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The United States space program began as a response to Russia during the Cold War, but soon became an important part of American history. Advances in technology, medicine, and many other areas gave the program the validity the validity needed to continue to sustain itself. The pioneering spirit that naturally inspires humanity was kept alive through all the success and failures that were experienced during the early part of the program. The National Aeronautics and Space Administration (NASA) personnel that worked in those early days of the United States space program laid a foundation that was built upon for decades to come.

In 1949, the Soviet Union tested a nuclear bomb, and since the Americans had already proven their nuclear capabilities at Hiroshima and Nagasaki, the Cold War was officially underway. Another level of the Cold War was created when the Soviets launched the first space satellite, *Sputnik,* on October 4, 1957.[1] Questions loomed about the capabilities of this satellite: was it spying, or could it drop a bomb from space? Two weeks later the Russians launched another *Sputnik* satellite carrying a dog, proving outer space was livable. These satellites could orbit the earth in about ninety minutes; space was now a new battlefield of the Cold War.

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[1] John Lewis Gaddis. *The Cold War:A New History* (New York: Penguin, 2005), 68.

At the same time, Lyndon B. Johnson was a democratic senator who chaired the Senate Preparedness Investigation Subcommittee of the Senate Armed Services Committee. Concerned that the United States was falling behind the Soviets when it came to missile technology, Johnson called on Dr. Eilene Galloway, recent author of a paper published by the House of Representatives titled "Guided Missiles in Foreign Countries." Johnson used Dr. Galloway's assistance as he conducted meetings and investigations on how the United States could catch and surpass the Soviets in missile technology.[2] Many engineers and scientists testified, convincing Johnson and the committee that space should before advancing mankind in peaceful exploration, not as a place to conduct war. On July 28, 1958 President Eisenhower signed the National Aeronautics and Space Act, creating NASA.[3] It was determined that engineers, not military generals, would lead this particular government entity. Galloway also assisted in drafting the Committee on the Peaceful Uses of Outer Space, presented to the United Nations in November of 1958. This committee promoted the peaceful exploration and research of outer space in hopes that countries would collaborate instead of compete.

On May 2, 1944, a German rocket scientist named Magnus Von Braun approached an Army private on a motorcycle telling him, "My name is Magnus von Braun. My brother invented the V-2. We wish to surrender".[4] His brother, Wernher von Braun, was on the top of

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[2] NASA. *NASA: 50 Years of Exploration and Discovery* (Tampa, FL: Faircount Media Group, 2008), 226.
[3] Peter Bond. *Heroes in Space: From Gagarian to Challenger* (New York: Basil Blackwell, 1986), 26.
[4] William E. Burrows. *This New Ocean: The Story of the First Space Age* (New York: Random House, 1998), 116.

the military's list of German scientists wanted for interrogation, and he assisted the United States in gathering other German scientists sympathetic to the allies. The U.S. Secretary of State approved the transfer of von Braun and his team to the United States on June 20, 1945, where their Nazi association was expunged and they were provided with false employment histories. While most of them were taken to the Aberdeen Proving Grounds in Maryland, von Braun was taken to Ft. Bliss, Texas. The young von Braun was tasked with rebuilding and testing *V-2* rockets for research at White Sands Proving Ground in New Mexico. In 1950, von Braun was transferred to Huntsville, Alabama to work at Redstone Arsenal, where he lived and worked for the next twenty years. Between 1950 and 1956, he developed on the Redstone rockets, the rocket used in American's attempts to put the first man in space.[5]

During one early test of a Redstone rocket, the rocket fired but failed to launch. When the smoke cleared, NASA engineers could see the rocket still sitting on the launch pad; apparently it left the pad just enough for all the umbilicals to disengage and sever all control over the rocket. The escape tower on top of the rocket also ejected and landed several hundred feet from the launch pad, and the recovery parachutes fired and fully deployed. The wind was high enough for those parachutes to pull the top of the rocket hard enough for the rocket would tip over, which was extremely dangerous considering the rocket was still live and contained tons of fuel. After mulling over ideas on how to empty the rocket safely, with one of the most ridiculous being simply shooting holes into the fuel tank, it was finally decided to let the batteries of the fuel control system to run down and automatically open

