NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

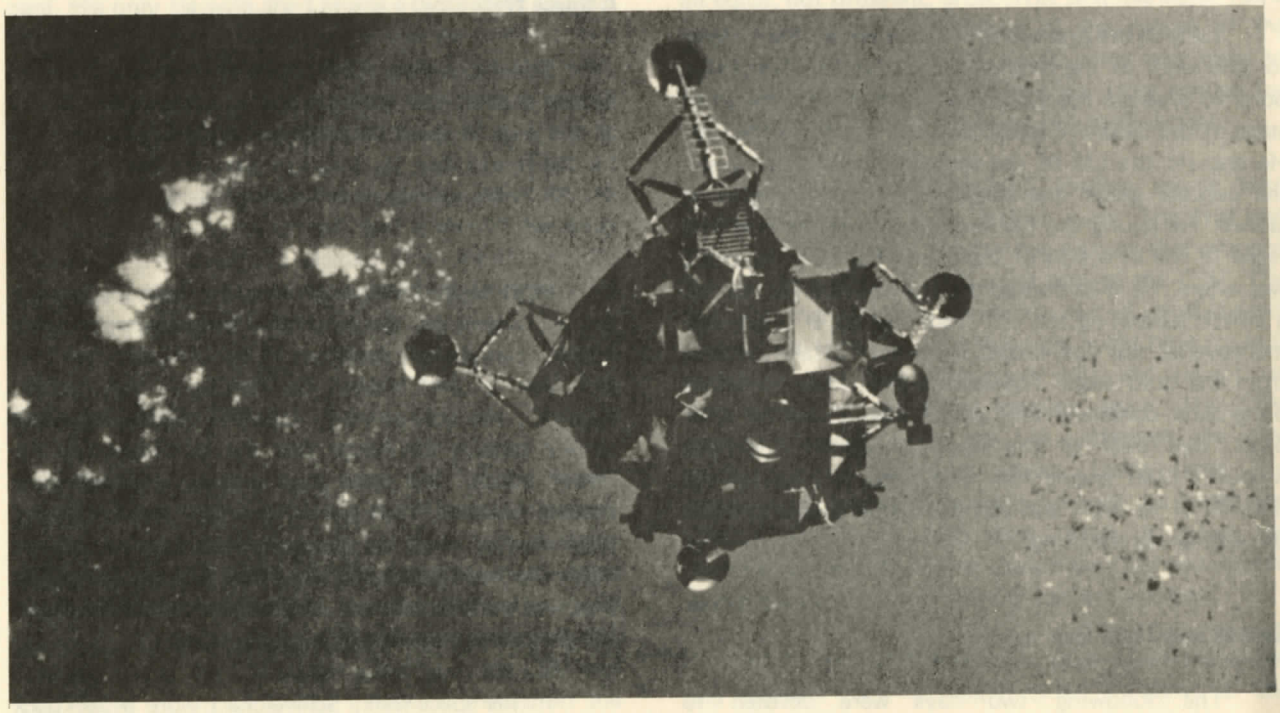
mission report

MR-3

APOLLO 9

Following ten days in orbit, Apollo 9 splashed into the Atlantic Ocean after a superb demonstration of orbital maneuvers that removed the last physical obstacle to an actual landing on the moon's surface. The star of the performance was a weirdly configured Lunar Module (LM), dubbed the "spider" by the crew, which was being flown for the first time with men aboard. The spider executed flawlessly every scheduled maneuver with a precision that won enthusiastic approval from the astronauts and ground-based controllers alike. President Nixon congratulated the astronauts personally, declaring: "The epic flight of Apollo 9 will be recorded in history as 10 days that thrilled the world."

The LM is a key piece of hardware for the lunar landing. It is designed to act as a sort of lunar ferry. In it, two astronauts will separate from the Command and Service Module (CSM) while in lunar orbit and descend to a gentle landing on the moon's surface. The CSM will continue to circle the moon. On completion of their work on the moon's surface, the two astronauts will re-enter the spider and fire the ascent engine—using the descent stage as a launch pad—return to lunar orbit and rendezvous and dock with the mother ship, the Command Module. On the Apollo 9 flight, the spider convincingly demonstrated its ability to execute its mission.



A view of the Lunar Module from the Command Module.

