Special Edition
NASA
National Aeronautics and Space Administration
Goddard Space Flight Center
Goddard News
Greenbelt, Maryland and Wallops Island, Virginia
Summer 1989

Apollo 11—Goddard Heard It First

ONE SMALL STEP...ONE GIANT LEAP—**Pictured below: Communication Specialists Dwayne Robertson (standing) and Ed Lawless were among the first Earthlings to hear voices from the Moon. By 1969, Lawless, then age 28, had "controlled" the voice of every astronaut in flight, insuring there was always voice communication available between the spacemen, Houston, and tracking stations. Picture right: Astronaut Edwin E. Aldrin, Jr., lunar module pilot, is photographed walking near the lunar module during the Apollo 11 extravehicular activity.**

by Carolynne White

When humans set foot on the Moon for the first time on July 20, 1969, the first word spoken may have been "Houston"—but the first place it was heard was Greenbelt. It was heard by the technicians, voice control operators, and managers of the Manned Space Flight Network (MSFN) and NASA Communications (NASCOM) at Goddard.

President John F. Kennedy went before Congress on May 24, 1961, and charged the government and the American people with landing a man on the Moon and returning him safely before the decade was out. The 1969 Moon landing of the Apollo 11 lunar module was the climax of eight years of effort of the U.S. space program and the turning point in human exploration of space.

Goddard has been called the vital link in this historic mission. Where are the astronauts? What are they doing? During the mission, Goddard provided the answers to these questions instantly, breaching the thousands of miles that separated Apollo 11 and the Earth with a complex worldwide network of radio, radar and optical systems, tied together through Goddard.

When the Saturn V rocket, carrying Apollo 11 and its crew—astronauts Neil Armstrong, Michael Collins and Edwin 'Buzz" Aldrin—blasted off from Cape Canaveral on July 16, 1969, Goddard followed the spacecraft into orbit with the help of 17 ground stations, four ships and eight aircraft stationed around the world to transmit and receive voice, data, and television transmissions from Apollo 11.

Controllers in Goddard's Network Control Center (NCC), many of them former air traffic controllers recruited by Goddard for the Manned Flight Program, worked around the clock to maintain constant communications with these stations, controlling the flow of data, monitoring the progress of the spacecraft, and troubleshooting any problems at the stations.

Continued on page 3

Apollo 11 — The Logical Climax

by Carolynne White

The Apollo 11 lunar landing—when humans set foot on another planet for the first time—marked the culmination of ten years of American efforts in space.

Beginning with the Mercury program, and progressing through Gemini to Apollo, America's space program followed a logical progression of achievements leading to the climactic lunar landing that has been called the event of the century.

Each program has stood on the technological achievements of its predecessor. The complex, sophisticated Space Shuttle of today, with its ability to carry routinely six or more people into space, began as a tiny capsule where even one person felt cramped—the Mercury program.

Project Mercury — Can Humans Survive in Space?

The Mercury program was established in 1958 to investigate mankind's ability to survive and perform in the space environment and to develop the basic space technology and hardware for manned space flight programs to come. A nationwide call for jet pilots produced the pioneers of today's astronaut corps—seven astronauts chosen in April 1959 to be America's first humans in space.

On May 5, 1961, launched by a Redstone Booster, the bell-shaped Mercury spacecraft carried Astronaut Alan B. Shepard 116 miles (186.7 kilometers) above the Earth on the first U.S. manned space flight, a suborbital mission lasting 15 minutes.

Another suborbital flight followed—Astronaut Virgil I. "Gus" Grissom, in the Liberty Bell 7 spacecraft, added another 15 minutes to U.S. manned space flight.

Astronaut John Glenn orbited the Earth three times in the Friendship 7 spacecraft, remaining in space for more than four hours.

Three more Mercury flights followed, each with increasing complexity and duration: Astronaut Scott Carpenter's three-orbit flight in Aurora 7; Astronaut Walter M. Schirra, Jr.'s six-orbit flight aboard the Sigma 7; and Astronaut L. Gordon Cooper, Jr.'s 22-orbit mission in Faith 7, which triumphantly concluded the $392.6 million Project Mercury Program.

