MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GEMINI VIII

FACT SHEET 291-E
APRIL 1966

RENDEZVOUS AND DOCKING MISSION

The eventful eighth flight of the Gemini program carried out by the National Aeronautics and Space Administration on March 16, 1966, resulted in a number of significant achievements:

- The first docking of two vehicles in space
- The second successful rendezvous of two spacecraft in orbital flight
- The first rendezvous of a manned spacecraft with an unmanned target vehicle
- The first successful flight of the Agena as a target vehicle
- The successful retrieval of the spacecraft and astronauts in a planned secondary landing area—required for the first time in U. S. space history
- The first successful simultaneous countdown and launch of two vehicles on the same day at the precise minute planned.

Astronauts Neil A. Armstrong and David R. Scott were the command pilot and pilot, respectively, for the Gemini VIII mission. Astronaut Charles Conrad, Jr., command pilot, and Astronaut Richard F. Gordon, Jr., pilot, served as the backup crew.

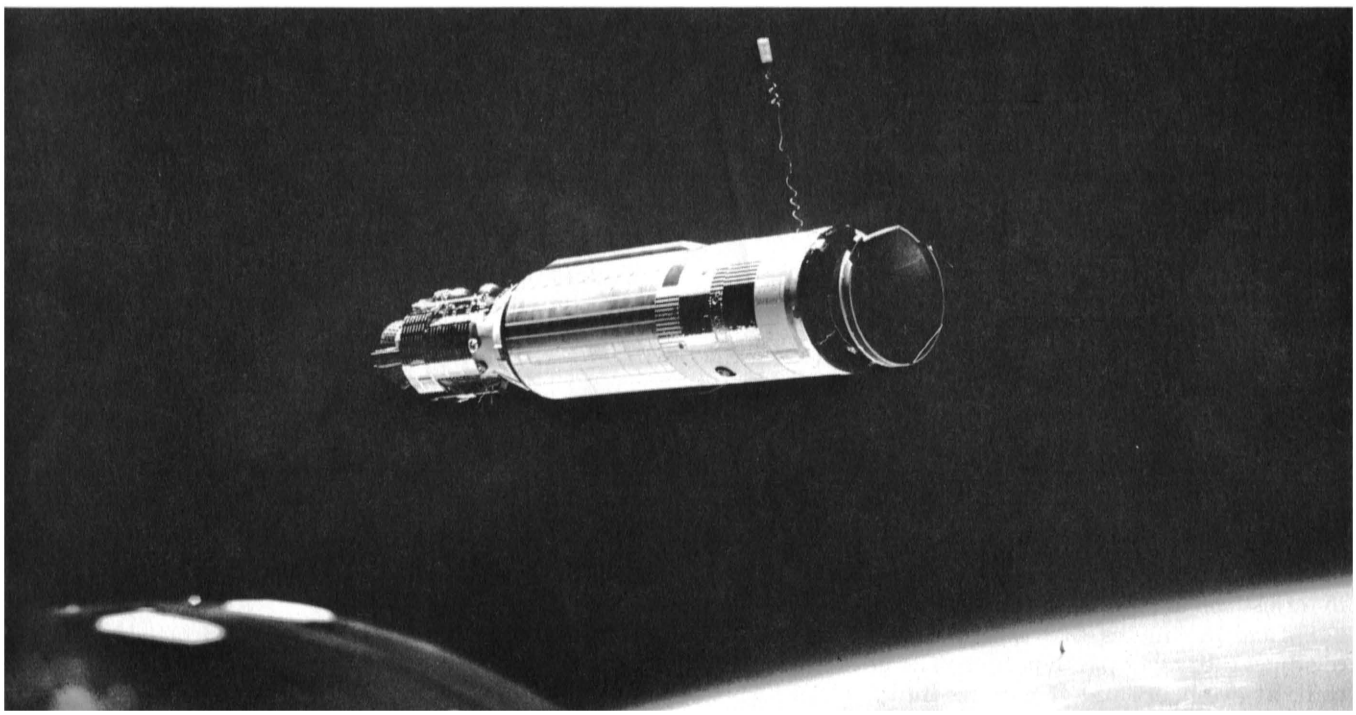
Scheduled to last approximately three days, it became necessary to terminate the Gemini VIII flight during the seventh orbit after the crew had encountered control difficulties about seven hours after liftoff.

