CHINA: THE NEW NO. 2 SPACE POWER

Brad Tucker

On 4 October 1957, the USSR launched Sputnik, the world's first artificial satellite, and with it the Space Age itself. In February 2023, China's National Museum put on a grand exhibition marking thirty years since the start of the Chinese human space program.[1]

The environment in space is very different from that of Earth. The extremes in temperatures, from less than −150 degrees Celcius to more than 150 degrees, the lack of atmospheric pressure, and other issues mean that the margin for error to achieve success is zero. Even the most experienced space powers, the United States and Russia, can fail. Luna 25, Russia's first probe to the Moon in nearly fifty years, crashed there in August 2023.

The difficulties of space travel are challenging for countries and companies relatively new to the space race. China, during a period of about thirty years, has not just overcome these hurdles but also surpassed many other countries, including Russia, to become the world's number 2 space power.

Launching rockets

One way to measure the progress China has made is by the number of rocket launches. The US National Aeronautics and Space Administration (NASA), which put the first people on the Moon, now primarily relies on private companies to launch its spacecraft, including crewed missions. SpaceX is one of the companies doing most of this work for NASA. SpaceX can launch multiple rockets per week, sometimes every day, while having the rocket boosters return to Earth to be refuelled and reused.

In 2022, the United States achieved a total of seventy-four orbital launches, sixty-one by SpaceX; China boasted sixty-four. Far behind was Russia at twenty-one, and fourth was New Zealand's RocketLab at nine.[2]

SpaceX rockets often take multiple, and in some cases, nearly a hundred satellites into space whereas Chinese rockets usually only carry one or two. This is not because China lacks the capability but because it is sending larger satellites and only one or two can fit. However, China is rapidly developing the capability to do these missions that take multiple satellites, called ride-share.

The Tiangong Space Station: Building in space at speed

Space exploration is not only a hard journey but also a long one. Missions take years to design and develop, and the equipment must be tested, and often the process repeats. It is common for missions to run over time and over budget.

The two issues—time and money—are related. Most costs are related to paying hundreds to thousands of highly skilled people. The longer they work on a project, the more that project will cost. Famously, NASA's James Webb Space Telescope ended up being more than ten years late and US$9 billion over budget.

When the China Manned Space Agency (CMSA) announced that it would need six additional major missions to complete China's first space station, Tiangong 天宫太空站 (literally 'Heavenly Palace Space Station'), the goal of finishing in one year seemed ambitious. It involved launching and preparing two modules (sections), multiple crewed missions and associated launches. But in the end it only took eleven months, with the space station beginning operation in late October 2022. The Chinese space program is one of the few that not only meets its deadlines but also beats them. In the case of Tiangong, early cooperation and knowledge-sharing with Russia saved China time and effort.

Even when the United States was spending 7–9 percent of its GDP to get the Moon, delays were experienced. China is only the third country to operate its own space station after the United States and USSR/Russia, which has since cooperated on the International Space Station (ISS). However, the ISS is ageing and has an uncertain future. Russia has not committed to partner on it beyond 2024. The United States is planning for private companies to build and operate commercial stations around the Earth that NASA can use.

At the same time, NASA is focusing on the Gateway, a space station that will orbit the Moon. The Gateway, built and operated with commercial and international partners, will be able to support four astronauts at a time for a few months—much like the International Space Station. It will specialise in

research, exploration and resource extraction on the Moon. Russia has said it will build its own. However, it is doubtful that Russia has the financial and other means to do so, especially in light of the Luna 25 failure. They are also planning on collaborating with China on efforts on the Moon, which will further diminish their limited budget. It might eventuate that China has the only national space station orbiting the Earth.

China's race to the 'dark side' of the Moon

Landing on the Moon requires probes to decelerate from tens of thousands of kilometres per hour on leaving Earth's orbit to thousands of kilometres per hour around the Moon to zero. Adding to the difficulty of a Moon landing, the surface is rocky and the soil fine and adhesive. Just over half of missions to the Moon have succeeded.