Project Gemini—Expanding Our Reach

The 12 longer-duration flights of the Gemini program were designed to expand the capabilities of humans in space. Mercury proved humans could survive—but what were the limits of what they could do in space?

Gemini astronauts spent nearly 970 hours in space, docking with the Agena stage target vehicle, performing extravehicular "space walks" (EVA's), and experimenting with station-keeping maneuvers.

The Gemini spacecraft was designed to be piloted by two astronauts. It was similar to but heavier than the Mercury capsule, requiring the more powerful Modified Titan II to launch the spacecraft into Earth orbit.

Of 12 Gemini flights—two unmanned and ten manned—four rendezvoused with an Atlas/Agena target vehicle, launched from Complex 14 at Cape Canaveral, FL, just before the launch of the Gemini vehicle itself from Complex 19.

After two unmanned flights, the Gemini program began in earnest when the Intrepid, called the "Molly Brown" by its two occupants, astronauts Virgil I. "Gus" Grissom and John W. Young, duplicated Mercury's three-orbit flight on March 23, 1965—with one major difference: it carried two astronauts instead of one.

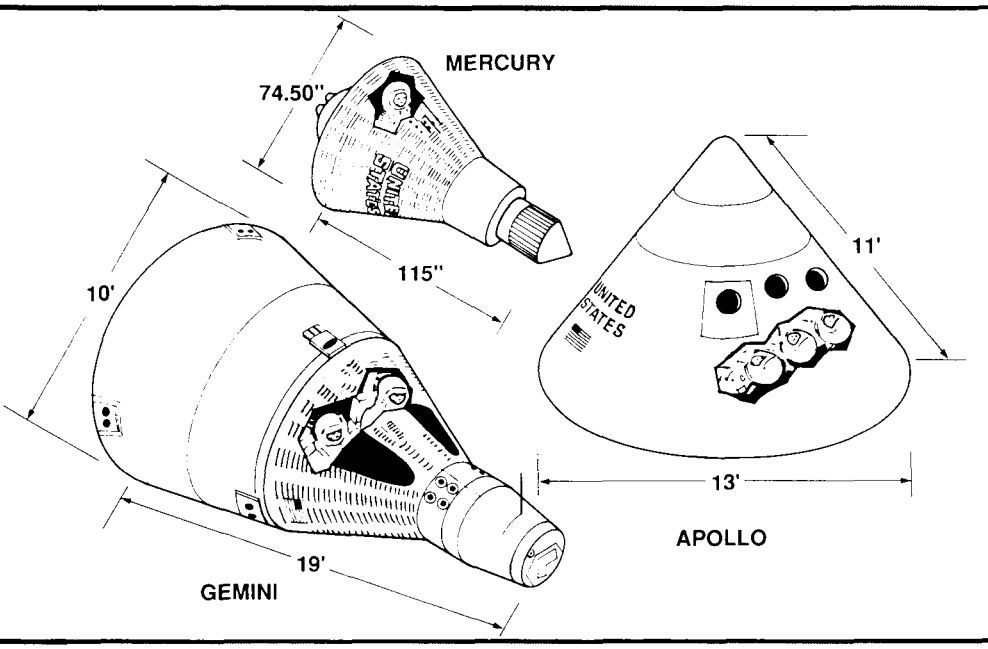
Nine manned flights followed Gemini 3, including the longest Gemini flight, launched December 4, 1965, by Astronauts Frank Borman and James A. Lovell, Jr., who performed 206 orbits in just over 330 hours and provided a rendezvous target for Gemini 6, launched 9 days later.

Project Apollo—To the Moon

NASA first publicly proposed a post-Mercury manned flight program in July 1960, envisioning the goals of the newly-designated Project Apollo as Earth-orbital and circumlunar flights of a three-man spacecraft.

On May 25, 1961, President Kennedy proposed to Congress in his now-famous speech that the United States accelerate its space program and establish a manned lunar landing and safe return as a national

Continued on page 7



PRE-SHUTTLE SPACE FLIGHT—These sketches show the comparative sizes of the Mercury capsule, the Gemini Spacecraft, and the Apollo Command Module. Project Mercury with its solo pilots, Project Gemini and its two-man crews, and Project Apollo with a crew of three became a methodical progression to complete the U.S. commitment to a lunar landing.