The Gemini-Agena target vehicle was launched from Cape Kennedy at 10 a.m., EST, and the Gemini VIII spacecraft was launched precisely on time one hour and 41 minutes later. A previous simultaneous countdown for Gemini VI and its Agena target vehicle had been initiated on October 25, 1965, but the countdown terminated when the target vehicle was lost after about six minutes of flight.

The Gemini VIII flight had been planned for March 15 but was delayed one day because of minor difficulties which cropped up during the countdown in both the spacecraft and the Atlas launch vehicle.

Awakened at 7 a.m. on launch day, the flight crew shortly thereafter underwent their final physical examination and were pronounced fit. Then they had breakfast with several fellow astronauts.

Armstrong and Scott left Merritt Island crew quarters at 8:17 a.m. and proceeded to the suit trailer at launch complex 16. There they were briefed on the weather and the status of the countdown, and donned their Gemini suits. The Gemini extravehicular suit worn by Scott has seven layers. This type suit is used by each Gemini crew



THE AGENA TARGET VEHICLE, as it appeared to the Gemini VIII crew during the station keeping activity. The Agena was approximately 55 feet from the spacecraft at this time.

member to participate in extravehicular activity. It weighs 33 pounds.

Although the countdown on both the Atlas-Agena and the Gemini-Titan launch configurations was on schedule, a minor difficulty which was encountered had to be resolved. This difficulty was with a heater circuit which conditions the orbital attitude and maneuvering system in the spacecraft. A short circuit, resulting from a wire which had been cut by a spacecraft fairing, was discovered, the wire was replaced, and the heater condition was then acceptable.

Only minor difficulties presented a variety of troubles at the various Manned Space Flight Network sites. These problems were remedied to the extent that they posed no threat to proper support of the mission.

The astronauts entered their spacecraft at one hour and 55 minutes prior to liftoff and participated in the remainder of the countdown activities related to the spacecraft. Before this event the backup crew had spent about three hours in the spacecraft and had briefed Armstrong and Scott on the mission status.

Ignition of the Atlas engines occurred at 10 a.m., EST, with liftoff three seconds later as programmed. All major events of the Atlas-Agena powered flight phase were completed as planned and the waiting flight crew was kept advised. When told about the splendid performance of the Agena, Armstrong came back with an elated "very good" reply. Meanwhile the Gemini VIII countdown continued toward a "built-in" hold scheduled at ignition minus three minutes.

This hold had been scheduled in order to launch the Gemini spacecraft at the precise time for insertion into a nominal orbit for rendezvous during the fourth revolution. There was only a six-minute period during which to launch to achieve the rendezvous and docking at the desired time. Launch of the Gemini during this period would permit rendezvous during the fourth, fifth, or sixth revolution, depending upon the time of liftoff.

With the Agena in a near perfect circular orbit 161 nautical miles above the earth, Flight Director John D. Hodge ordered the countdown held for five minutes and 45 seconds at the three-minute mark. After the count was picked up, Gemini VIII was launched at 11:41:02, EST.

The initial elliptical orbit planned for the Gemini spacecraft was a perigee of 87 miles and an apogee of 146 nautical miles; actual values achieved were an 87-mile perigee and a 147-mile apogee. At orbital insertion the Gemini spacecraft was 1,050 miles behind its target.

During the first four revolutions Armstrong and Scott kept busy preparing for and performing the required maneuvers to effect the rendezvous.

One hour and 34 minutes after liftoff, several hundred miles south of New Orleans, they performed a maneuver to adjust the apogee of the spacecraft. Then, after two hours and 18 minutes, they executed a second maneuver to adjust the height of the perigee. The next adjustment came at two hours and 45 minutes into the flight when the Gemini VIII crew performed an out-of-plane maneuver to change their flight path about one-half a degree to match the flight path of the Agena. At this time they were at about a 375-mile slantrange behind and below their target.

After three hours and 47 minutes of their flight, the Gemini VIII crew performed a circularization maneuver which placed them into an orbit of about 147 miles. At this point in the mission they were an estimated 170 miles behind the Agena. Shortly afterwards the crew reported to the ground that they achieved a solid radar lock-on with the Agena at a range of 158 miles. Armstrong, in a later report to a ground station, said they sighted the Agena at a range of 76 miles when the ground elapsed time of the mission had reached four hours and 40 minutes.

