CHAPTER 4

The space shuttle Atlantis and its six-person crew launch into space to rendezvous with the International Space Station.

Courtesy of NASA/Sandra Joseph and Kevin O'Connell.

Space Programs

Chapter Outline

LESSON 1
Strategic Significance of Space Programs

LESSON 2
US Manned Space Program

LESSON 3
Making Space People Friendly

"We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win."

President John F. Kennedy
35th US President

LESSON 1

Strategic Significance of Space Programs

Quick Write

How do you think the launch of the Sputnik satellites helped fuel the United States' space exploration endeavors?

Learn About

- US space policy
- Russian space program
- Chinese space program
- space programs around the world

After World War II, the United States and the Soviet Union were locked in a period of competition for global influence. Each was striving to be the first nation to launch a man-made object into space. On October 4, 1957, the Soviets became the first nation to launch a man-made satellite into orbit around Earth with Sputnik 1. The launch came as a surprise to the United States because it occurred much earlier than anticipated.

Sputnik 1 was a simple satellite. Shaped like a sphere, it was about the size of a beach ball. The satellite weighed 183 pounds and carried a radio transmitter that allowed it to be tracked as it orbited the Earth. The launch of Sputnik was announced to the world, and the Soviets provided the radio transmission frequencies so that everyone could track it. This ensured that all would believe the first satellite had been launched. Sputnik 1 orbited Earth once every 90 minutes. Although the transmission details had been provided beforehand, the United States had not expected Sputnik 1 to be launched until months later. The satellite completed two orbits before the US military even realized it was in space.

The success of Sputnik 1 kicked off tremendous support for the space program in the Soviet Union. Political and financial support followed for the space program to continue its efforts.

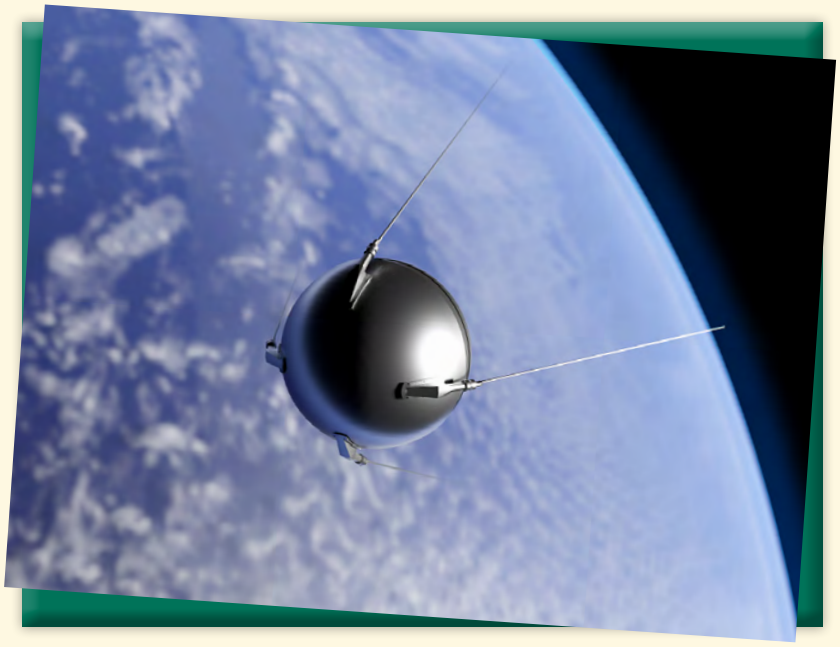
As a follow-up to Sputnik 1, the Soviets launched Sputnik 2 on November 3, 1957. This was less than a month after the Sputnik 1 launch! Sputnik 2's goal was to put an animal into orbit. A stray dog from the streets of Moscow, Laika, was the sole passenger of Sputnik 2. She was carried into orbit along with equipment to run experiments.

Video and data feeds were sent back to Earth every 15 minutes during orbit. Unfortunately, the mission was not designed to be a round-trip journey for Laika. Although the satellite automatically dispensed food and water for Laika at timed intervals, the Soviets had no intention of returning the satellite to Earth. The satellite eventually ran out of oxygen and Laika died in orbit. The Soviets were not prepared for the enormous backlash they received from around the world following Laika's death.

