Air and Space this Week

Item of the Week

Neil Armstrong and the Flight of *Gemini 8*

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(Almost) everyone is familiar with Neil Armstrong as the first person to set foot on the Moon. However, it was not his first time in Space, nor was it the first time he faced danger aloft. He also was the command pilot of Gemini 8, along with fellow rookie Dave Scott; ***the launch date was March 16, 1966, 54 years ago today****.*

Neil Armstrong was born in Wapakoneta, Ohio, on August 5, 1930. He enlisted in the Naval Reserve on August 25, 1947, in a seven-year program that would provide two years of classroom instruction at Purdue University, followed by flight training and active duty before returning to Purdue to complete his degree and be commissioned. It didn't quite work out that way. He went on active duty on February 16, 1949, earning a commission as Ensign on February 24, 1951. He was a naval aviator from 1949 to 1952, flying a total of 78 combat missions during the Korean conflict. His commission ended on February 25, 1952, after which he returned to Purdue to finish his aeronautical engineering degree. He would also acquire an MS in Aerospace Engineering from USC.

Armstrong's first brush with great danger came in Korea. He had been assigned to the *USS Essex*, flying an F9F Panther attack aircraft in VF-51. On a ground-attack mission on September 3, 1951, he destroyed his target bridge using a very low-level attack, but as he started his recovery from the bombing run, he hit an anti-aircraft cable, neatly slicing off the end of his right wing. Armstrong struggled to control his jet, and could do so after a fashion, but had to maintain high speed to do so – too fast (and too uncontrollable) for a carrier landing. ***His plane was becoming progressively-difficult to control, but he was able to make it to Marine-held territory, over which he ejected***.

Ejection seats were really dangerous, especially in those days. A number of pilots, including Neil's wingman on some missions, the famed baseball player Ted Williams, said they weren't going to "commit suicide to avoid getting killed," as test pilot Chuck Yeager would later describe ejecting. The g-forces on a pilot ejecting, even at sub-sonic speeds, were enormous; Neil would have to survive brief exposure to 20+ g's. His flight leader stayed with him, and he made it down OK, landing in a rice paddy. A Jeep drove up to effect rescue, and Armstrong was very surprised to see it was driven by Goodell Warren, one of his roommates from flight school.

Armstrong joined NACA (NASA's predecessor organization), starting out at the Lewis Research Center outside of Cleveland (Lewis was originally a NACA lab devoted to propeller research, now it is known as the Glenn Research Center, where Venus landing technologies (among many other things) are being researched). He then went to Edwards AFB, where he was a program pilot for the X-15 program, and flew many different models of other high-performance aircraft.

The F-104 Starfighter now in the collection of the National Air and Space Museum was one of the aircraft he flew. NASA was using this particular aircraft to study systems and train pilots for the X-15. Armstrong was one of three (of 19) pilots to fly the X-15 who attained an altitude high enough to qualify them for "Astronaut" status. But even flying a Starfighter on a more "routine" flight profile was dangerous; it was also known as the F-104 ***Widowmaker***…

Armstrong's next exposure to real danger in the air came on Friday, April 20, 1962, at the controls of an X-15. He would take it to Mach 6+ and over 200,000 feet that day. The typical mission profile for the X-15 program would have the rocket plane attached to a B-52 mother ship that would fly out over northern Nevada, where the X-15 would be released. It would fire its rocket engine until his fuel was exhausted, climb steeply to extreme altitude, then deadstick all the way to Edwards, dropping the lower half of its tailplane before landing on skids on the dry lakebed. One of the objects of Armstrong's mission was to test thrusters fitted to the X-15 for use when it was too high for there to be enough air for its conventional control surfaces to be effective. He was also testing a new automatic piloting aid, which caused extra lift and was dangerously extending his glide ("lift" is generous, the X-15 was a brick with itty-bitty tiny wings). He overshot Edwards and sailed high over the San Gabriel Mountains, over Pasadena, before getting low enough to steer the aircraft. He was able to turn, coast back over the San Gabes, then land at Rosamond Lake, just south of Edwards. His extra southerly excursion made the ground track and time aloft for this flight to be the longest of any of the other 198 flights in the X-15 program.

Being a ground attack pilot in Korea was dangerous work (27 *Essex* pilots from his cruise were KIA), but was comparatively a no-danger zone compared to being a test pilot at Edwards. In one bad nine-month period in 1952, ***62*** test pilots died there in flight test.

Armstrong applied for the NASA Astronaut Program, and in 1962 he was selected for Astronaut Class #2. He and fellow space rookie, Dave Scott, were assigned as Mission Commander and Pilot, respectively, of *Gemini 8*.