Goddard Heard It First

Continued from page 1

"We were the nerve center for all NASA tracking," said Ed Danko, who was a Network Operations Manager and sat on console in Building 3 during the Apollo 11 lunar landing.

"Everything came to Goddard first and then on to the rest of the world," said Henry Iuliano, a Duty Network Controller during the mission.

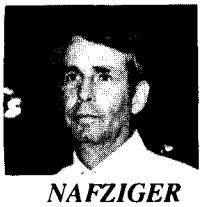
Immediately following launch, the 30-foot antennas at Merritt Island (MILA) picked up communications with the spacecraft, then handed the circuits off to the ground station at Grand Bahama Island; then to Bermuda; followed by the tracking ship Vanguard in the Atlantic Ocean; then on to ground stations in Canary Islands; Carnarvon, Australia, and Hawaii; followed by one of three tracking ships stationed in the Pacific—the Huntsville, the Mercury, and the Redstone; then to the Guaymas, Mexico station; and finally to the ground station in Corpus Christi, TX.

Talking to these tracking stations in exotic locations around the world, all working towards the common goal of human presence in space, was part of the excitement at the time, according to Ed Lawless, a voice controller in the NASCOM area during Apollo 11.

"We'd go back and forth between the stations during each pass, checking the circuits and troubleshooting any problems," said Lawless.

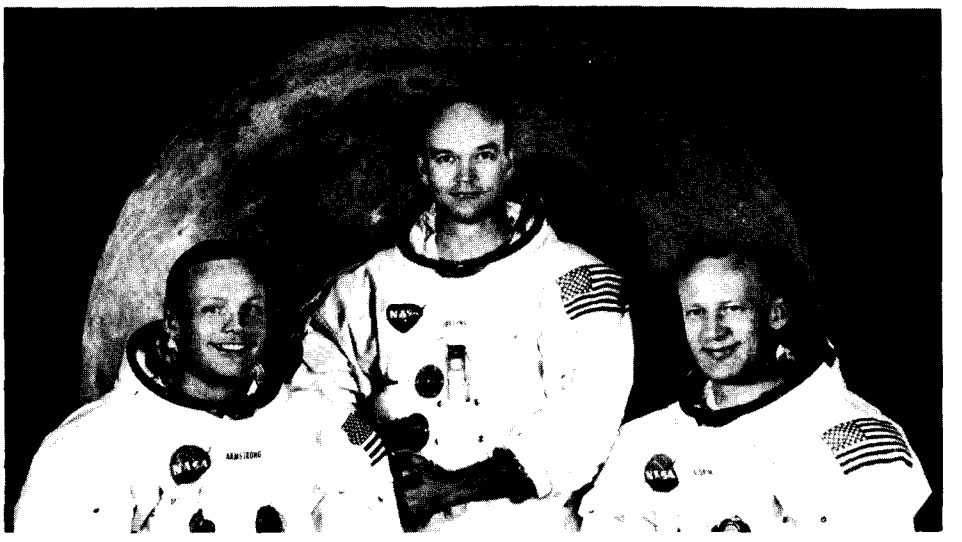
NASCOM Circuit Logs from the time show voice, data, and television transmissions from the Lunar Module (Eagle) and the Command Module (Columbia) alongside circuit checks from Hawaii, Australia, Guam, Madrid, and the White House, where a special circuit was installed to give President Richard Nixon a direct line to the astronauts.

The Largest Television Audience



NAFZIGER

On July 20, 1969, people around the world were glued to their television sets to see the first live pictures. The pictures they saw—and the video coverage we have today—would be nothing but gobbledy-gook without the special camera and processing techniques developed by a team of Goddard engineers headed by Dick Nafziger.



***APOLLO 11 CREW*—Pictured is the crew of the historic Apollo 11 lunar landing mission. Left to right are Neil A. Armstrong, Commander; Michael Collins, Command Module Pilot; and Edwin E. Aldrin, Jr., Lunar Module Pilot.**

"We needed a very lightweight camera that required minimal power and bandwidth to transmit its signal," said Nafziger. "The result was the slow-scan TV used for Apollo 11."

"This is not TV as the average viewer knows it," he said, "without processing, the picture simply appears as a flicker."

