

AEROSPACE MICRO-LESSON

Easily digestible Aerospace Principles revealed for K-12 Students and Educators. These lessons will be sent on a bi-weekly basis and allow grade-level focused learning. - AIAA STEM K-12 Committee.

NEIL ARMSTRONG

Best known as the first person to walk on the Moon, Neil Armstrong was a remarkable man in many other ways. He was a gifted pilot, flying fighter airplanes during the Korean War and a variety of high-performance research planes, and an insightful engineer whose technical mind made him an exceptional test pilot and astronaut. But who was Neil Armstrong and how did he end up as humanity's most famous space explorer? This lesson aims to answer this question by looking at Mr. Armstrong's life and achievements.

GRADES K-2

Neil Armstrong is one of the most famous Americans, and one of the most famous humans, to have ever lived. He will always be remembered as the first person to set foot on the moon—one of humanity's most impressive achievements to date.

Armstrong was born in a small town in Ohio called Wapakoneta on August 5, 1930. He was fascinated by flying from a very young age—although he was probably too young to remember the 1932 Cleveland Air Races (which he attended with his father), he took his first airplane ride at the age of six in a big plane called a Ford Trimotor. Neil, it seems, was hooked—he spent much of his childhood building and flying model airplanes. Even as a young child, Neil was curious and methodical. To make his model planes fly farther, he built a wind tunnel that helped him to study their flight characteristics. A wind tunnel uses a fan to move air through a long tube (hence the term “wind tunnel”). By placing objects in the tube, we can get an idea of how they will fly through the air; since they are suspended motionless in the wind tunnel, they are easier to study than things which are actually flying through the sky. Neil Armstrong's wind tunnel allowed him to refine his model airplane designs so that they could fly more efficiently and perform better.

Neil knew from his first airplane flight that he wanted to be a pilot, so he worked odd jobs to save up money so that he could learn to fly. When he was 14, he began taking flight lessons. Since they were expensive—\$9 an hour, the equivalent of well over \$100 an hour today—he worked at the local airfield, washing planes, cleaning hangars, and doing whatever he could to support his passion. All of his hard work paid off; he learned to fly before he could even drive a car, and was awarded his student pilot's license on his 16th birthday.

GRADES K-2 (CONTINUED)

Even while pursuing his passion for flight, Neil Armstrong continued to work hard in the other areas of his life. He was an excellent student who was accepted at some of the top universities in the country for aeronautical engineering and he also became an Eagle Scout. All of these accomplishments helped set Armstrong on his path to being an American hero.

GRADES 3-5

The first steps of Neil Armstrong's career were through the military. Armstrong enrolled in a scholarship program that paid for his college education in exchange for some service in the United States Navy. He began his studies at Purdue University, in Indiana, and after two years reported to Pensacola Naval Air Station, in Florida, for his military training. Although he had already learned how to fly before entering college, he still had to earn his wings (that is, become qualified) as a Naval Aviator. After qualifying to fly some of the Navy's propeller aircraft, Armstrong became the youngest officer in Fighter Squadron 51, an all-jet squadron in San Diego, California. At that time, the United States was fighting a war in Korea, so on June 28, 1951, Armstrong and his squadron set sail for Korea aboard the aircraft carrier USS Essex.

In Korea, Neil Armstrong flew 78 combat missions against the enemy. His second mission required him to make a low bombing run, flying close to the ground at over 300 mph. His airplane was damaged by anti-aircraft fire; while he was figuring out how to fly the damaged airplane properly, he accidentally flew it into a pole which sliced off the outside three feet of his right wing. When this happened, Armstrong was over enemy territory. If he had ejected from his airplane, he would have been taken prisoner by the North Koreans. If he had tried to land, the damaged airplane would have likely killed him. What Armstrong did was to fly his struggling airplane back to friendly territory and eject. He flew it out over a bay just offshore (so that when it crashed it wouldn't hurt anything on the ground) and ejected. He had planned to land with his parachute in the water and be picked up by a rescue helicopter, but the wind blew him back onto the land and a fellow Navy pilot drove a jeep over and picked him up.