Two other minor maneuvers were conducted, one at five hours and 13 minutes into the flight to initiate the terminal phase, the other at five hours and 45 minutes for the final terminal phase activity.

Six hours after liftoff Neil Armstrong informed the Hawaii tracking station that they were 150 feet from the Agena and were performing station-keeping activities. As he carefully maneuvered the spacecraft around the Agena, Armstrong described the target as "looking fine." He said the antennas were all in proper position and that the target docking adapter looked good and apparently "no worse for the wear" after its seven hours and 42 minutes in space.

Ten minutes later, over the eastern Pacific, data indicated that the two spacecraft were from 60 to 80 feet apart and that the spacecraft had matched the velocity of the Agena—25,365.9 feet per second. Armstrong cautiously closed in on the Agena and held the spacecraft steady in a docking position about two feet from the docking adapter until they were over the south Atlantic and in communication range with the Rose Knot tracking ship.

After they had compared notes, flight controller Keith K. Kundel on the Rose Knot gave Armstrong the okay to dock, and that historic event was accomplished six hours and 34 minutes after Gemini VIII had lifted off from Cape Kennedy. At the post flight news conference held in Houston, March 26, Armstrong estimated his closing speed for the docking at about three-quarter foot per second. The flight plan had called for the final docking maneuver to be accomplished with a relative speed differential of the two spacecraft of about one foot per second. The pilot had desired a closing speed of at least one-half foot per second to insure that all latches would be engaged and the link-up properly achieved.

After docking, Armstrong reported to the Rose Knot, saying, "It was a real smoothie." He then informed the flight controller that the Agena was very stable and that there were no noticeable oscillations.

Following the docking, the Gemini VIII crew performed a 90-degree yaw maneuver of the combined Gemini-Agena vehicle using the Agena control system. Later, during the news conference, Scott said that the maneuver took about 55 seconds. He added that it takes about 16 commands to yaw the Agena around and stop it at any particular point.

Approximately 27 minutes after docking, the space-

NASA OFFICIALS participated in the Mission Review Conference at Cape Kennedy prior to the Gemini VIII mission. Left to right, seated around the table, are Kenneth Nagler and Ernest Amman, U. S. Weather Bureau; Astronaut Neil Armstrong; Dr. George Mueller, Associate Administrator Office of Manned Space Flight, NASA Headquarters; Donald K. Slayton, Assistant Director of MSC for Flight Crew Operations; Dr. Charles Berry, Chief of Medical Programs, MSC; Astronaut David Scott; and George Low, Deputy Director of MSC. In the background are, left to right, Kenneth Kleinknecht, Deputy Manager, Gemini Program Office, MSC; and Leroy Day, Acting Deputy Director, Gemini Program, Office of Manned Space Flight, NASA Headquarters.

THIS DOUBLE EXPOSURE gives the impression that the Gemini VIII vehicle, in the foreground, started chasing its Agena target as it left the launch pad. The two launches occurred one hour and 41 minutes apart.

craft-target vehicle combination encountered greater than expected yaw and roll rates. The crew had not heard any thruster activity nor had they seen any reflection of thruster activity on the spacecraft. The crew assumed that some anomaly in the Agena control system had caused these rates. They activated the spacecraft orbital attitude control system and turned off the Agena control system.

They later said they spent about three minutes attempting to bring the combination under control and to reduce the rates by giving the Agena various commands. When it became obvious that this action would not be completely effective, they suspected that some part of the spacecraft control system might be involved. For about four minutes the rates were materially reduced and the crew proceeded to put the joined vehicles into the attitude they desired. Suddenly the rates increased to the point where the crew felt the structural integrity of the combination was in jeopardy.