Despite the death of Laika and the public criticism, Sputnik 2 was considered a huge success. The satellite remained in orbit for 200 days and returned massive amounts of scientific data.

Vocabulary

- space race
- intercontinental ballistic missiles (ICBMs)
- suborbital flight
- orbital flight
- exploitation



An illustration of Sputnik 1 in orbit.
AuntSpray/Shutterstock

US Space Policy

After World War II, the space race began, with the US and Soviet Union in a race to get a human into space. The space race was *the competition between the United States and the Soviet Union to prove their superiority with the technology and man power required to send a man to space*. In an effort to indicate America's commitment to winning the space race, the US Congress passed legislation establishing the National Aeronautics and Space Administration (NASA) on Oct. 1, 1958. Less than a week later, President Dwight D. Eisenhower tasked NASA with putting a man into orbit.

Why is space important to US national interests? During the Cold War, the space race represented not just national pride, but national security, as well. In the 1960s, Vice President Lyndon B. Johnson stated, "Failure to master space means being second best in every aspect, in the crucial arena of our Cold War world. In the eyes of the world, first in space means first period; second in space is second in everything."

The initial push to explore space was heavily influenced by national security. Space was seen as a possible component of war. Reconnaissance from high-altitude orbiting satellites could provide real-time information. And if a satellite could be launched into space, then a weapon could feasibly be launched across the ocean as well. Many saw the need to explore space as a key to US safety.

Who Develops US Space Policy?

The responsibility for developing national space policy ultimately falls onto the President of the United States. Obviously, each president relies on advisors and experts in the field to help develop space policy. In addition, the level of space ambitions varies with each president. New space policies are not developed with each new president; as President Eisenhower recognized, space goals are long-term plans. It takes time, effort, and resources to develop the technology and knowledge to complete a space mission. Therefore, space policies typically have covered several presidential terms.

NASA is a civilian-operated agency that handles both civilian and military space initiatives. The DoD is responsible for directing the military space efforts for the nation. The Army, Navy, and Air Force all operate separate organizations dedicated to space applications. In 2001, the DoD specified that the Air Force was the military's executive agency for space. The Air Force Space Command is responsible for the acquisition and operations of all military space systems.

1950s

History forever changed when the Soviet Union launched Sputnik 1. The US was caught completely off guard, the public feared that if the Soviet Union could launch a satellite into space, they could also launch intercontinental ballistic missiles at the United States. Intercontinental ballistic missiles (ICBMs) are *missiles with a flight capability of over 3,400 miles*.

The US Defense Department responded by providing additional funding for multiple space satellite programs. And, in January 1958, the US successfully launched Explorer 1. This satellite carried a scientific payload that eventually discovered magnetic radiation belts around the Earth. The space race was officially on!

1960s

The Right Stuff

"First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth."

That proclamation by President John F. Kennedy before a joint session of Congress on May 25, 1961 set the stage for an amazing time in our nation's emerging space program.

NASA created the Space Task Group to set up and manage space flight. The Space Task Group consisted of a small group of NASA engineers tasked with managing manned space flight programs. Robert Gilruth, an expert in rocket testing and development, was assigned to lead the group. Gilruth was a pioneer in aeronautics and is considered the father of the US manned space program.

Robert Gilruth, considered the father of the US manned space program
Courtesy of NASA

Following the Soviet Union's launch of Yuri Gagarin in April 1961, President John F. Kennedy announced a daring plan, challenging NASA to safely send a man to the moon and back by the end of the decade. The US launched its own astronauts in capsules with the mythical names of Mercury, Gemini, and Apollo. From suborbital flights in 1961 to orbital flights in 1962, NASA proved that humans could survive in space. A suborbital flight is *a flight trajectory that does not complete a full orbit of the Earth*. Orbital flight is *when an object is placed on a flight trajectory that keeps it in space for at least one orbit around a planet*. During this period, astronauts became a new breed of national heroes, admired for their courage and dedication to exploring the new frontier of space. The two-man flights of 1965 and 1966 demonstrated that humans could fly in space, undertake complex rendezvous and docking operations, and even leave the spacecraft for extravehicular activity (EVA), or activity done by an astronaut outside the spacecraft, while in orbit. In 1969, NASA achieved President Kennedy's goal of landing a human on the moon and safely returning him to Earth. NASA's space exploration and moon landings will be discussed in a later lesson.