But Nafziger's team developed a special processing procedure and equipment to reconstruct these "flickers" into a video signal approaching broadcast quality.

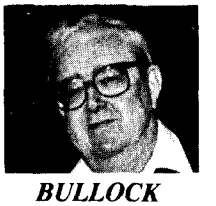
When the camera on the lunar lander began to transmit pictures as it approached the Moon, Nafziger's team received the signal at a special processing facility set up in the Australian Overseas Telecommunications Commission Building in Sydney. When the lunar module was out of range of the Sydney, Australia, site, similar processing facilities at Goldstone, CA, and Madrid, Spain, received the signal.

The Goddard support team stationed at these sites then processed the signals, and sent the video to Houston—and the rest of the world.

"There were thousands of people in the streets of Sydney," said Nafziger, "waiting to see that first step onto the Moon on monitors set up around the main square."

"And we were waiting just as expectantly," he added, "after all, no one had ever been to the Moon before. We didn't know we were going to get pictures until we got one!"

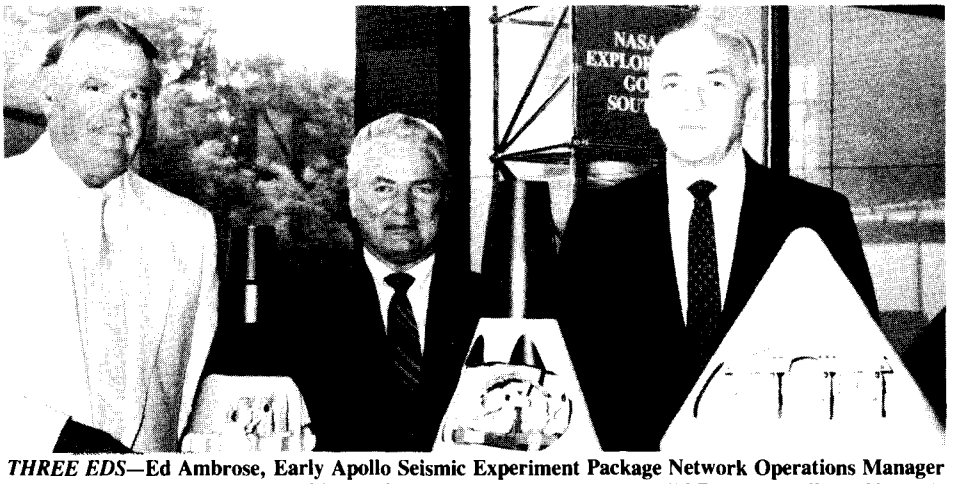
To the Moon or Bust



BULLOCK

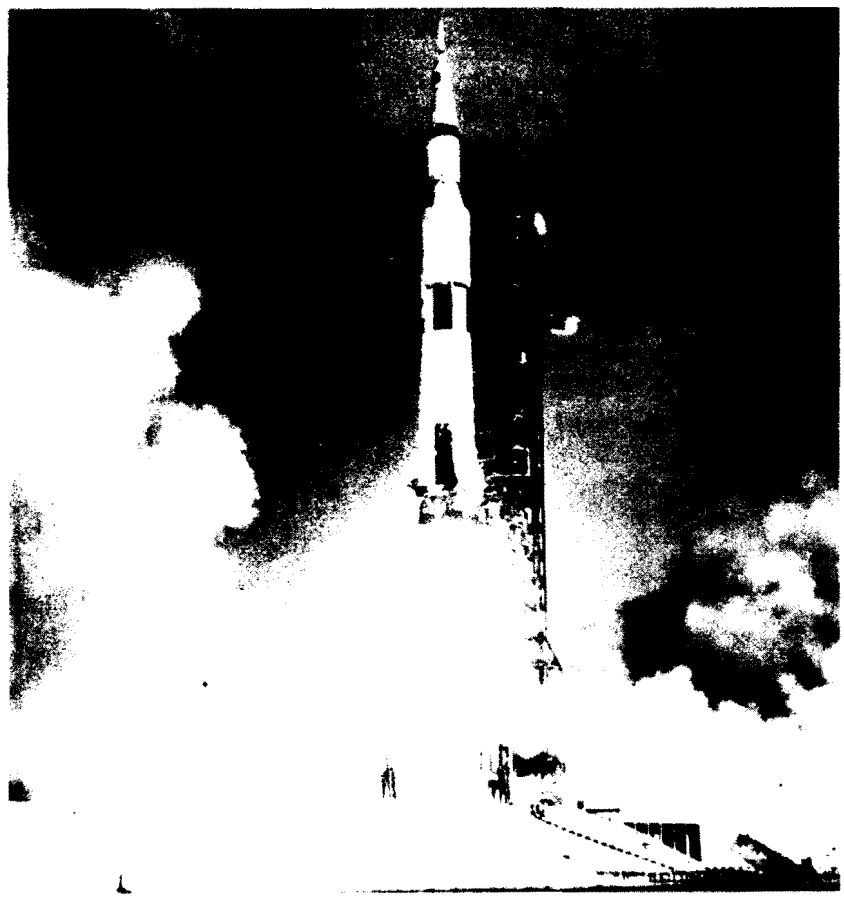
After one-and-a-half orbits around Earth, Mission Control gave the signal to begin engine burn to inject Apollo 11 into a translunar flight path. The signal went from Mission Control, in Houston, to Goddard, via ATS-1