[5] Alan Shepard and Deke Slayton, *Moon Shot: The Inside Story of America's Race to the Moon* (Atlanta: Turner Publishing, 1994), 31-34.

the release valves, thus emptying the rocket of its fuel. This "Four Inch Flight" fiasco prompted Flight Director Chris Kraft to say, "That is the first rule of flight control. If you don't know what to do, don't do anything!"[6]

Despite the lack of full confidence in the Redstone rocket, it was decided to rush the Mercury program along as the United States needed to catch up to the Russian space program very quickly, as they had already made Yuri Gagarin the first man in space. On May 5, 1961, Alan Shepard became the first American in space when he took a fifteen-minute ride on *Mercury 3*. While Shepard's flight was short and did not reach orbit like Gagarin did, it was still significant, not just because he was the first American in space, but also because the launch was carried live across the nation. The Russians were conducting their space operations in secret, yet the United States was conducing theirs in full view of the public.[7] After the successful launch of *Mercury 3*, John F. Kennedy made a speech in front of Congress on May 25, 1961 that would put the most pressure on NASA yet, as he made the proclamation that the United States would go to the moon before the end of the decade. This placed the most pressure on NASA yet, and although Gene Kranz initially believed that the President was crazy, he soon realized the President was showing full faith and trust in what they were doing at NASA.[8]

On February 20, 1962, NASA experienced their first crisis while a man was in space during the *Mercury 6* mission, the first orbit of the Earth by an American, John Glenn. The launch went just as planned and the first orbit could not have gone any better, but during

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[6] Kranz, *Failure Is Not an Option*, 28-32.
[7] Jay Barbree. *Live from Cape Canaveral: Covering the Space Race from Sputnik to Today* (New York: HarperCollins, 2007), 54-59.
[8] Kranz, *Failure Is Not an Option*, 56-57.

the second orbit, Mercury Control received a warning light indicating the heat shield might have come loose. The heat shield coming off during re-entry would be catastrophic, so NASA engineers discussed possible resolutions to this problem. More worrisome was Glenn's report of "a big mass of very small particles that are brilliantly lit up" floating around the spacecraft, leading some to wonder if the heat shield was already damaged. Chris Kraft thought the warning light was a false alarm, but to be safe the retro-rocket pack was left on instead of ejecting it before re-entry initialization. When Glenn asked why he was told to keep the retro-rocket package on during re-entry, the controller communicating with Glenn tells him that he does not have the answer, but assured him that there was nothing to worry about.[9] The communications blackout during re-entry, caused by the ionization of the capsule, created a very tense and silent four minutes, but Glenn came through the re-entry process unscathed, and the first real crisis for mission control was joyfully overcome. Later, the engineers discovered that the warning light was a false alarm, just as Kraft thought. This incident boosted the confidence of NASA personnel, increased their faith in the mission flight director, and led to four more Mercury launces, all of which encountered very few problems.[10]

On November 22, 1963, NASA's biggest supporter in the government, President Kennedy, was assassinated in Dallas, Texas. NASA decided the best way to honor his memory was to redouble their efforts and meet his challenge of reaching the moon during the 1960's.[11] However, NASA had to reach some very important milestones before beginning operations to reach the moon, including

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[9] M. Scott Carpenter et al. *We Seven* (New York: Simon and Schuster, 1962), 324-327.
[10] Kranz, *Failure Is Not an Option*, 76-77.
[11] NASA, *50 Years of Exploration and Discovery*, 229.

finding solutions to the problems of extra-vehicular activities (EVA), rendezvous and docking, prolonged human activity, and equipment endurance. Project Gemini played an important role in the history of United States manned space flight, providing NASA and the astronauts the chance to practice and perfect the activities needed to go to the moon. Gemini would be a two-man program, so no longer did astronauts go into space by themselves.