1970s

While NASA continued Apollo missions to the Moon and further space exploration, the US government had turned its attention toward the economy and the Vietnam War. President Nixon had also decided that the US should focus on a new type of space transportation, the space shuttle. By 1975, NASA's budget had been slashed from a high of five billion dollars in the mid-1960s to just over two billion dollars by 1974.

President Richard Nixon with NASA Administrator James C. Fletcher announced the Space Shuttle program in 1972.
Courtesy of NASA

President Nixon also stressed the importance of cooperation with space exploration. In 1972, President Nixon signed a cooperative program agreement between NASA and the Soviet Union that would last for five years. The deal resulted in the 1975 Apollo-Soyuz Test Project between the two nations.

President Carter did not have lofty goals for spaceflight during his term in office, but did direct military policies on space. In 1978, President Carter restated previous resolutions and treaties that addressed the exploration of space for peaceful purposes and for the benefit of all mankind. Carter wanted to restrict the use of space weapons with the policy. This directive also stated that the US shall encourage domestic commercial exploitation of space capabilities for economic benefit under supervision and regulation of the US government. Under this directive, exploitation is *the action of making use of and benefiting from resources such as new technology*.

1980s

President Ronald Reagan was a strong supporter of NASA and the shuttle program. Reagan believed that space should be explored for strategic defense and not only a surveillance platform. Reagan also wanted to streamline space travel and believed in the power of a free market. His policies encouraged commercial organizations to join the space industry. In March 1983, Reagan announced the Strategic Defense Initiative, also known by some as Reagan's "Star Wars." The Strategic Defense Initiative involved the construction of a space-based anti-missile system to defend the nation from attack.

With the announcement of the Strategic Defense Initiative and the Challenger disaster in January 1986 (more on this in a later lesson), the US issued a revised space policy in January 1988 that set new goals for space:

1. Strengthen the security of the United Sates.
2. Obtain scientific, technological, and economic benefits for the general population and improve the quality of life on Earth through space-related activities.
3. Encourage continuing US private-sector investment in space and related activities.
4. Promote international cooperative activities.
5. Maintain freedom of space.
6. Expand human presence and activity beyond Earth orbit into the solar system.

The Reagan administration's shift in policy implied for the first time that space was not a perfect environment, but, like land, sea and air, was another arena for military operations.

1990s

As the Cold War ended between the US and the now-dissolved Soviet Union, presidents were focused on using space as a means for protecting US national interests.

The beginning of the 1990s saw great support for NASA and space initiatives. President George H. W. Bush increased NASA's budget in a slow economy. He also proposed a grand plan for the space program. The Space Exploration Initiative would focus on the construction of a space station, a permanent presence on the moon, and a manned mission to Mars by 2019. The goals were ambitious and estimated to cost over $500 billion. Many did not agree with the extensive plan, and the initiative was never implemented. Space was not a high priority under Bill Clinton's administration and NASA saw decreases in its budget. President Clinton emphasized the subject of international space cooperation. The 1996 US National Space Policy was the first post-Cold War policy on space. It focused on cooperation when it stated, "Access to and use of space is central for preserving peace and protecting US national security as well as civil and commercial interests."

The congressionally chartered "Space Commission" completed an evaluation of US space policy when it reached five unanimous conclusions in its report:

1. Space should be a top national priority. To reach this conclusion, the committee reviewed the current US dependence on space, the pace at which dependence is increasing, and the vulnerability it creates.
2. The US government is not ready to meet the space needs of the twenty-first century.
3. Space programs in the US are essential to peace and stability of the nation.
4. Space will see conflict. As history has proven, conflict occurs everywhere—air, land, and sea. Space will be no different. The US must develop methods to deter and to defend against conflicts in space.
5. It is essential for the US to invest in science and technology resources to remain a leader in space exploration.

Did You Know?