MARCH 26, 1969

A Near-Perfect Flight

Apollo 9, which Dr. Wernher von Braun (Director of the Marshall Space Flight Center and head of the design team of the Saturn V Space Vehicle) described as "at least 25% more difficult" than any previous Apollo flight, including Apollo 8, was near-perfect from lift-off to splashdown. The huge Saturn V rocket roared to life on the dot of eleven o'clock March 3rd, exactly as planned. Eleven minutes later the Apollo spacecraft, still attached to the third stage of the Saturn V, entered a nearly circular orbit, 103 nautical miles high—again according to plan.

With orbit achieved, the Apollo 9 crew of Spacecraft Commander James A. McDivitt, Command Module Pilot David R. Scott, and Lunar Module Pilot Russell L. Schweickart, got ready for some very busy days. The schedule for the first half of the flight programmed more work for the crew than any previous mission. The crowded schedule was calculated to insure that major mission objectives would be accomplished even if it were necessary to bring the Apollo 9 down early. The final five days of the flight called for a more relaxed routine involving landmark tracking and experimental earth photography, along with the regular engineering checkouts needed during flight. The reduced work load drew comment from the crew about their "bankers' hours."

Early in the first orbit, the crew began to get ready for the work of the mission. Scott fired the explosive bolts to separate the Command Module from the third stage of the Saturn V which was still mated to the LM. He also rid the LM of the shroud-adapter that housed the delicate spider and shielded it from the rigors of launch. He swung the CM around so that the butt end faced in the direction of flight and the docking probe was astern. He then docked the CM with the LM, turned a switch separating the LM from the upper stage, and maneuvered the now-linked spacecraft a safe distance from the third stage. The latter's engine was re-started on ground command and driven into a looping solar orbit, well clear of the Apollo's path. The Service Module's (SM) engine was then fired to lengthen the lifetime of its orbit and test the digital autopilot while the engine was thrusting.

Second and Third Day

The following two days were devoted to preparations for the critical sector of the mission. Three more stability tests of the autopilot were run while the Service Module engine was thrusting. This fuel consumption reduced the weight of the Command and Service Modules—a reduction that would facilitate a rescue of the LM should an emergency arise during the coming rendezvous—by using only the CSM's small reaction control thrusters. Results from all tests were good.

On the third day, McDivitt and Schweickart crawled from the CM to the spider using the 32-inch-diameter tunnel which is the core of the docking mechanism to begin the check-out of the LM. The spacecraft was pressurized, its power turned on and its various systems tried out. Then the LM's descent engine was fired for the first time. The descent engine can be throttled over a wide range of power settings either by the autopilot or manually. Both modes were used during the test. With the test schedule completed, the vehicle was shut down and the two astronauts crawled back into the CM. A fifth burn of the CSM circularized the orbit at 135 nautical miles as the base orbit for the rendezvous maneuvers.

A feature of the day for earthlings was a 5-minute TV show by the astronauts in the LM. They trained the camera on the instrument displays, other features of the LM interior, and themselves.

A Space Walk

Schweickart's quick recovery from several bouts of nausea enabled the re-institution of a modified version of the walk in space that had originally been scheduled for the fourth day. Its duration was cut from two hours to 38 minutes and Schweickart's activities were curtailed.

With McDivitt and Schweickart back in the LM and all systems on, the hatches of both spacecraft were opened. Schweickart eased out of the LM hatch feet first and face up, and secured his footing in the "golden slippers", the gold-painted restraints affixed to a flat surface outside the hatch that the astronauts call the "front porch." He took photographs, retrieved some thermal samples from the exterior of the spider and experimented with the handrails—although he did not make the hand-over-hand trip from the LM to the CM that was initially planned. He reported the handrails an excellent device for maintaining position.

In his space-walk, Schweickart wore a backpack which provided his communications, supplied him with oxygen and circulated water through the suit to keep him

Infrared view from 130 miles up of the mouth of the Colorado River and the Gulf of California.

cool. His only tie with the LM was a nylon cord to keep him from drifting off into space. It was the first trial of a backpack of this kind in space and it worked well. Schweickart's venture was the first time in two years a U.S. astronaut has space-walked.

After Schweickart came back inside, both spacecraft were re-pressurized, and a second and final 10-minute TV show was telecast from inside the LM. Both voice and pictures were good—an improvement over the previous day's effort.