Yet the race to the Moon is heating up. Since late 2022, a number of countries have sent probes and satellites to the Moon for the first time including South Korea, the United Arab Emirates and New Zealand. A private Japanese company, ispace, unsuccessfully attempted a landing while the US company Intuitive Machines will attempt a landing in 2024. India became the fourth country to land on the Moon and operate a rover in August 2023, while Japan became the fifth, with JAXA landing SLIM on the Moon in January 2024.

China was the first country, and is still the only country, to land on the far side of the Moon, sometimes misleadingly called the dark side, as it does receive sunlight; it is called the far side because it always faces away from the Earth. The Moon does one orbit around the Earth every 27.29 days. Since the orbit around Earth occurs at the same rate as its rotation, it means the same side is always facing towards Earth. Likewise, every spot on the Moon has about two weeks of continuous sunlight and daytime, followed by two weeks of continuous night-time and darkness.

What makes landing on the far side tricky, is that if you are facing away from Earth, you cannot see Earth or communicate with it. Landing a probe on the Moon is hard enough, harder when you are cut off from communications. To solve this problem, China launched two satellites in orbit around the Moon to act as communication relays between Earth and the rover.

China has already landed two missions, Chang'e 3 and Chang'e 4, on the far side of the Moon. Chang'e 3 conducted experiments including successfully growing plants in a biosphere. Chang'e 4 extracted samples of the Moon's rocks and soil, and carried them back to Earth—only the third country to do so.

China is planning a mission to the Moon nearly every year for the rest of the decade. Its lunar ambitions will culminate in landing taikonauts (what China calls its astronauts) on the Moon in 2030. Given the current pace, it should have no trouble making the timeline.

The new Moon race—resources in space

The new Moon race centres around the utilisation of resources on the Moon. It started when India's Chandrayaan-1 discovered vast amounts of water ice there, in particular at the Moon's South Pole. Through a simple process, water (H_20) can be broken down into hydrogen (H_2) and oxygen (O_2), providing astronauts with water, air and ingredients for rocket fuel. There are other potential fuel sources on the Moon as well—in particular Helium-3: an isotope of Helium. The Helium used to inflate balloons is Helium-4, which has two protons and two neutrons. Helium-3 only has 1 neutron. You can smash, or fuse, a neutron on to it—creating a nuclear fusion reaction, which creates Helium-4 and, more importantly, a lot of energy. It is not yet known whether Helium-3 exists on the Moon, especially in any useful or accessible quantities. China is examining the samples brought back to Earth from Chang'e 4 mission to the Moon for Helium-3.[3]

The weaker gravity on the Moon means spacecraft need less energy to leave the surface of the Moon than to leave Earth: about twenty times less. Take NASA's new, gigantic Space Launch System (SLS) rocket for the Artemis

missions, which is bigger than the Saturn V in the 1960s and 1970s. Most of the rocket is fuel to lift and fly a lander, along with a tiny amount of fuel to reach the Moon, so there is enough fuel to leave the Moon's surface.

The possibility of refuelling on the Moon will significantly lessen the limitations of space travel. This is part of a broader discussion around in-situ resource utilization—living off the land, so to speak. By using resources in space, rather than taking them up from here, it will be cheaper and more effective in the long term.

Space exploration and astronomy

The name NASA conjures up images from the Hubble Space Telescope, missions to Mars, and asteroids. Its space and astronomy explorations set it apart from other such bodies, which are focused on human space flight, like building space stations or landing on the Moon.

Increasingly, China has been doing the same. It has its own Mars exploration program, landing its first rover on Mars—Tianwen 天问 ('Heavenly Questions')—in February 2021, only the second country to do so after the United States. In late 2024, China is planning to launch its own space telescope: Xuntian 巡天 ('Heavenly Exploration').

Telescopes are measured by how big their mirrors are. The bigger the mirror, the more light they can collect. China's telescope will be nearly the same size as NASA's Hubble: two metres in diameter compared with Hubble's 2.4 metres, and therefore will be able to see in similar detail. Its field of view, moreover, will be about 300 times wider than that of the Hubble. It will be capable of taking a highly detailed picture of a much larger area at the same amazing resolution as Hubble.