Secretary of Defense William Cohen under President Clinton wrote in a letter to his military service leaders, "Space is a medium like the land, sea, and air within which military activities will be conducted to achieve US national security objectives."

US Department of Defense Secretary William Cohen.
Courtesy of DOD

2000s

Seeing a need to update the 1996 US space policy to reflect both the post-Cold War and post-9/11 situations, on June 28, 2002, President Bush instructed the National Security Council to chair a review of US space policies and report back during 2003. A new National Space Policy was released in 2006 that established a national policy for conduct of US space activities. This new policy replaced the earlier National Space Policy of 1996.

This new document was the first full revision of US space policy in 10 years. The new policy emphasized security, encouraged private investment in space, and the role of US space diplomacy. The policy stated that in this century, those who effectively utilize space will enjoy added prosperity and security and will hold a substantial advantage over

those who do not. Freedom of action in space is as important to the United States as air power and sea power. In order to increase knowledge, discovery, and economic prosperity and to enhance national security, the United States must have robust, effective, and efficient space capabilities.

In 2009, the Augustine Commission reviewed America's spaceflight plans at the direction of President Barack Obama. After the commission reported its findings, President Obama directed NASA to focus on manned missions to an asteroid by 2025 and manned missions to Mars by the mid-2030s. Obama's new policy also provided additional NASA funding to help commercial space companies enhance their capabilities.

Present

President Donald Trump's National Space Strategy strives for the United States to establish a leadership role in space. In partnership with private industry and US allies, President Trump decided to base space strategy on four pillars:

1. Accelerate the plans of the US in designing and building inhabited space environments, such as space stations to enhance defenses, and the ability to repair space systems.
2. Strengthen US and allied options to deter potential adversaries from extending conflict into space and, if necessary, counter hostile threats.
3. Ensure effective space operations through improved situational awareness, information gathering, and the process of investment in technologies, programs, and needed support.
4. Streamline regulations, policies, and processes to better support US commercial industry.

On December 11, 2017, President Trump once again set America's sights toward the stars by signing Space Policy Directive -1, which instructed the National Aeronautics and Space Administration (NASA) to return American astronauts to the moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.

Russian Space Program

Before Mercury could launch a man into orbit, Soviet cosmonaut, Yuri Gagarin, became the first human to orbit Earth on April 12, 1961 in the Vostok capsule.

Vostok

The spherical Vostok capsule was a simple design. It used an adapted R-7 rocket to launch into space and, although the craft had manual controls, it was to be controlled by mission control on the ground.

All early Soviet missions were designed to be controlled by mission control for two reasons. If the cosmonaut became incapacitated, the Soviets needed a way to control the capsule and return the cosmonaut to Earth. Second, they worried that if a cosmonaut had control of the craft they may defect, give up allegiance to their country for another country, to the West and cause embarrassment to the country.

The Vostok rocket that delivered Yuri Gagarin to space.
dimbar76/Shutterstock

The Vostok capsule was designed to eject the cosmonaut during re-entry. Since the Soviets could not slow down the capsule and the landing terrain was rough, the safest method of landing was ejection. The cosmonaut would eject from the capsule and parachute back down to Earth.

Yuri Gagarin successfully completed one orbit of Earth during his 108-minute flight. The entire flight was controlled by mission control on the ground.

During Gagarin's flight, the Soviets encountered problems with re-entry. The capsule spun out of control during the initial re-entry when the equipment did not separate completely from the capsule. After about 10 minutes, the connectors burned away, allowing the equipment to separate. This stabilized the capsule, and re-entry continued as planned.

The Right Stuff

Selecting Cosmonauts

The Soviet process for selecting cosmonauts was very private. Sergei Korolev was an aeronautical engineer who designed and developed rockets. He was responsible for the Sputnik program. In September 1959, Korolev created a cosmonaut selection commission that reported to the Scientific Research Institute of the Soviet Air Force. Because NASA's efforts to train and select astronauts were public, the Soviets adapted much of their training from the NASA program.

From a pool of 3,000 military pilots, they whittled down the group to 15 cosmonauts known as the "Air Force Group One." The cosmonauts would train at the new Cosmonaut Training Center outside Moscow. The center would eventually evolve into Star City, which is still in use today.