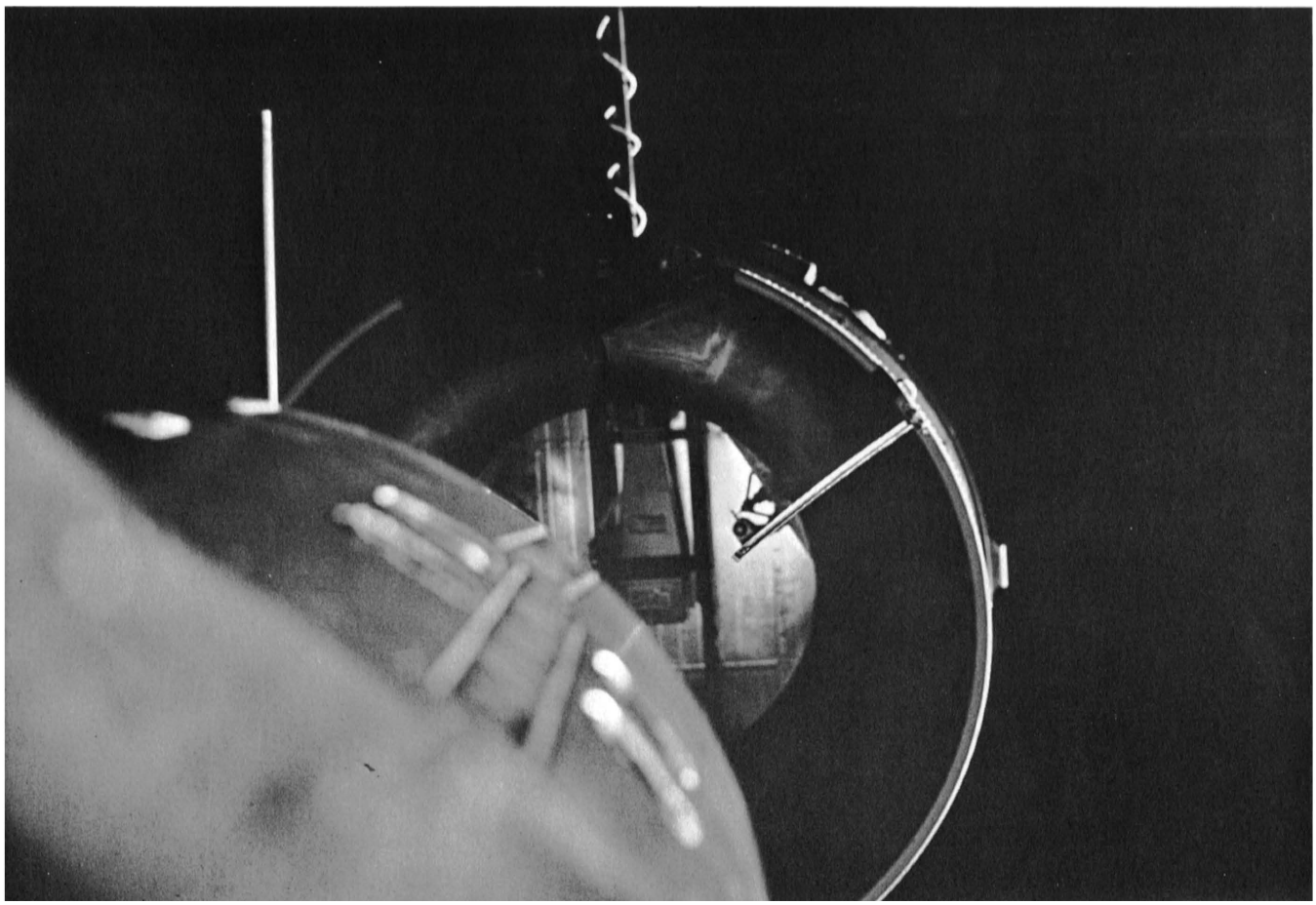
Attempting to identify the specific spacecraft control malfunction without success, the crew reduced the rates to a point where they felt they could safely undock and backed away as quickly as possible.

After completing this maneuver, it became quite evident that the spacecraft control system had caused the problem. Roll and yaw rates had now increased to such an extent that the spacecraft was making about one full revolution per second. For approximately three minutes they tried to isolate the problem, but found it necessary to activate the reentry control system to reduce the motion to acceptable rates and to regain control of the spacecraft.

NASA and McDonnell engineers immediately started an investigation to determine the cause of the anomaly. On the basis of data received from the spacecraft and the Agena, plus the pilots' report, they determined that the condition was caused by a short in the circuit to the yaw left thruster of the spacecraft orbital attitude and maneuver system which continued to thrust although this operation was not commanded.