While NASA started the Gemini program, the Soviets beat the Americans with another "first" in space on March 18, 1965, when Alexei Leonov became the first human to conduct an EVA, or "spacewalk."[12] The Americans needed to respond, so during their *Gemini 4* flight on June 3, 1965, astronaut Ed White conducted the first American EVA. White exited the vehicle with no problem and was tethered to the spacecraft while using a handheld oxygen gun to help him maneuver around the spacecraft. Jim McDivitt even took a picture of a window that White had smeared on the outside of the Gemini spacecraft.[13] However, all did not go completely as planned because the voice activated communications system (VOX) on White's spacesuit failed to work properly, so commands had to be relayed from ground control to White through McDivitt. Despite the communications problem, all went to plan despite White having to be ordered twice to get back in the ship, before reaching the dark side of Earth; he was having too much fun.[14]

It was almost a year later on June 6, 1966 that Gene Cernan and Tom Stafford conducted the second NASA EVA during *Gemini 9A* (the "A" was added because the primary crew for *Gemini 9*, Elliot See

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[12] Bond, *Heroes in Space*, 77-79.
[13] Tony Reichhardt. "Ghosts of Gemini," *Smithsonian Air & Space*, (May 2012): 60.
[14] Burrows, *This New Ocean*, 358-359.

and Charles Basset were killed in plane crash a few months before their planned launch). The mission began badly because one of the goals was to dock with a target vehicle, but the shroud that covers the docking mechanism on the target vehicle did not eject, making it impossible to dock with the target. The second EVA was also going to test a new type of spacesuit made to go with a new piece of EVA equipment called the Astronaut Maneuvering Unit (AMU). When Cernan pressurized his spacesuit, it became so stiff that it was very difficult to move, and that was only the first sign of trouble. When he went to the back of the spacecraft to attach himself to the AMU, he noticed that the suit visor was fogging up, making it difficult to complete tasks.[15] All of this extra effort caused Cernan's heart rate to jump to over 170 beats per minute. Stafford and Mission Control cold hear his labored breathing and they decided to abort the EVA. This failed spacewalk led to a redesigned space suit that would also be water-cooled for lunar operations, decreased work load for the astronauts during each operation, and to not attempt to use the AMU until the Space Shuttle program. NASA also came up with the idea to practice EVAs underwater as it most closely simulated the zero gravity environment of space, a practice still used today. Later successful EVAs were conducted on *Gemini 10*, *11*, and *12*. During *Gemini 12*, with Edwin "Buzz" Aldrin and Jim Lovell, Aldrin would conduct three successful space walks on November 12-14, 1966.

Rendezvous was the next important step that needed to be accomplished, so engineers had to figure out how to launch two different spacecraft and then have them rendezvous in orbit with both spacecraft travelling around 17,000 miles per hour. The Russians had attempted this twice back in 1962 and 1963, but they were

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[15] Kranz, *Failure Is Not an Option*, 186-187.

unsuccessful. So, in 1965, NASA attempted to finally beat the Russians at something since the space race began. The first attempt at a rendezvous was when McDivitt and White tried to get their *Gemini 4* spacecraft to meet back up with the last stage of their *Titan* rocket. However, this was unsuccessful due to depth perception problems and the fact that the engineers at NASA just had not quite figured out the mechanics of orbital rendezvous yet. The next attempt was made a few months later on December 15 when Wally Schirra and Tom Stafford piloted their *Gemini 6* spacecraft to meet up with *Gemini 7*, which was already in orbit with Jim Lovell and Frank Borman. If all calculations were correct, *Gemini 6* should arrive in orbit just several hundred miles away from *Gemini 7*. After several burns to increase the speed of *Gemini 6*, they caught up with *Gemini 7* a little over 5 hours later, getting within 130 feet of each other. For the next several hours both spacecraft conducted several maneuvers to test the agility and control of the spacecraft at such close proximity, at one time getting within a foot. Americans had accomplished the first successful rendezvous in space and the morale at NASA enjoyed a huge boost.[16]

The next logical step was a successful docking to another spacecraft in space. This was probably the most important objective as the command module and lunar module would have to dock, undock, and re-dock with each other during a lunar mission. Neil Armstrong and David Scott were both on the *Gemini 8* crew that successfully conducted the first docking in space with another vehicle, the Agena target vehicle, on March 16, 1966. During that docking procedure, a thruster control problem arose with the Gemini spacecraft, and the rest of the mission had to be aborted. This was the first time that a NASA

[16] Shepard and Slayton, *Moon Shot*, 180-185.

manned vehicle had to return under emergency protocols.[17] *Gemini 10*, *11*, and *12* conducted further successful docking procedures, thus another prerequisite to moon operations was completed. The list of other objectives successfully completed from the Gemini program included breaking an altitude record for highest orbit, eight and fourteen day endurance records, and proving that actual productive work could be done during an EVA. Alongside the other accomplishments, Gemini was seen as a very successful program, and helped build up the confidence for all NASA personnel, and everything learned from the program served the next project that would send man to the moon.