GRADES 3-5 (CONTINUED)

When he finished his tour of duty in Korea, he was assigned to a transport squadron for a few months and then ended his full-time Navy service. Going back to college, he completed his bachelor's degree from Purdue University in 1955. While at Purdue, Armstrong continued to fly as a member of the Naval Reserves, flying propeller planes such as the FG-1D Corsair and F9F Panther at Naval Air Station Glenview (near Chicago) and Los Alamitos (in California). Armstrong closed the book on his Navy flying in 1957 to focus on his new job as a test pilot for the National Advisory Committee on Aeronautics – a government agency focused on advanced flight research that would pave the way for another famous organization—NASA.

GRADES 6-8

After finishing his bachelor's degree at Purdue University, Neil Armstrong accepted an exciting new job as a research pilot for the National Advisory Committee on Aeronautics, or NACA. NACA had been around since World War One and its scientists and pilots had been a driving force in many of the most significant technological advancements in aeronautics. By 1955, NACA was well on its way to trailblazing a wholly new era of flight research by building aircraft which flew far faster and higher than ever before, pushing the boundaries of aviation forward at a dizzying pace. In 1947, NACA (together with the Air Force and the Bell Aircraft Company) had made history by breaking the sound barrier, and within a few years research pilots flying for NACA had gone two and three times faster than the speed of sound. Other highlights included aircraft with variable-shape wings and completely new, alien-looking geometries. It's probably no coincidence that civilian reports of "unidentified" flying objects, or UFOs, began to increase in the area around NACA's flight research station in the California desert. This was the organization that Neil Armstrong joined in 1955. Although working as a civil servant offered less pay than flying for the Navy or for a big aircraft company, the combination of engineering work and advanced research was irresistible to Armstrong and he accepted a job at NACA's Lewis Field research facility (in Cleveland, Ohio) in 1955.

After flying for several months at NACA Lewis, Armstrong earned a transfer to the highly competitive and coveted facility at NACA's High Speed Flight Research Center, in Southern California. Here, Armstrong developed a sterling reputation as an excellent engineer and test pilot. At first, he flew chase planes, following research aircraft to make in-flight observations from a distance, and drop aircraft, which would carry research planes to high altitude before air-launching them. On one such flight, Armstrong and another

GRADES 6-8 (CONTINUED)

pilot were carrying a high-speed research plane to altitude in a drop aircraft. As they got ready to launch the rocket-powered plane, one of the drop aircraft's four engines started to fail. No sooner had they released the research aircraft than their engine exploded, damaging two of the other engines. The two pilots were fortunately able to rely upon their training to bring the huge, four-engine aircraft in for a landing with just one engine.

Armstrong played a major role in the development of several fighter aircraft as one of the lead test pilots for the so-called "Century Series" of aircraft. As his skills and experience grew, he was selected for increasingly challenging and unique assignments. His many contributions to flight research for NACA are too numerous to list here, but one of his most famous and most significant roles was as a test pilot for the revolutionary X-15 rocket plane.



The X-15 was so fast and so high-flying that it blurred the line between aircraft and spacecraft. Like many early X-planes, it was designed to be air-launched from a larger aircraft, but unlike any of its predecessors, it had such a powerful rocket engine that it was technically capable of reaching space. Pilots flying the X-15 had to learn how to maneuver the vehicle not only at high speeds, but at such high altitudes that there was no air for the conventional aircraft controls to work. To compensate, the vehicle was fitted with tiny thrusters that allowed the pilots to accurately control it in the vacuum of space. Armstrong flew seven flights in the X-15, helping to develop the aircraft's control system, among other things. Armstrong's flights in the X-15 helped to set the stage for the next stage of his career—although he had already earned a reputation as an outstanding aircraft pilot, the world was turning its eyes even higher than his rocket plane flights. NACA had been absorbed into a new agency, NASA, which needed pilots for a new adventure entirely—space exploration.

GRADES 9-12

Neil Armstrong was not initially selected as a NASA astronaut because only military test pilots were initially eligible and Armstrong was a civilian.

Armstrong instead worked on a project with the Air Force and Boeing to develop a spaceplane called the Dyna-Soar; however, when NASA began recruiting civilian astronauts in 1962, he nonetheless submitted an application. Based on his exemplary record, he was quickly selected as one of the “New Nine” — NASA’s second class of astronauts.



