San Diego Air & Space Museum’s
Space Pre-Visit Materials

Greetings from the San Diego Air & Space Museum’s Education Department! We want your museum visit to be as meaningful as possible. One way to help your students learn the most is to introduce them to the aerospace environment in the days preceding the visit.

This pre-visit packet offers background information for you and your students. Please notice the Kids’ History of Space Flight includes a timeline. We suggest making single-sided copies so students can connect the sheets end to end.

Additional aerospace-themed worksheets, puzzles, and other activities are available at our website in the Education Materials section, http://sandiegoairandspace.org/education/materials.php. These materials cover:

- History
- Science
- Language Arts
- Geography
- Mathematics
- Art

These materials are diverse and comprehensive, allowing you to prepare your students for their museum experience to whatever extent you desire.

As always, the Education Department wants to know how we can better serve you. Please contact us with any comments, suggestions or questions you may have.

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• A Brief History of Space Flight

In 1902, filmmaker Georges Méliès used the new medium of moving pictures to project his vision of *A Trip to the Moon*. Méliès’ characters were not the first – and certainly would not be the last - to make a fictional journey to the lunar surface; the possibility of space flight has inspired the human imagination for centuries. In the past 100 years, though, advancements in technology have turned the fiction of space exploration into fact.

The earliest recorded use of rockets was by the Chinese in a battle in 1232. “Fire arrows,” as they were called, were powered by gunpowder and used as incendiary weapons. Although the Chinese perfected the mechanics of their rockets through trial and error, no evidence suggests that they made a scientific study of the principals that governed them.

In 1687, England’s Sir Isaac Newton made an indirect but significant contribution to the science of space flight when he published *Principia Mathematica*. This famous work included his Laws of Motion, which explained the behavior of objects in motion and at rest. Although neither Newton nor his contemporaries realized it, the three laws formed the foundation of the laws governing the physics of space flight.

European nations experimented with rockets to a small degree during the next centuries, but no great improvement over the technology of 12th century China was made until 1802, when Englishman William Congreve began conducting rigorous tests on contemporary rockets. As a result of his research, Congreve designed rockets that were capable of a much longer range (1800-2700 meters) than their predecessors (450-500 meters).

The War of 1812, like many conflicts of the time, included the use of Congreve rockets as weapons. The British used them to bombard Fort McHenry, which guarded Baltimore Harbor, on September 14, 1814. “The rockets’ red glare” enabled Francis Scott key to see the American flag still flying over the fort throughout the night as he penned his famous poem, “The Star-Spangled Banner,” which was later set to music and became the United States’ official national anthem in 1931.

In the latter half of the 19th century, space travel became the subject of both creative and scientific thought. Jules Verne’s 1865 novel *From the Earth to the Moon*
One of Tsiolkovsky’s rocket designs

inspired many readers, including the Russian Konstantin Tsiolkovsky. In 1898, Tsiolkovsky developed a theory of liquid-fueled rocket propulsion that he believed could transport people into space. He published his ideas in 1903, the same year that the Wright brothers made their historic airplane flight at Kitty Hawk. Although Tsiolkovsky’s contributions were not seriously acknowledged until late in his life, they were significant and influential as the first scientific assessments of the possibilities of space flight.

America had its own “rocket man” in the early 20th century: Robert Goddard. With no knowledge of Tsiolkovsky’s accomplishments in Russia, Goddard validated his own theories with practical experimentation and in 1926 launched the first liquid-fueled rocket, which rose to a height of 12.5 meters. His experience with rockets were widely publicized, but the characterization most often given to him by journalists was that of a mad scientist who errantly believed humans could fly to the moon. Not everyone scoffed, though – from 1930 to 1945 Goddard’s efforts were supported first by the Guggenheim Fund for the Promotion of Aeronautics and later by the U.S. Navy.