While Gemini was being carried out, Wernher von Braun and his team worked on the Saturn-class rocket program for Project Apollo at Marshall Space Flight Center in Huntsville, AL. Von Braun had designed various sizes of the Saturn for the various stages of the launch vehicle, with the *Saturn V* being the main rocket to take the vehicle off the launch pad.[18] On January 27, 1967, the *Apollo 1* crew, made up of Ed White, Gus Grissom, and Roger Chaffee, conducted a drill commonly called the "plugs out test". It was basically a dress rehearsal among the flight controllers and astronauts to practice the procedures to take place for all pre-launch ground operations. The astronauts wore full spacesuits and were sealed into the *Apollo 1* command module, which was then pumped full of pure oxygen. There had already been problems with the command module design, as it changed more than 500 times, making it hard for the simulator engineers to keep up with the changes of the spacecraft. This frustrated Grissom so much that one day he hung a lemon on the simulator to represent its uselessness.

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[17] Slayton, *Deke!*, 169-171.
[18] Barbree, *Live from Cape Canaveral*, 97-98.

During the test run on January 27, they discovered even more problems, with the most important that evening being the communications system. The astronauts and flight controllers had a very difficult time understanding each other, and Grissom asked, "How are we going to get to the Moon if we can't talk between three buildings?"[19] This caused many delays of the simulation countdown, and the drill to run into the evening hours. Then, at 6:31 PM, "Go Fever" caught up with NASA as alarms went off all over the flight control room. Controllers heard the astronauts say something about a fire before all communications went dead, while the flames swept through the command module and killed all three astronauts within a matter of seconds. The first casualties directly related to the United States space program became an unfortunate part of NASA's history and their feeling of invincibility was gone.

The following Monday, Gene Kranz called the flight control team for a meeting, where he gave the following speech:

> Spaceflight will never tolerate carelessness, incapacity, and neglect. Somewhere, somehow, we screwed up. It could have been in design, build, or test. Whatever it was, we should have caught it. We were too gung ho about the schedule and we locked out all the problems we saw each day in our work. Every element of the program was in trouble and so were we. The simulators were not working, Mission Control was behind in virtually every area, and the flight and test procedures changed daily. Nothing we did had any shelf life. Not one of us stood up and said, "Dammit, stop!" I don't know what Thompson's committee will find as the cause, but I know what

[19] Rod Pyle. *Destination Moon: The Apollo Missions in the Astronaut's Own Words* (New York: HarperCollins, 2005), 13.

> I find. We are the cause! We were not ready! We did not do our job! We were rolling the dice, hoping that things would come together by launch day, when in our hearts we knew it would take a miracle. We were pushing the schedule and betting the Cape would slip before we did. From this day forward, Flight Control will be known by two words; tough and competent. Tough means we are forever accountable for what we do or what we fail to do. We will never again compromise our responsibilities. Every time we walk into Mission Control, we will know what we stand for. Competent means we will never again take anything for granted. We will never be found short in our knowledge and in our skills. Mission Control will be perfect. We will never stop learning. When you leave here today, you will write these two words on your blackboard and they will never be erased. They will serve as a constant reminder of the sacrifice of Grissom, White, and Chaffee. These words will be the price of admission into Mission Control.[20]

The Thompson Committee conducted their investigation and discovered that faulty wiring had short-circuited in the pure oxygen environment, causing a flash fire that had consumed the capsule within a matter of seconds, giving the astronauts no time to react and no chance of escaping. The committee also determined that the contracted work was shoddy, and the program was grounded until the spacecraft could be redesigned and rebuilt to make it safer.[21]

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[20] Kranz, *Failure Is Not an Option*, 204.
[21] Pyle, *Destination Moon*, 17-18.