Flight Director Hodge decided to terminate the mission during the seventh revolution when he learned that the crew had regained control of the spacecraft by using the reentry control system. This necessitated bringing the spacecraft down in a planned secondary area in the western Pacific about 500 miles east of Okinawa and about 630 miles south of Yokosuka, Japan. Weather support reported that sea conditions in this landing area were mild, with waves of three to five feet.

To implement this decision, the recovery forces commander immediately ordered the destroyer USS Mason and aircraft to converge on the area. The Mason was estimated to be about 160 miles away from the predicted landing point and would require from five to six



THE GEMINI SPACECRAFT is shown with its nose about two feet from the Agena target docking adapter just prior to accomplishing the first docking of two space vehicles in history.

hours to arrive on the scene.

A C-54 airplane was dispatched from the Tachikawa Air Force Base in Japan and another C-54 proceeded to the area from Okinawa. In addition, the area recovery commander sent an HU16 amphibian aircraft to the scene.

Based on the flight events, retrofire was now scheduled to take place after 10 hours and four minutes into the flight, with the impact about 32 minutes later.

Retrofire took place over south central Africa and the spacecraft landed within seven miles of the target point. As the spacecraft parachuted to the ocean, an aircraft crew observed the event from a distance of about three miles. Impact occurred at 10:22 p.m., EST, and pararescuemen dropped from a plane about 13 minutes later. The flight crew was picked up by the Mason at 1:28 a.m., EST, March 17; nine minutes later the spacecraft was safely on board; and within 18 hours the destroyer docked at Okinawa.

Dr. A. Duane Catterson, Astronaut Walter M. Schirra, Jr., and other NASA officials who had been on a "good will" tour of southeast Asia and Australia, met the Gemini VIII crew in Okinawa and accompanied them, after a short rest stop in Hawaii, to Cape Kennedy. Technical debriefings, typical of each manned space mission, were started.

About an hour and a half after Gemini VIII landed, the Mission Control Center personnel at Houston held a news conference to provide news representatives with information available at that time. Those briefing the newsmen were Mission Director William C. Schneider, Office of Manned Space Flight; Dr. Robert R. Gilruth, Director of Manned Spacecraft Center; Flight Director Hodge, MSC; Christopher C. Kraft, Jr., Assistant Director of MSC for Flight Operations; Donald K. Slayton, Assistant Director of MSC for Flight Crew Operations; Major General Vincent G. Huston, Deputy Department of Defense Manager for Manned Space Flight Support Operations; Dr. Charles A. Berry, Chief of Center Medical Programs, MSC; and Paul P. Haney, MSC Public Affairs Officer.

Information indicated that the spacecraft had rolled at a rate of about 36 degrees per second, based on an isolated bit from data received. Later, after talking to the flight crew and observing motion picture film, the roll rate was determined to be about one complete revolution (300 to 360 degrees) per second. Participants stressed repeatedly the fact that the source of the spacecraft's problems involved many unknowns. Specific answers could not be provided to the newsmen until all data had been examined and the flight crew debriefed. Those in attendance were also told that the mission had to be terminated early since the crew had been forced to use the reentry control system (RCS) in order to stabilize the spacecraft. One of the mission rules stipulated that if the RCS squibs were blown, the operations team must consider reentering the spacecraft at the next best planned landing area.

Dr. Gilruth, at the conference, referred to a statement in which President Johnson said in part that Armstrong and Scott "have shown remarkable courage and poise under stress . . . From their skill and strength we all take heart, knowing that the personal qualities of the astronauts and their colleagues will ultimately prevail in the conquest of space. We are very proud of them."

Dr. Gilruth also pointed out that the first seven hours

ARMSTRONG AND SCOTT smiled broadly as they arrived at Patrick Air Force Base, Fla., following their flight.

of the mission had been very successful, that both launches were as near perfect as one could expect, and that the docking operation was carried out smoothly and successfully. He added, in part, "The flight crew and the ground crew, I feel, reacted extremely well and ably to an inflight emergency and we feel very fortunate to have experienced a problem like this and to have been able to overcome it and bring the craft back successfully. We missed the space walk, of course, and we missed doing some experiments, but by and large we feel that we got in a very important day's work. We have learned a lot . . . perhaps we have learned more than we set out to learn."

