secret proposals. One was a plan to build a military base on the Moon, dubbed Project Horizon. Alarming, the base would also house a small number of nuclear weapons.

While Project Horizon was never taken up, the US redirected its efforts to the civilian Apollo programme. While we remember President John F Kennedy's stirring 1962 speech in which he pledged the US would send humans to the Moon, it's easy to forget that most of his talk that day was focused on specific aspects of the

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extensive supporting capabilities. Before putting humans on the Moon, space agencies will first want to conduct uncrewed surveys. ISRO should be able to launch several Chandrayaan-like landers to support these missions and get paid for it. ISRO chief S Somanath also hinted at another possible model of cooperation in June when he revealed that the American company Blue Origin was keen to use the Indian LVM-3 crew capsule to ferry people to its planned low Earth orbit space station, Orbital Reef.

International cooperation expands India's ability to pursue its own lunar missions as well. ISRO's first task will be to close the gap with China, which in 2020 completed a mission to bring back samples from the lunar surface. Its broader goal must be to work with India's private sector in ways that expand their ability to generate designs and intellectual property of their own. Space exploration inspires high ideals, but these must be tied to our economic and strategic realities on Earth.