The Apollo program resumed nearly two years later on October 11, 1968 *Apollo 7*, when Don Eisley, Wally Schirra, and Walt Cunningham, launched into orbit. This marked the first manned launch of the program and the first time three men were sent into space. The mission had no complicated operations to conduct, but was meant to simply boost confidence booster and test out the new spacecraft. The mission lasted eleven days and the tension between the astronauts and Mission Control became thick, and it did not help that Shirra had developed a head cold while in space. There were a few contentious exchanges between the astronauts and flight control, ranging from complaining about the type of food to the necessity of wearing their helmets during re-entry. The latter was brought up because Schirra was afraid he would not be able to equalize the sinus pressure if he could not hold his nose to clear his sinuses, and possibly blow out his eardrums. Still, despite the astronauts' problems, the spacecraft itself performed as desired.[22]

It was not long after *Apollo 7* splashed down that CIA photos revealed that the Soviets had a moon rocket ready for launch for a flight that would orbit the moon. NASA was about a year away from that type of mission, but there was political pressure to beat by the Russians, so the time frame was accelerated. *Apollo 8* was the first spacecraft to reach the moon and the first time the *Saturn V* rocket saw use.[23] The *Saturn V*, nearly thirty-stories tall, was so powerful that it needed a six-story pit to deflect the flames or otherwise the rocket could burn itself up during launch; the launch was so powerful that it created one of the loudest man-made noise ever created, second only to

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[22] NASA. *Apollo 7 Onboard Voice Transcription* (Houston, TX: Johnson Space Flight Center, 1968), Microfilm, p. 276.
[23] Shepard and Slayton, *Moon Shot*, 225-228.

nuclear explosion.[24] *Apollo 8* launched on December 21, 1968 at 6:51 AM with Frank Borman, Jim Lovell, and Bill Anders aboard the spacecraft. Then two hours and fifty minutes later, humans left the orbit of earth and headed for deep space for the first time. The engine burn needed to be just right or the spacecraft could fly out of the solar system or crash right into the moon. The burn succeeded and three days later, on Christmas Eve, lunar orbit is successfully accomplished. During one of the ten orbits of the moon, the crew read the first ten verses from Genesis 1 to a live television broadcast, resulting in a few watery eyes in Mission Control.[25] Later in March and May of 1969, *Apollo 9* and *Apollo 10* launch respectively, in which their missions were successfully completed by testing the lunar module (LM) while in orbit of the moon.

On July 16, 1969, *Apollo 11* launched with Michael Collins, Buzz Aldrin, and Neil Armstrong as the crew; three days later the crew reached lunar orbit. The next day, on July 20, the mission of the day was to make an American the first human to set foot on the moon. Gene Kranz locked the doors of Mission Control and told his staff that nobody could come in or leave during the operation, and he would support any decisions made that day, assuring them that "No matter what happens today, we will all leave this room as a team."[26] The lunar module detached from the *Apollo 11* command module, starting its descent to the lunar surface with Armstrong and Aldrin on board. Then, at 12:01 PM, a "12-0-2" warning light flashed in Mission Control and there was confusion among the controllers about what it meant. Moments later, a "12-0-1" light also flashed, and an engineer

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[24] Kranz, *Failure Is Not an Option*, 201.
[25] Pyle, Destination Moon, 25-28.
[26] Kranz, *Failure Is Not an Option*, 283-284.

remembered that the same exact warning light that came on the navigation computer during the last simulation. Believing the light to be another false alarm, and lacking time to deliberate about the issue, Mission Control issued a "go," but by the time, the lunar module overshot the planned landing zone.[27]

Armstrong, running out of fuel, saw nothing but boulders and deep craters with nowhere to land safely in sight. Kranz issued an order for no more "call outs" except for fuel levels. Moments later, Bob Carlton made a fuel call of "low level," meaning the tank on the lunar module was virtually empty and the lunar module was running on whatever fuel was in the system. The next fuel call out was for sixty seconds of fuel left, then a thirty-second fuel call out when Armstrong reported he was picking up dust, confusing Mission Control. The crew then heard the shutdown sequence just as fifteen-second call out. With zero seconds of fuel left, Mission Control hears, to their surprise, "Houston, Tranquility Base here. The *Eagle* has landed."[28] The whole room erupted into cheers as they realized that the lunar module was safely on the surface of the moon. Kranz ordered everybody to settle down and refocus because the decision to stay on the moon still had to be made. Armstrong and Aldrin were ordered to stay and get a good night's sleep before the lunar EVA the next day, but both were too excited to sleep and bugged Mission Control to begin their lunar excursion early the next day. On July 21, 1969 Neil Armstrong was the first human to set foot on the moon, where he uttered the now famous statement, "That's one small step for (a) man, and one giant leap for