It will also take a page out of NASA's playbook. The Hubble Space Telescope is more than thirty years old. The US Space Shuttle program had four missions to Hubble: upgrading, fixing and servicing the space telescope. This kept Hubble at the forefront of science until the shuttle program came

to an end. Once it is in orbit, the taikonauts on Tiangong will be able to dock with Xuntian, and therefore service and upgrade Xuntian with the best technology available, keeping it at the forefront of science.

Space telescopes are not the only thing China is building. In 2022, NASA with Johns Hopkins University launched the Double Asteroid Redirection Test (DART). This probe deliberately crashed into an asteroid to see how much energy could be directed into an asteroid to alter its orbit. It was built so that if an asteroid was heading for Earth, we could divert it, avoiding the sort of impact that put an end to the dinosaurs.

Chinese space suit display
Source: Shujianyang, Wikimedia Commons

China will launch its own asteroid redirection mission in 2025, a year earlier than originally planned, and to a different asteroid. They will also launch Tianwen-2, which will be sent to an asteroid, land, extract samples and return to Earth—much like Japan's Hayabusa-2 did in 2020 and NASA's OSIRIS-Rex did in 2023. These samples have revealed exciting features like amino acids, nucleobases (which go into making DNA) and organic compounds.[4]

China also operates the largest single-dish radio telescope on Earth, the Five-hundred-metre Aperture Spherical Telescope, or FAST, nicknamed Tianyan 天眼 ('Heavenly Eye'). This telescope is built into a natural depression on top of a mountain in remote Pingtang County, Guizhou. In Australia, by way of contrast, the largest single-dish radio telescope is 70 metres in diameter.

Commerce and defense in space

Like the United States, Europe, and Australia, China has commercial and military infrastructure in space, and is massively expanding its footprint there. China is second in spending on space projects and infrastructure, spending nearly four times what Russia spends annually.

SpaceX through its Starlink service, soon to be joined by Amazon with Kuiper, operates thousands of communications satellites to provide global high-speed internet. China has started building its own rival network this year, called Guo Wang 国网, or 'National Network'.

Since 2000, China has maintained its own Global Navigation Satellite System (GNSS)—the generic term for GPS. GPS is the US version of a GNSS network. China's is BeiDou, Russia operates GLONASS and Europe has Galileo. While all are similar in operation, GPS is still the most accurate. However, due to the importance and dependency of countries on these networks, in particular for defence, they operate their own.

China is also developing cutting edge space technology for government and defense purposes. China has also now built and flown what can only be described as a space drone. In the mid-2010s, Boeing built the X-37B for the US Space Force. Not much is known about it, but it is about a quarter the size of the old US Space Shuttle, can stay in orbit for more than four years and can land remotely.[5] It appears that China has also developed and launched its own space drone to do so.[6] Like the US versions, knowledge of the details of it and its capabilities are limited; however, it is most likely for flying and testing military payloads in orbit.

China will also soon enter the space tourism race. Blue Origin and Virgin Galactic have built dedicated space vehicles for short tourist flights. SpaceX and Axiom Space have also flown tourists into orbit and to the International Space Station. A Chinese company with mixed private and state ownership (partly funded by the Chinese Academy of Sciences), trading as CAS Space in English but actually called Guangzhou Zhongke Aerospace Exploration Technology Co. Ltd 广州中科宇航探索技术有限公司, is developing a system similar to that of Blue Origin: vehicles that will go about 100 kilometres above the surface of the Earth for a few minutes before returning.[7] Their aim is to start operations in 2025.

China, Russia and money

With only twenty years since the first Chinese taikonaut ventured into space, how has China caught up? There are a few reasons, two of which are money and Russia. The Russian space program itself, despite its long and proud history, is falling behind. A lack of investment and exciting projects, and a failure to embrace the private sector, has meant that Russia is no longer the power in space it used to be. However, it does have the experience and knowledge China has needed.