Fifteen of the cosmonauts trained to go into space and 11 of them successfully made it to space as part of the Vostok project.

The Right Stuff

The First Woman in Space

Sergei Korolev had an idea to send a woman to space. He secretly selected and trained several women cosmonauts for the mission. Valentina Tereshkova soon excelled at the testing and had an ideal background. She had a background as a worker in a textile factory, and her father was killed in the Winter War that was part of World War II; he was regarded as a hero. Korolev felt this made Tereshkova the ideal candidate, as the country would embrace her as a hero. While all other cosmonauts had been pilots, Tereshkova was a parachutist. On June 16, 1963, Tereshkova became the first woman in space. She orbited the Earth 48 times over three days in the Vostok capsule. This was more time in space than all Americans combined, at that point.

However, Tereshkova's time in space was also a publicity stunt. The Soviets wanted to achieve another first in the space war. It would be more than 19 years before the Soviets sent another woman into space. And shortly after Tereshkova's flight, the Soviets disbanded the women's cosmonaut program.

Valentina Tereshkova
Courtesy of ESA

Voskhod

The Voskhod program aimed to explore the effects of space on the human body. The mission had two launches. The Voskhod 1 launched on October 12, 1964 with a three-person crew. On March 18, 1965, the Voskhod 2 launched with a two-person crew. During the 1965 flight, Alexei Leonov completed the first spacewalk in history—another first for the Soviets.

However, in 1964, the Soviet leadership changed. This new leadership had less focus on space. As a result, Korolev cancelled the Voskhod program to focus on the Soyuz capsule.

Soyuz

The Soyuz was designed as a lunar landing program. The capsule would take two cosmonauts and a lander into space. One cosmonaut would then take the lander to the lunar surface, walk around, fly back into lunar orbit to rendezvous with the Soyuz, and then return to Earth. The project was plagued with technical difficulties. And in January 1966, Korolev died and left a major hole in the program. The mission was abandoned in 1974 and the Soviets turned their attention to space stations.

The Soyuz spacecraft orbiting Earth.
Andrey Armyagov/Shutterstock

Chinese Space Program

The Chinese did not begin to engage in space travel until the late 1950s. China's major goal in exploring space travel was the launch of weapons into space. The United States and Soviet Union were well into their space race to put a man on the moon, and the use of rockets to send weapons into space alarmed China.

The Chinese government had an agreement with the Soviets that allowed them to use the R-2 rocket technology. This agreement ended in the 1960s, which forced China to develop its own rockets. China started launching rockets into space in 1960.

The Chinese space program was initially slow-moving. The country was dealing with a major political division and its interest in space was largely due to defense. The Chinese focused on missile development rather than space exploration. The Ministry of Aerospace Industry was established by China in 1988. A few years later, the ministry was split into two organizations: China National Space Administration (CNSA) and China Aerospace Science and Technology Corporation (CASC). The two organizations allow both the government and private companies to participate in space travel.

The Chinese space program has grown immensely over the past 20 years. It developed the Long March rocket, deployed the country's first space station, and launched the Chinese Lunar Exploration Program (CLEP).

The Chinese have both lofty goals for their space program and the money to fund those goals. In 1992, the Chinese set a long-range plan for their space program, and they successfully executed that plan on schedule. In 2016, the Chinese established a new long-range plan. Some of the projects in the plan are as follows:

- A Mars probe by 2020 that will orbit Mars and land a rover on the surface
- A reusable space plane by 2020 that will carry astronauts by 2025
- A nuclear-powered spacecraft by 2040
- Exploration of the asteroid belt
- Solar-powered plants in space
- Mining on the moon and asteroids
- A fully colonized space village

The Right Stuff

Taikonauts

Chinese astronauts are called "taikonauts." The process to become a taikonaut is very long and strenuous. Some taikonauts study for over 15 years before they are ready to go to space. The first generation of taikonauts was selected in 1998. Two of the taikonauts went to the Russian Cosmonaut Training Center to be trained and to learn how to set up their own training program. The first generation of taikonauts included 15 male military pilots.

The second generation of taikonauts was selected in 2010. It included five male fighter pilots and two female military transport pilots between the ages of 27and 34. After being selected, the taikonauts complete a minimum of 2 to 3 years of training before they can train for a mission.