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[27] Slayton, *Deke!*, 243.
[28] Burrows, *This New Ocean*, 428.

mankind." When Buzz Aldrin exited the craft almost twenty minutes later, he described the moon as "magnificent desolation".[29]

After the successful *Apollo 12* mission, *Apollo 13* launched on April 11, 1970 with space flight veteran with Jim Lovell as commander, and Fred Haise, and Jack Swigert as pilots. Fifty-six hours into the flight, Mission Control called for a "cryo-stir", intended to stir up the super cold liquid oxygen mixture in a tank. However, the "cryo-stir" caused the whole spacecraft to shutter, and Mission Control was told "Houston, we've a problem here." At first, Haise believed the shuttering was caused by a temporary power failure due to a small meteorite hitting the spacecraft. Because the spacecraft was vibrating violently, Lovell decided to look outside and noticed that the ship was venting some type of gas into space from the command module, causing the ship to rotate wildly. The astronauts discovered they were losing oxygen from the spacecraft from a faulty wire that caused an explosion in the liquid oxygen tank. [30]

The first thing Kranz ordered the engineers to do was to devise a way to reclaim oxygen for the astronauts. They still had enough oxygen to get home, but they needed to filter the carbon dioxide out of the air. The problem was that the lunar module was meant for two men, not three, so the carbon dioxide levels would increase quickly. The other immediate problem was that the command module was losing power and would not have enough to return home. John Aaron ordered the command module to power down to save the emergency batteries needed for re-entry. The crew moved into the lunar module, now their

[29] Pyle, *Destination Moon*, 54-59.
[30] Shepard and Slayton, *Moon Shot*, 260-261.

lifeboat. Mission Control's only objective at this point was to get the crew back home.[31]

It took three days to design a cold start-up sequence that would work. When the crew jettisoned the command module from the capsule before re-entry, they saw the giant hole that resulted from the explosion. Lovell exclaimed, "There is one whole side of that spacecraft missing!"[32] They realized the hole was just a few feet from the heat shield on the capsule, and they feared that the heat shield cracked. This could result in catastrophe for the astronauts during the re-entry operation, but at this point, nothing could be done about it. The *Apollo 13* capsule began re-entry and the normal four-minute communications blackout came and went with nothing heard from the crew. Joe Kerwin was at CapCom (the controller, usually another astronaut, that communicates with the crew) and hailed the spacecraft when the communications blackout should have ended, but to no avail. Mission Control feared the worst until the words "Okay Joe!" flooded into Mission Control. [33] The first major disaster in space for NASA was averted. It was NASA's finest hour; failure was not an option for the engineers during *Apollo 13*.

The later Apollo missions went on without any more significant problems. *Apollo 14* was the first lunar landing involving two EVAs, commanded by the oldest and most veteran astronaut of the program, Alan Shepard. While Shepard and Edgar Mitchell were on the surface collecting samples, Stuart Roosa was in the command module conducting experiments with seeds while in lunar orbit. *Apollo 15* stayed even longer on the moon, almost three days, and was the first to

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[31] Kranz, *Failure Is Not an Option*, 316.
[32] Slayton, *Deke!*, 261.
[33] Kranz, *Failure Is Not an Option*, 335-336.

use the Lunar Roving Vehicle, which allowed the astronauts to travel further away from the lunar module. *Apollo 15* was the first mission of NASA that focused purely on collecting scientific data. *Apollo 16* was the first to land on the lunar highlands and stayed the longest so far, less than an hour short of three complete days on the surface of the moon. *Apollo 17* was the final manned mission to the moon that launched on December 11, 1972 and returned on December 19. The mission took a geologist, Harrison Schmitt, and broke records for total stay on the lunar surface: three days and two hours, with the total EVA time on the moon at twenty-two hours. The mission also brought back the biggest sample of moon material of all the Apollo missions.[34]

The Apollo program showed NASA at their best and worst, but it proved that with the right attitude the program could accomplish great things. The courage and fortitude it took for astronauts to step into those giant rockets, not knowing if they would ever be able to return from the lunar surface if they did make it there, was unimaginable. The United States not only reached the moon before the Russians, the Soviet Union never put a man on the lunar surface, though they did launch unmanned spacecraft that successfully orbited and landed on the moon.[35] The scientific data about spaceflight and the data collected from the moon is some of the most important ever collected in the history of space exploration, and material collected from those Apollo missions are still studied and scrutinized by scientists today.