Kraft said that this was an operation where all the planning had paid off both in terms of onboard operations and operations with the Department of Defense, and he called on General Huston to describe the recovery operations.

General Huston stated that the Mason had started toward the aiming point immediately following the decision to use the 7-3 recovery area. In addition a total of five aircraft were deployed—three C-54's, a C-130, and the HU-16. He remarked that a C-54 from Naha, Okinawa—the first scheduled to arrive at the scene—reached the area 22 minutes prior to the spacecraft landing.

Hodge announced that the flight controllers would be going over all the data on the Agena during the night and that a scheduled operation with the vehicle covering the next several days would be worked out. Armstrong and Scott, Hodge said, had reported that at their last sighting the Agena looked stable. Data received by ground stations had verified that report.

AGENA MANEUVERS

A total of 10 major maneuvers were performed with the Gemini-Agena target vehicle after the successful recovery of the Gemini VIII spacecraft. Twenty-one hours and 42 minutes after launch, and while the Agena was still in the 161-mile orbit used for docking on the previous day, the first maneuver was executed. A 104-foot-per-second posigrade burn resulted in an orbit with a perigee of 160 miles and an apogee of 220 miles. Five hours and 21 minutes later a similar burn circularized the orbit at 220 miles.

A plane-adjusting maneuver was initiated 39 hours and 16 minutes into the Agena flight. During this plane-change maneuver, a yaw offset was noted in the velocity of the Agena. This offset introduced a dispersion into the guidance with the result that the out-of-plane burn added energy to the orbit and raised the apogee to 336 miles, although the perigee remained at 220 miles. The inclination angle desired by the flight controllers was achieved during the maneuver, and the dispersion affected only the apogee. The problem was analyzed and determined to be the result of a center of gravity offset from the vehicle center line in conjunction with a slow responding control system.

Jerome B. Hammack, acting chief of the Gemini Vehicle Development Office, said that this condition will be remedied on future Agenas by the addition of ballast weight as required. Hammack also pointed out that a slow responding control system had been intentionally designed into the Agena to insure stability of the two vehicles while docked.

Subsequent maneuvers of the Agena resulted in the following perigees and apogees at different times during the three days of operations:

Perigee	Apogee
220 miles	229 miles
258 miles	384 miles
219 miles	258 miles
221 miles	407 miles
220 miles	223 miles
220 miles	224 miles
220 miles	222 miles

At the end of the final maneuver the Gemini-Agena target vehicle was estimated to have an orbital lifetime of at least 134 days. Flight Directors John Hodge and Eugene F. Kranz said that the Agena had performed perfectly with the exception of the center of gravity problem. There were no malfunctions in the Agena command system. During the course of the mission, flight controllers gave the Agena approximately 5100 commands and the vehicle did everything it was asked to do.

POSTFLIGHT NEWS CONFERENCE

Dr. Robert C. Seamans, Jr., Deputy Administrator of the National Aeronautics and Space Administration, conducted a NASA awards ceremony at the Manned Spacecraft Center Auditorium in Houston, Texas, on March 26, 1966. NASA's Group Achievement Award was presented to General Huston on behalf of the Department of Defense's recovery forces for their outstanding performance in reacting rapidly to the emergency situation in the recovery of Armstrong and Scott and the Gemini VIII spacecraft. Rear Admiral Henry S. Persons, Commander of Task Force 130 (to which the destroyer Mason was assigned), was with General Huston when the award was made.

The three pararescuemen who attached the flotation collar to the spacecraft were also present and received special awards. They were Airman Second Class Glenn Moore of Cleveland, Ohio; Staff Sergeant Larry D. Huyett of Manchester, Pennsylvania; and Airman First Class Eldridge M. Neal of Charleston, West Virginia.

Armstrong and Scott were awarded the NASA Exceptional Service Award for "the remarkable job they did in carrying out the mission . . . and of bringing back much useful data."

At the postflight news conference, following the awards ceremony, Dr. Seamans and Dr. Gilruth made introductory statements before the Gemini VIII crew described the mission.

Dr. Seamens praised the crew for their activities and said, in part: "During the emergency period they had the presence of mind as they were undocking to leave the Agena responsive to ground command and with the tape data intact so that it could be read out to the ground. . . ."