While America alternately ridiculed and ignored Robert Goddard, the Germans paid attention. One man who did so, Wernher von Braun, worked for the German Army designing rockets to be used as military weapons. From his testing facilities in Peenemünde, von Braun developed the V-2, an explosives-carrying rocket based on Goddard’s designs that wreaked destruction on London during World War II. While working on the V-2 program, von Braun made no secret that he would prefer to be designing rockets for space travel rather than warfare.

After the war, a group of 120 German engineers including von Braun were relocated to America to work for the U.S. Army. At locations in White Sands, New Mexico and Fort Bliss, Texas, von Braun’s team researched and tested rockets designed for military use. In the early 1950s the group relocated to Huntsville, Alabama, where von Braun would eventually be able to concentrate on his first love, space flight.

At the same time, in the Soviet Union, Chief Designer Sergei Korolev and his team of engineers were developing rockets that could be used as guided missiles or launch vehicles for space craft. The success of their efforts stunned the world on October 4th, 1957, when one of their rockets launched Sputnik, the first man-made satellite to orbit the earth. In Cold War America, Sputnik became an unwelcome symbol of the U.S.S.R.’s seeming technology superiority and raised the specter of Soviet space domination. Americans clamored for their country to prove its own technical prowess by achieving space flight.
The Soviets’ success with Sputnik and with the launch one month later of another satellite – this one carrying a dog named Laika – created the public and governmental support for an American space flight program that had previously been lacking. Vanguard, the rocket slated to launch the first American satellite, had been undergoing and failing tests before Sputnik achieved orbit and was scheduled for another test on December 6\textsuperscript{th}, 1957. Word came from the White House, however, that this would be an actual launch. America needed to put a satellite into orbit as soon as possible. This decision was unfortunate, because Vanguard’s launch was an unmitigated failure. The four-stage rocket lifted 1.2 meters off its launch pad and then sank back down to earth before exploding.

As the press publicized the fate of “Kaputnik” and doom-saying government officials prophesied that losing the space race would mean the end of democracy, von Braun persuaded the government to accept the rocket assembly his team had designed as an alternative to Vanguard. On January 31\textsuperscript{st}, 1958, the Huntsville engineers used their Jupiter C rocket to launch America’s first satellite, Explorer 1.

The space race, however, was far from finished. As the Cold War heated up, space became a highly visible arena for the struggle for domination between the United States and the Soviet Union. To many who watched events unfold in the late 1950s, America often seemed a day late and a dollar short. This belief was strengthened on April 12\textsuperscript{th}, 1961, when cosmonaut Yuri Gagarin, aboard Korolev’s Vostok, became the first human in space, making one orbit of the earth. America’s immediate reaction to the Soviets’ achievement was mixed. The National Aeronautics and Space Administration (NASA) called for all-out philosophical and financial support of the space program, but President John F. Kennedy was initially ambivalent.

Within weeks, however, Kennedy reversed his position. Several factors influenced his decision to propose a massive increase in monetary and human resources allocated to the space program, but his primary concern was national prestige. The Cuban Bay of Pigs invasion, which occurred only five days after Gagarin’s flight and failed spectacularly in its goal of ousting Fidel Castro, the Cuban Communist leader, convinced Kennedy that America could not afford to rank second to the Soviets in any contest. He therefore accepted the recommendation of Vice President Lyndon B. Johnson that committing America to excellence in space exploration was a “strategic decision” that would improve public opinion of the administration and the nation both at home and abroad. In a speech to a joint session of Congress on May 25\textsuperscript{th}, 1961, Kennedy made the now-historic statement that America “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.” His remarks were the kick-off for a vastly increased American space program.

NASA focused its efforts on preparing for an eventual lunar landing. The Main goal of Project Mercury (1959-1963) was to put an American in space. Alan Shepard became that person on May 5, 1961, during a 15 minute sub-orbital flight that traveled 303 miles downrange from Cape Canaveral, Florida. Gus Grissom made a similar flight two months later. It was not until February, 1962, that an American, John Glenn, orbited the Earth. The remaining three manned Mercury flights progressively increased the amount of time spent in orbit.