In January 2018, China announced that it will begin the selection for the next generation of taikonauts. Candidates will be selected from space industry companies, research entities, and universities. To become an engineer on the Chinese Space Station, a candidate must have a master's degree. To become a payload specialist on the Chinese Space Station, a candidate must have a doctorate degree.

Shenzhou

The first manned Chinese spacecraft program was the Shenzhou. The Shenzhou spacecraft was similar to the Russian Soyuz, except it was larger and newer. The goal of the program was to perfect manned spacecraft techniques, including extravehicular activity, rendezvous, and docking, and eventually ferry taikonauts to the Chinese space stations.

Yang Liwei's spacesuit on display at the China National Museum

Shan-shan/Shutterstock

The spacecraft itself was comprised of three parts: orbital module, re-entry capsule, and aft service module. The orbital module was able to maintain autonomous flight and had its own propulsion, solar power, and control systems. The re-entry module was similar to the Soyuz, but was 13% larger. The service module housed the electrical power, control, and propulsion for use in orbit.

Work began on the Shenzhou program in 1992, but limited funding slowed its progress. In 1999 and 2000, unmanned flights were sent into orbit. Then, in 2003, the first Chinese taikonaut, Yang Liwei, traveled to space aboard the Shenzhou 5. The flight was relatively short and lasted only 21 hours. Nonetheless, China became the third country to send a human into space.

Shenzhou 6 was the second manned mission and carried two taikonauts to space for five days in October 2005. Then, in 2008, Shenzhou 7 deployed China's first EVA with a spacewalk by crew member Zhai Zhigang. The Shenzhou 7 mission lasted for 2.85 days.

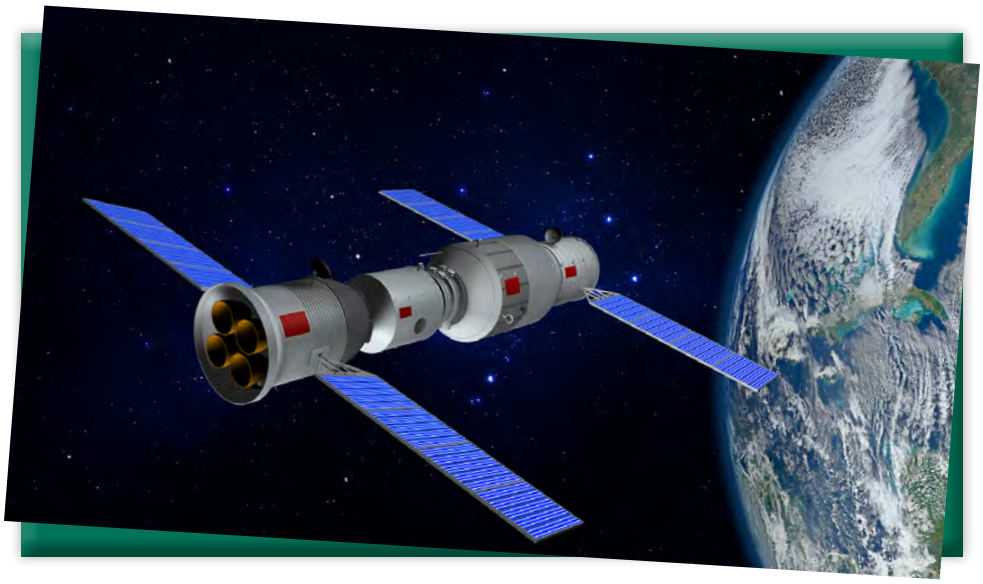
Did You Know?

China currently cooperates with the European Space Agency (ESA) as they partner on space missions. However, the United States and China do not work together. In 2011, Congress passed a bill that forbids NASA from working with China for fear of espionage.

Chinese Space Station

The first Chinese space station to launch was the Tiangong-1 which translates to "Heavenly Palace 1." The space station was about the size of a school bus at 34 feet long and 11 feet wide. It weighed in at nine tons. The space station had two main parts. The experimental module was used to house visiting taikonauts. The resource module housed the solar energy and propulsion systems.