Though the Apollo missions to the moon ended with *Apollo 17*, the Apollo program lived on with two more projects. The *Apollo-Soyuz* test project and *Skylab* played important roles in the continuation of space exploration at NASA. Since the Apollo lunar missions had

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[34] Launius, *Frontiers of Space Exploration*, xxiv-xxv.
[35] Shepard and Slayton, *Moon Shot*, 226-227.

been cut short due to cutbacks by Congress, there was a surplus of Saturn engines and spacecraft that could still be used for other potential flight operations. It was proposed to convert the third stage of a *Saturn V* rocket into a space station that for experiments that included the study of long term space flight on the human body. After much discussion, Congress gave their final approval and the *Skylab* program was born. On May 14, 1973 the first station for the United States launched into orbit.[36] The information gained from *Skylab* was influential in the planning of the Russian *Mir* station and the *International Space Station*. The Skylab spacecraft stayed in orbit until 1979, when it was sent into a forced entry and burned almost completely in the atmosphere.

There was one more Apollo mission that did not go to the moon, but was arguably as important as any mission to the moon. That project was called *Apollo-Soyuz*, a joint space mission involving the United States and the Soviet Union during the Cold War. Besides trying to improve relations between both nations, the goal of the mission was to test the compatibility of NASA and Russian spacecraft for a space rescue if it was ever necessary. There was also the outside chance that there could be future joint manned space flights.[37] On July 15, 1975 an Apollo rocket with Tom Stafford, Deke Slayton, and Vance Brand launched into orbit. In the Soviet Union, *Soyuz 19,* manned by Valeriy Kubasov and Alexei Leonov, launched on the same day seven hours before. NASA designed a coupling system for docking the two spacecraft, and the pride of the United States and its space program was on the line. There were some concerns among NASA pilots as to how well the Russian pilots could execute a space dock, as

[36] Barbree, *Live from Cape Canaveral,* 200-201.
[37] Burrows, *This New Ocean,* 447-448.

NASA had much more experience with rendezvous and docking in space due to the Gemini and Apollo programs. American astronauts were able to pilot their spacecraft while *Soyuz* spacecraft was automatically flown with very little input from the crew.[38] Deke Slayton was one of the original seven Mercury astronauts, but due to a medical condition with his heart, he had not ever been cleared to fly during the Gemini and Apollo missions. However, he was able to get his condition treated and passed the flight surgeon's test that returned him to active flight status. The fifty-one year old was the oldest NASA rookie ever, and when Deke finally reached orbit, he excitedly exclaimed, "I love it! Damn, I love it. It sure as hell was worth waiting sixteen years."[39] A few hours later Tom Stafford successfully docked the Apollo spacecraft at 17,400 miles per hour and live television audiences around the world watched both spacecraft open their hatches for Stafford and Leonov to shake hands.

When that *Apollo-Soyuz* mission was over, an era of space exploration ended for NASA. A few years later the first Space Shuttle, *Columbia*, launched John Young and Robert Crippen into orbit on April 12, 1981. The successes and failures of Projects Mercury, Gemini, and Apollo would laid the foundation for future space programs such as the Space Shuttle, the *International Space Station*, and the exploration of Mars. Those earlier programs proved that ingenuity and perseverance could overcome just about any obstacle placed in front of humanity. There was no challenge too hard and no problem too big to overcome. Unfortunately, Gene Kranz's speech after the Apollo tragedy did not stick with the next generation of NASA personnel, who suffered their own tragedies in the Space Shuttle

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[38] Slayton, *Deke!*, 283.
[39] Barbree, *Live from Cape Canaveral*, 206.

Challenger and *Columbia* disasters. Yet, even after those calamities the newer generation imitated their predecessors by picking themselves up, honoring those that fell, and learning from their mistakes.