Armstrong’s first assignment as an astronaut was as the backup commander for the Gemini 5 mission, which was intended to develop the capability for one spacecraft to rendezvous with another spacecraft. Although Armstrong didn’t fly this mission, he spent a lot of time preparing for it and developing the skills to fly rendezvous maneuvers in space which set him up perfectly to be the prime commander of his own mission, Gemini 8, the next year. The objective for this mission was to not only rendezvous with another [unmanned] spacecraft, but to dock with it and mate the two vehicles together—the first time such a feat had ever been attempted. It was an ambitious plan, but the mission went awry and created one of America’s first major spaceflight emergencies. Armstrong was able to successfully rendezvous and dock with the target vehicle, but shortly thereafter the two spacecraft began to tumble out of control. When Armstrong undocked his Gemini space capsule from the target vehicle, it began to spin even more rapidly, reaching a peak rotation rate of approximately one revolution per second. At this speed, Armstrong and his copilot were pinned into their seats and almost incapacitated by the fast spinning. However, Armstrong fell back on his training as a test pilot and was able to use a backup control system to stop the spacecraft’s rotation and diagnose the problem—a faulty thruster. Although a larger crisis was averted, protocol required them to end the mission early and they safely splashed down on Earth. Although Armstrong and many of his colleagues were disappointed by the abbreviated mission, both he and his copilot received medals for keeping their cool under difficult circumstances.

Armstrong had another, eerily similar emergency a few years later as he was preparing for Apollo 11, his moon landing mission. A key part of his training was flying the Lunar Landing Training Vehicle—an ungainly, seemingly makeshift flying machine nicknamed the “flying bedstead” designed to simulate the flight characteristics of the lunar lander.

GRADES 9-12 (CONTINUED)

The LLTV relied on a downward-facing jet engine to produce enough thrust to cancel out 5/6ths of the vehicle's weight – thus mimicking the effect of the Moon's 1/6th gravity. The pilot would then use control jets to fly the machine around, getting a feel for the expected behavior of the lunar lander. On one such flight, Armstrong's LLTV started to veer out of control; after struggling to regain authority over the vehicle, [Armstrong ejected and parachuted to safety before the LLTV hit the ground and exploded](#). The post-accident investigation revealed that Armstrong's decision to eject happened at the last possible moment—if he had waited even half a second longer, he likely would have been killed.

Through these experiences, combined with his impressive resume as a research pilot, Armstrong developed a well-deserved reputation as an intensely analytical and intelligent pilot who could safely and effectively handle high-stress emergency situations. It was probably due in part to these traits that he was selected to command the first lunar landing mission, Apollo 11. Although everyone is familiar with the success of this mission, it, too, was nearly consumed by failure.

As Armstrong and fellow crewmember Buzz Aldrin descended towards the moon, their guidance computer flashed an unfamiliar “1202” error message (they learned later that they had left a switch in the wrong position and that was overloading the computer, giving it more work than it had time to do). In addition, the computer seemed to be guiding the craft towards a field that was strewn with boulders. If he landed there, it might tip over or otherwise damage itself. Taking control of the landing process over from the computer, Armstrong guided the lander toward a safer area. However, the lunar module's descent engine had a limited amount of fuel; if Armstrong depleted it, he and Aldrin would have no choice but to abort the landing and return to lunar orbit using the ascent engine.

Armstrong, displaying his typical sangfroid, was able to quickly select a landing site and guide the *Eagle* to a smooth touchdown with only seconds of fuel remaining. This last-minute intervention likely saved the mission and ensured that America's first moon landing succeeded on the first attempt.

To be able to face a difficult and dangerous situation takes both skill and bravery; Neil Armstrong had both of these traits in spades. His quick thinking and ability to stay calm under pressure not only ensured the success of his missions, but allowed him to become one of the most significant figures in the history of flight.

GRADES 9-12 (CONTINUED)

Like most real heroes, Neil Armstrong did not spend a lot of time thinking about his accomplishments. When asked about the Moon landing in later years, he would emphasize the efforts of the ten thousand people who had designed and built the rockets and assisted with the mission. Answering a question about his footprints on the Moon lasting for thousands of years, he replied that he hoped that somebody would “go up there and clean them up.”

Sixty Years Ago in the Space Race:

July 9, 1958: [A United States Thor DM-18 Able rocket carried a mouse named “Mia II” to an altitude of 990 miles.](#)

July 11, 1958: [The first test of the American Jason Argo E-5 five-stage sounding rocket ended in failure when the rocket reached a height of only 12 miles rather than the planned 500 miles.](#)