Continued on page 6

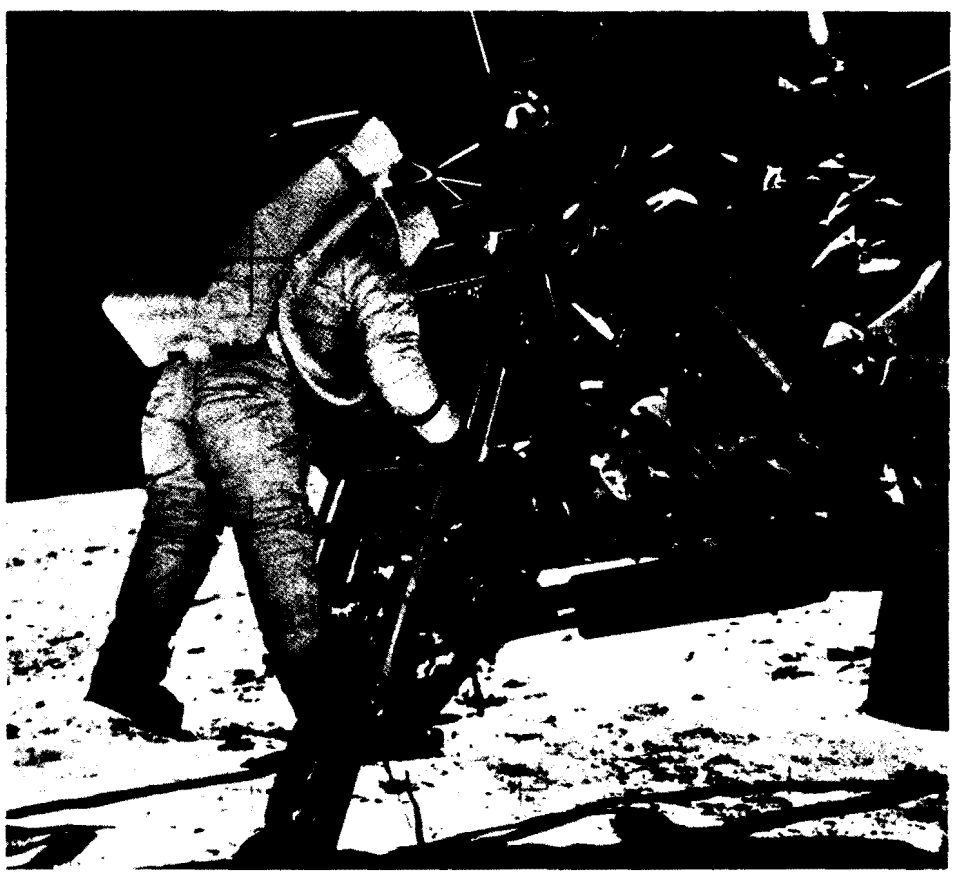


***THREE EDS*—Ed Ambrose, Early Apollo Seismic Experiment Package Network Operations Manager (left), Ed Lawless, Apollo 11 NASCOM Voice Controller (middle), and Ed Danko, Apollo 11 Network Operations Manager (right) are as friendly now as they were twenty years ago during the historic moon walk mission.**