The Tiangong-1 was launched on September 29, 2011 as an unmanned space station. It orbited slightly lower the much bigger ISS. The goal of the Tiangong-1 was to learn the technologies needed to assemble and operate a fully functioning space station.



3D module of the Chinese space station Tiangong-1.
Alejo Miranda/Shutterstock

The Shenzhou-8 was the first spacecraft to dock with the Tinagong-1 in November 2011. The first taikonauts to board the space station launched in June 2012 aboard the Shenzhou-9. Shenzhou-10 transported three taikonauts who spent two weeks on Tiangong-1.

The Tiangong-1 was designed to last for two years, and work with the space station ended with Shenzhou-10. Data transmission with the space station ended in 2016. The Chinese have never said if they lost communication or if the data transmission ended intentionally. On April 1, 2018 the Tiangong-1 broke apart and burned up over the southern Pacific Ocean during re-entry. The Chinese claim the re-entry was controlled; however, other agencies disagree with this statement. A controlled re-entry requires the spacecraft handlers to be in communication with the space station.

The stepping stones to a fully operational space station continued with the Tiangong-2. Tiangong-2 was launched in September 2016. The goal of this space station was to test advanced life support, refueling, and resupply. In late 2016, the Tiangong-2 hosted two taikonauts for 30 days. This was the longest human space mission for China. In June 2018, the Tiangong-2's orbit lowered by almost 100 km. It is likely that the Chinese are preparing to de-orbit the Tiangong-2.

The Chinese space program is currently constructing its own 60-ton space station, which will be named Tianhe. The first module will launch in 2020. This is the same year the ISS is scheduled to be decommissioned. Two more modules will be added, with the completion of Tianhe scheduled for 2022.

Chinese Lunar Exploration

The Chinese space program has conducted several missions with the Chang'e project to orbit the Moon. In January 2019, the Chang'e 4 became the first spacecraft to land on the far, or "dark," side of the Moon—the side of the moon that always faces away from Earth. The Chinese have also scheduled Chang'e 5 to land on the Moon in 2019 and return with a sample of lunar regolith, or rocky material that covers bedrock, from two meters deep. The Chang'e 5 mission will require the spacecraft to utilize four modules. Two modules will land on the Moon. One will collect the sample and give it to the second module. The second module will launch and dock with the third module that will be orbiting the Moon. The third module will transfer the lunar regolith sample to the fourth module in lunar orbit, which will return it to Earth.

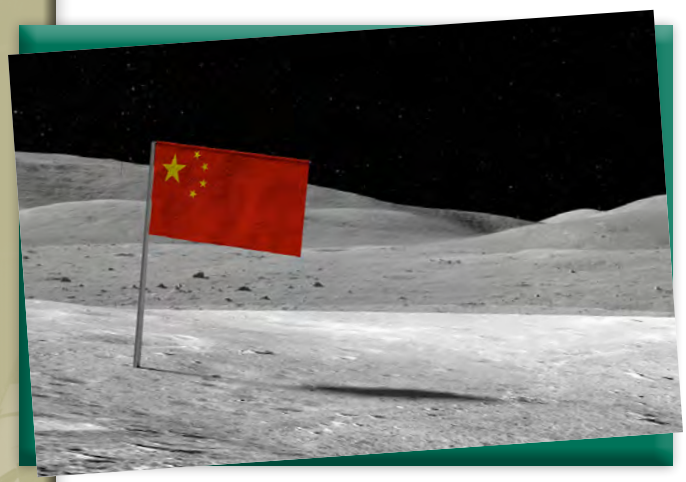


Illustration of the Chinese flag stuck in the surface of the Moon.
BeeBright/Shutterstock

The long-term goal of China's space program is to send crewed missions to the Moon and perhaps set up a lunar outpost. It is expected that the Chinese will work with the European Space Agency (ESA) to create the outpost, dubbed the "international Moon village." They are already working toward that goal by establishing a simulated lunar base in China. The Yuegong-1, or Lunar Palace, is a laboratory that simulates the lunar environment. Currently, potatoes, wheat, and carrots are being grown in the "lunar" base.