Project Mercury's mission was to develop the technology necessary to launch an astronaut into LRO, low Earth orbit. The capsules and life support systems were primitive, but since the longest Mercury flight was only 22 orbits, that was OK. The first two flights were sub-orbital, using an Army Redstone rocket (developed for delivery of tactical nukes). The Redstone was too small to put a man-size capsule into orbit, but the leading ICBM coming online then was. The Atlas missile was much more robust, and after some teething troubles (***see below***), it was used to launch successfully the next four Mercury missions (Glenn, Carpenter, Schirra, and Cooper). The capsule's simplicity and short mission durations helped keep in-flight problems to a minimum. Perhaps the worst (most worrisome) malfunction was a false loose heatshield indicator on John Glenn's historic flight).

A number of in-flight maneuvers would be required for the Apollo Moon missions, and working them out was one of the principal objectives of the Gemini program. The first few flights were system checkouts, primarily. Ed White made the first US Space walk on *Gemini 4*, Armstrong served as back-up commander for *Gemini 5* (along with Eliot See, who would soon die in an airplane crash), and *Gemini 6* and *7* conducted the first rendezvous in Space. The mission of *Gemini 8* would be two-fold, it would not only rendezvous with a separately-launched target vehicle, it would dock with it, and essential requirement for Apollo (if we were to get the Moon walkers back home!). The mission task list also included an extended Space walk by Scott.

Thrusters again became a cause of great danger for Armstrong. *Gemini 8* launched without difficulty on the morning of March 16, 1966. Rendezvous with the *Gemini Agena Target Vehicle* was made without problem by late that afternoon. At 5:14 EST, a successful docking took place, the very first time a docking had been accomplished. Things were fine at first, but as Armstrong started to steer the combined craft, it started to roll around its pitch axis. Armstrong could use his thrusters to compensate at first, but when they undocked from the *GATV*, the roll rate increased dramatically, spinning up the capsule to ~1 revolution per second, a dizzying and disorienting rate. A thruster had stuck in the full-open position, but Armstrong was able to disable the automatic thruster control system and manually stabilize the capsule. Scott was most impressed, saying "The guy was brilliant. He knew the system so well. He found the solution, he activated the solution, under extreme circumstances ... it was my lucky day to be flying with him." [source]

Armstrong's effort to restore stability used up much of the thruster fuel available for the mission. NASA rules mandated an immediate return to Earth, since those thrusters were an important part of a safe re-entry. Scott's EVA and the other planned experiments were cancelled. Instead of using the prime landing zone, where most of the recovery ships were stationed, *Gemini 8* came down off Okinawa instead. The *USS Mason* safely picked up the astronauts at 1:28 AM EST on 3/17, but it was daylight there.

Gemini 8*'s aborted mission was the first real in-flight calamity and was a real test of capsule design and component redundancy.* Some criticized the performance of Armstrong and Scott, but Gene Kranz was very satisfied. Others must have agreed, because Armstrong was named the back-up mission commander for *Gemini 11* two days later. NASA would give both astronauts its Exceptional Service Medal, and Scott received a promotion to USAF Lt. Colonel, and was awarded the Distinguished Flying Cross. Neil even got a raise, becoming NASA's highest paid astronaut (at a whopping $21,653 per year!). Of course, his travel budget would be kinda large ….

The prime crew handled the flight of *Gemini 11* well, with Armstrong serving as CAPCOM.

Armstrong was assigned as back-up mission commander for *Apollo 8*, and was slated to command *Apollo 11* after that. Michael Collins was assigned to *Apollo 8*'s prime crew, but he required back surgery and was replaced by James Lovell. Collins slipped to *Apollo 11*, joining Armstrong and Buzz Aldrin. Armstrong was given the choice of Aldrin or Lovell, and stayed with Buzz; Lovell went on to command *Apollo 13*…

Landing the Lunar Module was going to be a delicate task, and one difficult to train for. Those astronauts slated for the Moon landings practiced vertical flight in helicopters, but a morerealistic training vehicle was needed. ***And herein did danger in the form of thrusters and control systems strike again***.

NASA contracted Bell Aerospace to design and build a *Lunar Landing Research Vehicle*, an ungainly thing held aloft by a downward-thrusting turbofan and steering by small lateral thrusters. It was notoriously difficult to fly, and because it was low and slow, it was very dangerous. Good thing that it had an ejection seat, too, because Armstrong had to use it on May 6, 1968. Had he ejected a half-second later, somebody else would have been first to step on the Moon.

I won't go into his exploits on *Apollo 11*, referring you to the many books, videos, and other resources covering the flight.

Armstrong remained with NASA only a year or so after walking on the Moon. He taught for a decade at the University of Cincinnati, and served in a variety of business capacities. Unlike Buzz, Neil shunned the limelight of fame. He wasn't a recluse, but he did keep a low profile, and only rarely took advertising/spokesperson gigs.