Apollo 11: The V



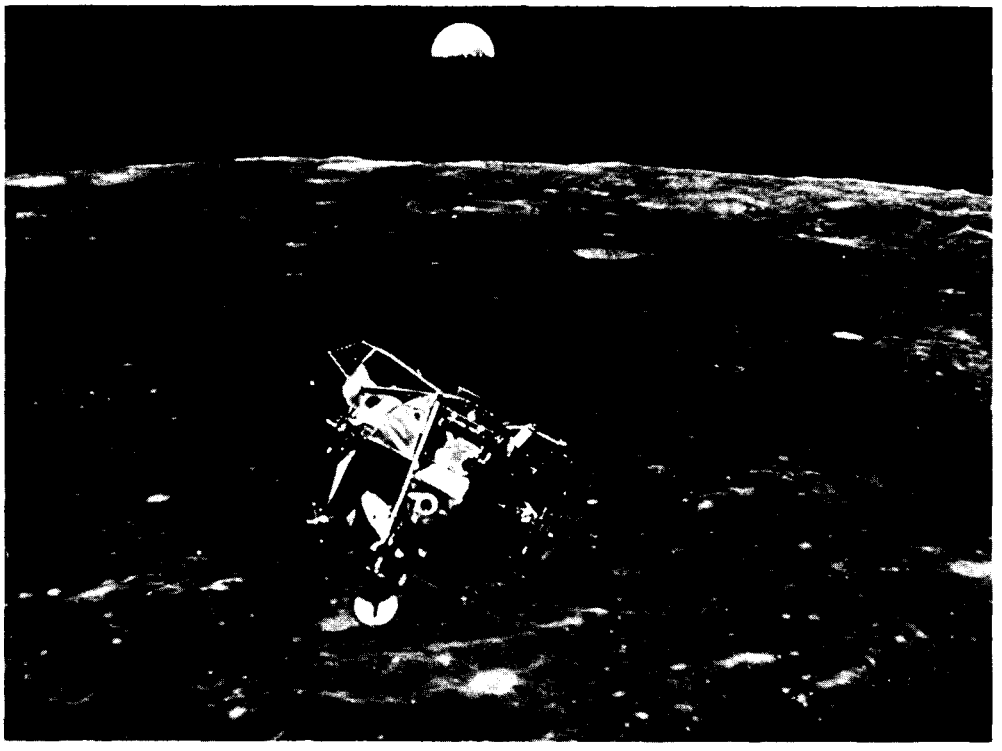
SATURN V — Apollo 11 raises past the launch tower at Pad 39A to begin man's first lunar landing mission. Liftoff occurred at 9:32 a.m. EDT, July 16, 1969. The launch vehicle was a Saturn V, developed for the Apollo lunar missions. With the Apollo spacecraft, the Saturn V stood 363 feet (111 meters) tall.



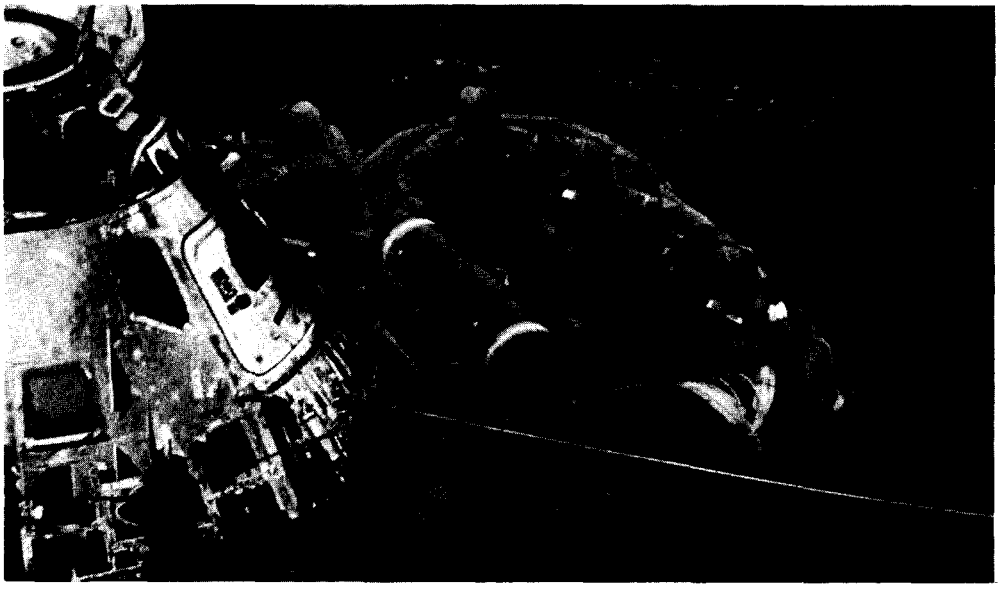
APOLLO 11 EVA — Astronaut Edwin E. Aldrin, Jr., Lunar Module Pilot, descends the steps of the Lunar Module ladder as he prepares to walk on the Moon. This photograph was taken by Astronaut Neil A. Armstrong, Commander, with a 70 mm lunar surface camera during the Apollo 11 extravehicular activity on July 20, 1969.