Dr. Gilruth then introduced the astronauts. In discussing the early phases of their flight both Armstrong and Scott stressed the visual aspect of the mission.

Armstrong said, "I wish that our pictures could be sufficiently accurate to describe the magnificence. . . . Seeing your own thruster fire, . . . , seeing particles drift away from the spacecraft at extremely low rates, seeing particles from the venting of gaseous supplies on the spacecraft, watching fires on the ground in Africa, seeing storms from above, . . . , and observing the whole weather panorama from 115 miles or more above the earth is something that unfortunately can't really be described adequately."

Scott's description was tied in to other activities. He said, in part, "We knew we would be very busy toward the later part of the day, so we unstowed some food and began preparing a meal since it was just about lunchtime. And, of course, we had to get out the books and charts and flight plan to prepare for the rendezvous. In the process of doing this, I would be down in the cockpit trying to unstow or prepare something, and about every five minutes I would get a 'Hey, look at that!!', and I'll tell you what Neil says is true. It's just utterly fantastic up there. . . ."

The crew described their activities up to the completion of the docking exercises in detail. They confirmed the report of the pilots of the Gemini VII/VI mission that station keeping with another vehicle in space is not at all difficult. Armstrong also said that he found that it was relatively easy to dock. There had been some conjecture as to whether there would be any electrical discharge when two space vehicles were joined. Armstrong and Scott reported that there was no such discharge and that they did not see any sparks when the spacecraft touched the target.

Both crew members said that even after encountering the control problem and undocking they were extremely reluctant to give up the flight, since there were a lot of other things they had hoped to work on. However, the decision to terminate the mission under such circumstances had been made prior to the flight by the established mission rules.

They praised the spacecraft communicators on the Rose Knot and Coastal Sentry (the only people the crew had contact with from the time of the control problem until after reentry) for the effort expended in getting them the information required for the reentry phase.

The crew said they heard an aircraft fly over shortly after the landing. They saw a plane about 15 minutes later, then a few minutes after that it flew by again and they saw the pararescuemen deploy. Scott said one of them landed about 15 feet in front of the spacecraft. He added that he and Armstrong both commented on the amount of gear the man carried as he came down. They learned later that the load was about 140 pounds.

During the question and answer period which followed, the VIII crew was asked about their physical condition during the peak rolling period. Armstrong said they did have a little bit of difficulty with particular head positions and with identifying proper circuit breakers and switches on the overhead panel. He compared the situation to one that test pilots encounter in spinning airplanes.

When asked whether they had begun to "grey out," the crew said they had not and felt they were perhaps some distance from that sort of physiological problem.

THE PILOTS

Neil A. Armstrong

Born in Wapakoneta, Ohio, August 5, 1930, Armstrong was graduated from Purdue University with a bachelor of science degree in aeronautical engineering. He is five feet, 11 inches tall, and has blue eyes and blond hair.

Armstrong was a naval aviator from 1949 to 1952 and flew 78 combat missions during the Korean action. He joined NASA's Lewis Research Center in 1955 (then NACA Lewis Flight Propulsion Laboratory) and later transferred to the NASA High Speed Flight Station at Edwards Air Force Base, California, as an aeronautical research pilot. He was an X-15 project pilot, flying the aircraft to more than 200,000 feet at a speed of about 4,000 miles per hour.

He has logged more than 3,400 hours flight time, including more than 1,900 hours in jet aircraft. Armstrong was selected as an astronaut in September 1962. In addition to normal training duties, his responsibilities include the readiness of Operations and Training in the Astronaut Office. Armstrong also served as command pilot of the backup crew for the Gemini V mission.

Armstrong is married to the former Janet Shearon of Evanston, Illinois. They have two sons—Eric, born June 30, 1957, and Mark, born April 8, 1963.