While China is rapidly developing its own expertise, its space scientists have taken advantage of Russian space heritage since 2000, most notably in the development of China's Tiangong Space Station. Agreements have led to the sharing of detailed knowledge, classified information, and technical advice.[8] As a result, Russia's scientists and space program can work on exciting projects, at the forefront of space exploration, without footing the whole bill. The two countries have worked on twenty missions together already.[9]

Just as the United States spent more than US$180 billion (in today's dollars) during the Apollo era, China is now rapidly increasing its spending, on space exploration and infrastructure. In 2020, it spent around US$10 billion, and in 2022, it spent US$12 billion.[10] As a result of investment and cooperation, China has now surpassed Russia in all measures of space

exploration. When looking at the amount, sophistication and sheer variety of missions and programs China is leading compared to Russia, it is clear who the number 2 space power is.

The two countries have agreed to work together on Moon exploration—including building a Moon colony and a semi-permanent presence on the Moon. However, judging from such evidence as Russia's failed Luna 25 mission, Russia needs China more than China needs Russia.

View of Earth and satellite
Source: NASA, Unsplash

A decade ago, India was working with Russia on the Luna 25 probe, not having had its own experience with Moon exploration. Due to a lack of progress and the belief it could do it faster and better, India stopped working with Russia and worked alone. Its first attempt, Chandrayaan-2, failed three and a half years before Luna 25 reached the Moon. Its second attempt, Chandrayaan-3, succeeded in the same week as Russia's failed attempt to land Luna 25. The question is whether China will similarly outgrow its need for Russia.

As mentioned above, Russia will leave the International Space Station after 2024. The United States banned China from participation in the International Space Station in 2011. Fuelled by worries that cooperation would lead to technology that benefits China's military, the United States passed the Wolf Amendment. Russia announced plans to build its own space station during the early days of the Ukraine invasion, amid other political ploys involving space exploration, such as propaganda videos showing that they would leave an American astronaut in space[11] or even hold a UK company's satellites hostage.[12] However, it is unlikely to be ready in the next couple of years, if ever, due to the limited resources Russia's space program is suffering from. One option is for Russia to build modules and attach them to Tiangong—or work with China some other way. Tiangong was built in a modular fashion, like the International Space Station, allowing for new modules in the future. It would be another situation where Russia needs China more than China needs Russia.

The race to the top

Will China become the number 1 space power? The United States claims that title thanks to investment and cooperation between NASA, the United States military (e.g. Space Force) and private companies (Lockheed Martin, Boeing, SpaceX and so on), which has accelerated the US space program. The progress, spending and pure diversity of projects, whether for exploration or commercial purposes, is truly astounding: missions to the moons of Jupiter and Saturn, satellite networks that will use lasers instead of radio waves to transmit gigabytes of data per second, as well as dozens of small exploration missions planned every few years.

However, this model is not drastically different from what China is doing. The biggest point of difference is the way private companies operate in the two countries. The independence of US companies, which is greater than those in China, has spurred innovation and reinvigoration in the US

space program. To challenge the United States for the top spot, China must continue the pace of its progress and find the right balance with the private space sector and innovation.

US companies have a level of independence that allows them to pursue innovation and seek new directions and technology that might not be the priority of the US government. As an example, the drive of private space travel from SpaceX, Blue Origin and others forced US companies to design systems that were cost effective and profitable. NASA frowned on private space travel for a long time. To accomplish it, private companies developed reusable rockets and capsules, making the cost of launching significantly cheaper—twenty-five times cheaper—than NASA's Space Shuttle. This cheaper access to space benefited not just private companies but also the research sector and the government itself. Until China has truly private companies that can determine their own directions, investments and subsequent priorities, the United States will remain top of the pecking order.

This text is taken from *China Story Yearbook: China's New Era*, edited by Annie Luman Ren and Ben Hillman, published 2024 by ANU Press, The Australian National University, Canberra, Australia.

doi.org/10.22459/CSY.2024.07A