Passing the Major Test

For the spider and its crew, and for the Apollo program, March 7th was the big day. The day's program would put the spider through its paces in a series of orbital maneuvers during part of which the lives of the astronauts would depend on the proper functioning of the craft. After a minor difficulty in retracting the docking probe, the LM pulled away from the CSM and then rolled on its axis, like a fashion model on the runway, to allow Scott to make a visual inspection. Then an engine burn pushed it 3 miles from its parent craft in an equal, but different, orbit. This first maneuver had a built-in safety factor. Because of the nature of the orbits, the LM and the CM would come very close to each other twice during a single orbit—close enough for the CM to recover the LM in case of a malfunction.

With this test completed, another engine burn pushed the LM 11 miles farther away. The final and major test began with another engine burn that dropped the LM an additional 100 miles behind the CSM. The two spacecraft were, at this point, out of visual contact (the strobe light on the LM which might have made it visible to the CSM had gone out) and reliant on instruments to get back together again. The CSM remained passive while the LM undertook the vital rendezvous on its own power. Using radar and instruments, the spider caught up with its target and approached within 100 feet. After a pause for re-checking, the LM inched toward the CSM and docked with pinpoint accuracy. The LM had proved itself.

McDivitt and Schweickart shut down the spider and crawled back to rejoin Scott in gumdrop—the Command Module. The LM was separated from the mothership and a final burn of the spider's ascent engine

sent it into a 4,000-nautical-mile high orbit. The orbital maneuvers, the rendezvous and the docking consumed approximately six hours.

After five strenuous and successful days, the crew shifted to a regime of light duties and well-deserved rest.

The remainder of the flight was taken up with landmark tracking and experiments in earth photography. The spacecraft carried four 70-mm cameras that took pictures in black and white, infrared, and color infrared. Photographs of earth on other flights had shown geologic formations of which scientists were hitherto unaware, suggesting the presence of minerals or oil. In the infrared, diseases of timber and crops were revealed, as were underground water sources. There was also evidence that such sensors could provide oceanographic data, even locate schools of fish. Thus the Apollo 9 panoramas of the earth's surface are laying the experimental groundwork for a study of the earth's resources that may provide an effective new tool for their better management.

The Spider—A Unique Craft

The 32,000-pound spider is, in many ways, a unique spacecraft. Built solely for operations in the hard vacuum and weightlessness of space, it is structurally too fragile to function under the atmospheric pressure and high gravity that prevail at ground level. Where the Command Module is built with a symmetrical exterior for aerodynamic reasons, and the equipment fitted in as best the shape allows, the LM is designed from the inside out. The equipment—made up of some 1.1 million parts and 25 miles of wiring—is functionally located and covered with a thin shell. The resultant exterior is queerly angled and asymmetrical. Gold and black surfaces are intermixed to prevent interior overheating from brilliant sunlight in space.

Once launched, the spider can never return to earth. The craft that flew on Apollo 9 will eventually reenter the atmosphere and burn. On the lunar mission, after carrying the astronauts back to the CSM from the moon's surface, the LM will be jettisoned and left in lunar orbit. Eventually it will crash into the moon's surface.

Although the mission encountered some minor difficulties, the flight went so smoothly that the astronauts were able to try out new ways of using the spacecraft systems to advantage. The planet Jupiter was used as a navigational reference—the first time a planet has been used. A new technique for keeping the spacecraft properly oriented for earth photography and landmark tracking was also perfected on this flight. This involved changing the pitch of the spacecraft very slowly by using the autopilot. Although it sounds simple, this is a very complex process. By trial and error, the astronauts perfected the technique which is far more precise than the manual control heretofore used. These and other innovations are individually small items, but collectively they represent a significant refinement in spacecraft handling.

Weather Problem Handled Without Difficulty

A storm in the initially selected landing zone forced ground control to move the landing area 500 miles to the south. The adjustment was made aand Apollo 9 splashed down within three miles of the prime recovery ship *Guadalcanal.* What had been a superb flight ended on a note of low comedy—for millions of spectators given a closeup by a TV camera on the recovery ship, if not for the astronauts. During the astronauts' transfer from the Apollo command module to the life rafts, the down-draft from the recovery helicopter overturned one raft. McDivitt and Scott were doused after climbing into the recovery basket in which they were to ride up to the helicopter.

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