Space Programs Around the World

NASA, Russia, and China are not alone in the world of space exploration. The European Space Agency (ESA) makes several orbital launches each year. ESA's very large launch site in French Guiana specializes in commercial and scientific missions. Israel, Japan, and India each have unique programs for studying space, too. Like NASA, each of these programs exists to support and promote manned and unmanned missions to space. The "Big Six" in space exploration consist of the following:

- National Aeronautics and Space Administration (NASA)
- Roscosmos (Russian space agency)
- Chinese National Space Agency (CNSA)
- European Space Agency (ESA)
- Indian Space Research Organization (ISRO)
- Japanese space agency (JAXA)

European Space Programs

After World War II, the space race was on between the United States and Russia. European scientists were eager to join in, but could not compete on a national level. Their countries were simply too small to invest the research and funds into space exploration individually. In 1958, Pierre Auger and Edoardo Amaldi suggested a joint organization for space research. In 1960, 10 European countries joined forces to set up a commission that would determine the space exploration projects for Europe. In 1961, the European Space Research Organisation (ESRO) was born. The commission decided to set up the European Launch Development Organisation (ELDO) to develop a launch system and the European Space Research Organisation (ESRO to develop the spacecraft.

The ESA's Automated Transfer Vehicle-4 approaches the International Space Station.
NASA Images/Shutterstock

In 1975, the ELDO and ESRO merged to create the European Space Agency (ESA). The members of the ESA include Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, and the United Kingdom.

Although the ESA usually is plagued with delays and technical difficulties in getting its rockets completed, it excels at cooperation. The ESA has enabled cooperation between space agencies and was an instrumental part of the cooperation behind the International Space Station.

One achievement of the ESA is the Giotto space probe. The probe was able to examine the core of Halley's Comet in 1986. In addition, the ESA developed the Ulysses spacecraft that launched in 1990 to explore the Sun's polar regions.

The Indian Space Program

In 1969, India established the Indian Space Research Organisation (ISRO). The ISRO strives to provide the country with space services and to develop new technologies. ISRO has one of the largest fleet of communication satellites. These satellites are used all over the world to provide us with reliable communication.

Although ISRO has not sent a human into space, it has achieved 97 spacecraft missions and has 237 satellites in orbit. On February 15, 2017, ISRO had a record-breaking launch when it launched 104 satellites into orbit using one rocket. ISRO is an extremely resourceful organization and has been able to accomplish much on a limited budget. It successfully sent a probe to Mars and began testing a space shuttle that it fully designed and developed.

The Japanese Space Program

Japan was late to the space race, but is making up time! It went from never having launched a satellite, in 1969, to being an emerging space agency by 1994. The Japanese Aerospace Exploration Agency (JAXA) is a merger of the Institute of Space and Astronautical Science (ISAS), National Aerospace Laboratory of Japan (NAL), and the National Space Development Agency of Japan (NASDA). JAXA supports the government's overall effort to conduct space research and development.

JAXA's Earth Observation Center.
Studio 400/Shutterstock

The major accomplishments of JAXA include the Hinotori satellite. This satellite was Japan's first solar observation satellite and studied solar flares in 1981. The satellite was able to return the first ever x-ray images of a solar flare. JAXA continued its studies of solar flares and launched additional satellites in 1991 and 1995.

As you will read in an upcoming chapter, many of these organizations are working together to successfully operate the International Space Station (ISS). Space exploration continues to be an area of interest for many countries, and new developments are continuously being made that will push space exploration farther and farther into deep space.

CHECKPOINTS

Lesson 1 Review

Using complete sentences, answer the following questions on a sheet of paper.

1. Why is space important to US national interests?
2. What did the two-man flights of 1965 and 1966 demonstrate?
3. What did the space policy released in 2006 emphasize?
4. Why did the Soviets control their spacecraft from the ground?
5. What problem did Yuri Gagarin have during re-entry?
6. What was the goal of the Voskhod program?
7. What was the main goal of the Chinese space program when it launched?
8. What were the goals for Tiangong-1 and Tiangong-2?
9. Who are the "Big Six" in space exploration?
10. What did the ESA's Giotto space probe accomplish?

APPLYING YOUR LEARNING

11. How do you think space exploration efforts would have been different if international agencies did not work together?