COMMAND PILOT NEIL A. ARMSTRONG

UNITED STATES SPACE FLIGHT LOG

MISSION	PILOT(S)	DATE(S)	ELAPSED TIME	TOTAL U.S. MANNED HOURS IN SPACE
Mercury-Redstone 3	Shepard	May 5, '61	00:15:22	00:15:22
Mercury-Redstone 4	Grissom	July 21, '61	00:15:37	00:30:59
Mercury-Atlas 6	Glenn	Feb. 20, '62	04:55:23	05:26:22
Mercury-Atlas 7	Carpenter	May 24, '62	04:56:05	10:22:27
Mercury-Atlas 8	Schirra	Oct. 3, '62	09:13:11	19:35:38
Mercury-Atlas 9	Cooper	May 15-16, '63	34:19:49	53:55:27
Gemini-Titan III	Grissom-Young	Mar. 23, '65	04:53:00	63:41:27
Gemini-Titan IV	McDivitt-White	June 3-7, '65	97:56:11	259:33:49
Gemini-Titan V	Cooper-Conrad	Aug. 21-29, '65	190:55:14	641:24:17
Gemini-Titan VII	Borman-Lovell	Dec. 4-18, '65	330:35:31	1302:35:19
Gemini-Titan VI	Schirra-Stafford	Dec. 15-16, '65	26:01:40	1354:38:39
Gemini-Titan VIII	Armstrong-Scott	Mar. 16, '66	10:41:26	1376:01:31

Armstrong is a charter member of the Society of Experimental Test Pilots, Associate Fellow of the American Institute of Aeronautics and Astronautics, and 1962 recipient of the Institute of Aerospace Sciences Octave Chanute Award.

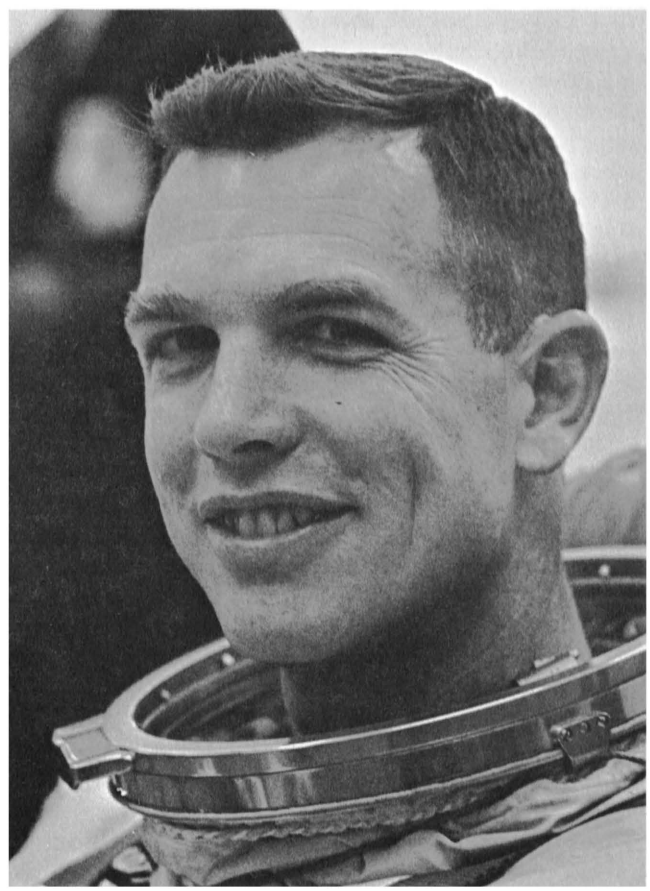
David R. Scott

David R. Scott was born in San Antonio, Texas, June 6, 1932. He received a bachelor of science degree from the United States Military Academy, a master of science degree in aeronautics and astronautics and an engineering degree in aeronautics and astronautics from Massachusetts Institute of Technology. Scott is six feet tall and has blond hair and blue eyes.

His thesis at MIT concerned interplanetary navigation. Scott is also a graduate of the Air Force Experimental Test Pilot School and the Air Force Aerospace Research Pilot School.

Scott was among the group of astronauts selected in October 1963. In addition to participation in the astronaut training program, he has specific responsibilities for monitoring design and development of guidance and navigation systems, and aiding in the coordination of mission planning. He has logged more than 2,600 hours flying time, including more than 2,400 hours in jet aircraft.

He is married to the former Ann Lurton Ott of San Antonio, Texas. The Scotts have two children—Tracy L., born March 25, 1961, and Douglas W., born October 8, 1963.



PILOT DAVID R. SCOTT