He was part of the Rogers Commission, investigating the loss of the Space Shuttle *Challenger*.

Armstrong, like Apollo 12's Alan Bean, was of Scottish heritage, and like Bean, he was very proud of it. He visited the ancestral home of the Clan Armstrong, Langholm, in 1972. He was made the first "freeman of the burgh." However warm Neil's reception was, it was apparently much better than at least one other of Armstrong's forebearers might have received. The local Justice of the Peace read Neil an unrepealed 400-year-old law that required him to hang any Armstrong found in the town!

Armstrong also enjoyed pilot a sailplane, and became very proficient at it, flying one well into his 70s.

Armstrong was badgered by many for autographs etc. in later life. He guarded his name, likeness, and signature to keep them from being used commercially without his consent. He even had to sue his barber, who had collected and sold his hair clippings! Armstrong won, and the barber had to donate his gains to charity.

There is one other item of note, one few people know about: In 1985, Armstrong joined explorer Mike Dunn, and a number of famous explorers (Sir Edmund Hillary, Hillary's son Peter, Steve Fossett, and Patrick Morrow), on an expedition to the North Pole, arriving there on April 6. Armstrong did not inform the press of this trip, but did say that "he was curious to see what it looked like from the ground, as he had seen it only from the Moon." [source]

Armstrong suffered a mild heart attack in February, 1991. He underwent by-pass surgery on August 7, 2012, but complications set in, and he passed away on August 25. His family invited curators from the National Air and Space Museum to acquire a number of items of his personal memorabilia. Upon their return, Armstrong's widow called back about a handbag filled with Apollo items he had told no one about. It's now called the Armstrong Purse, and it contained a number of important historical items.

And it was all possible because Armstrong kept his cool and solved a tough problem under very difficult conditions 54 years ago.

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Atlas missile teething pains

The Atlas missile was the first American-made rocket that could carry a nuclear warhead over long distances, coming into service in the very late 1950's. The propulsion system was working well, but early versions of the Atlas, when configured with a dummy nuclear warhead, had a nasty habit of breaking up when the missile crossed the speed of sound. Needless to say, this was a rather undesirable feature on the Nation's would-be primary delivery system, so the remedy budgeting was rather generous. NASA Ames Research Center had a great variety of aeronautical research wind tunnels, so it got the call to find out and fix the problem.

Two approaches were used: wind tunnel modeling and brute-force experimentation. One of the world's largest vacuum chambers was built to hold an Atlas and its supporting gantry and equipment and put them in an environment that matched conditions where the missile breakup had been occurring, as much as possible. The resulting building,"242 Structural Dynamics Lab," is quite impressive. It was built on a 36" floating, multiply steel-reinforced, concrete pad. The lower portion of its 100’ height had 36” walls of similarly-top grade concrete, tapering to 30” near the top of the tower. Its primary access door was 40’x40’, mounted on a railroad carriage set in a trench on the side of the building. An 8-ton forklift was required to move it because it had to be heavily-constructed enough to withstand 15 PSI over its surface area (about 1.5 million pounds in total). The pump to pull a vacuum on that huge volume covered a city block, and, when operated at maximum capacity, it used as much natural gas as a town of 80,000 homes, in winter. (It was later converted to run jet fuel, at a considerable energy savings.) The Atlas’ body was a pressure-stabilized monocoque design; the missile’s strength was strongly dependent on it being full of fuel; it would collapse under its own weight if laid on its side empty. The Atlas used in the testing was pressurized with nitrogen gas to provide the strength necessary for handling it. The missile was mounted on four gigantic hydraulic shakers, to simulate the turbulence of going supersonic, and acoustic waves and heat could be blasted at the missile during the test.

Of course, the wind tunnel guys solved the problem long before the building was completed!

The problem was the design of the fairing (cover) of the warhead. A separation of airflow was occurring from the nose of the faring, and the airflow “reattached” on the side of the warhead. However, the point of reattachment was not stable, it would oscillate back-and-forth. Transonic turbulence enhanced the instability to the point that the lateral difference in forces would rip the warhead off the booster.

The pump system has been used since then in the conduct of experiments all over the Lab, so it wasn’t a total waste. Far from it. Further, it could easily lower the air pressure in the chamber to that of the surface of Mars. A MARS WInd Tunnel (MARSWIT) was constructed, and used for years to experiment with the wind speed needed to move sand-sized material on Mars, how fast the dunes and wind streaks we were finding there might move, and how surface rocks might become wind-abraded over time. I was fortunate enough to operate this facility in 1981-82, and conducted much of my M.S. and Ph.D. research there.

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