Project Gemini (1963-1966) concentrated on establishing and perfecting procedures and techniques that would be necessary for a lunar landing mission. Astronauts in two-person spacecraft practiced spacewalking as well as rendezvous and docking in a series of ten earth orbit missions. Gemini also provided further opportunity to study the effects of weightlessness on the astronauts.

The Apollo program (1967-1972), which would eventually achieve Kennedy’s goal, had an inauspicious beginning. During a test of the Apollo system on the launch pad, a fire broke out in the spacecraft and killed astronauts Grissom, Roger Chaffee, and Edward White. Time was tight if the lunar landing deadline was still to be met, but NASA fixed the spacecraft flaws in an impressively short amount of time. During the first manned Apollo mission, Apollo 7, the crew performed tests in earth orbit of the spacecraft’s computer systems and offered assessments of the sleep schedule and food supply.

Apollo 8 took astronauts into lunar orbit for the first time. Crew members Frank Borman, James Lovell, and William Anders were the first humans to see the entire earth from space and to see the far side of the moon. They took hundreds of pictures and transmitted images for television broadcast. Their mission was second only to Apollo 11 in its impact on how humans viewed their world.

On July 20, 1969, Apollo 11 fulfilled the promise of nearly a decade’s work. Astronauts Neil Armstrong and Buzz Aldrin explored the lunar surface while Michael Collins orbited in the command module and millions on earth watched from their living rooms. NASA hailed the mission as an unqualified success, and it accomplished Kennedy’s goal of enhancing America’s technological reputation. There can be no doubt that landing humans on the moon was one of the most significant and technological accomplishments of the 20th century.

Subsequent Apollo missions allowed an additional 10 American astronauts to walk on the lunar surface. (Apollo 13’s lunar landing mission was abandoned after an in-flight explosion.) Public interest in and government support for the program,
however, was waning. NASA cancelled the final three proposed Apollo missions, and humans have not yet returned to the moon.

Having lost the opportunity to be the first in the nation to achieve a lunar landing, the Soviet Union directed its energy toward building and maintaining space stations. In 1971 it launched the world’s first space station, *Salyut 1*. Throughout the 1970s and 1980s, the Soviets continued improving and modifying their *Salyut* space stations.

Two years after cosmonauts lived on *Salyut 1*, American astronauts occupied the first American space station, *Skylab*. The *Skylab* and *Salyut* efforts both aimed to increase the amount of time astronauts and cosmonauts lived and worked in space. The Soviet space program developed the *Mir* space station in the 1980s while NASA worked on plans from an American space station called *Freedom*.

After the Cold War ended in the early 1990s, the two nations, along with 14 others, dedicated themselves to cooperating in the production of the International Space Station (ISS). The first components of the ISS went into space in November and December of 1998. And now provides living and working room for astronauts and cosmonauts on long-duration missions.

During the late 1970s, NASA developed the Space Transportation System, commonly referred to as the Space Shuttle, as a reusable vehicle. The first shuttle to fly in space, *Columbia*, was launched into orbit on April 12th, 1981, the twentieth anniversary of Gagarin’s orbital flight. Shuttles flew throughout the next three decades and provided an excellent opportunity for astronauts to conduct research in space. The shuttle program has experienced two major setbacks: the loss of the space shuttles *Challenger* and *Columbia*, along with their crews. They are still instrumental in the construction of the ISS, and NASA is now developing a new spacecraft that will replace it within the next decade.

The 20th century has witnessed remarkable progress in the arena of space flight. The subject of Méliès’ fantasy film in 1902 is now reality – humans have taken more than one trip to the moon. We have orbited the Earth and we have seen close-up photographs of every planet in the solar system. Space exploration has made innumerable contributions to human knowledge; perhaps one of the most significant is the new perspective it has given us on planet Earth.