Vhole World Was Watching

AMERICAN FLAG — On July 20, 1969 at 10:56 p.m., Astronaut Neil Armstrong planted his left boot on the Moon. Astronaut Edwin Aldrin followed him out at 11:11 p.m. and, for two hours and 47 minutes, they worked and investigated where no man had walked before. They erected and saluted an American flag that had a rod in place to keep it unfurled in this windless environment.



LUNAR MODULE ASCENT STAGE — Pictured is the Apollo 11 lunar module (LM) ascent stage photographed from the command service module (CSM) during rendezvous in lunar orbit. The LM was making its docking approach to the command service module. The large dark colored area in the background is Smith's Sea. This view is looking west. The Earth rises above the lunar horizon.



PACIFIC RECOVERY — Pictured is Pararescueman Lt. Clancy Hatleberg closing the Apollo 11 spacecraft hatch as the astronauts await helicopter pickup from their life raft. They splashed down at 12:50 p.m. EDT July 24, 1969, 900 miles southwest of Hawaii at the completion of their successful lunar landing mission.

Goddard Heard It First

Continued from page 3

and 3, the Applications Technology Satellites used for Apollo 11, according to Gil Bullock of Goddard's ATS project.

Operators in Goddard's Operations Control Center then passed the signal along to the Apollo 11 spacecraft, via the Mercury —one of the three tracking ships stationed in the Pacific Ocean. The VHF communications experiments on both ATS-1 and 3, which still operate today, were used as emergency backup links between the spacecraft and the NASA tracking ships for the astronaut voice circuit and at mission's end from the prime recovery aircraft carrier to the voice network. The same systems on both spacecraft were used to relay in-flight activity and recovery operations television coverage in Europe and Asia.

As Apollo II headed for the Moon, the engine burn was monitored by the tracking ships and one of eight Apollo Range Instrumentation Aircraft (ARIA) assigned to the mission.

When the spacecraft reached an altitude of 10,000 miles, the more powerful 85-foot antennas located at Madrid, Spain; Goldstone, CA; and Canberra, Australia, provided primary support of the flight as the 30-foot antennas continued to track and record data.

With these tracking stations spaced about 120 degrees apart around the Earth, at least one of the large 85-foot antennas had the Moon in view at all times. As the Earth revolved from west to east, one 85-foot station handed over control to the next as it moved into view of the spacecraft, in order to maintain data and communication flow.

These data then were relayed back through the huge antennas and transmitted via the NASA Communications Network (NASCOM)—a two-million mile hookup of landlines, undersea cables, radio circuits and communication satellites, controlled at the NASCOM facility still located in Goddard's Building 3/14.

When the lunar module separated from the command module the Manned Space Flight Network was required to keep track of both spacecraft at once, providing two-way communication and telemetry between them and Earth. To do this, each site used its prime 85-foot antenna to track one spacecraft, and a wing, or backup antenna to track the other.

The voice checks between the Eagle and the Columbia just prior to separation also are recorded on the NASCOM Circuit Log, logged in by Lawless, on duty in the NASCOM switching center.

"The command module and the lunar module not only had to have two-way communications with us on the ground, but with each other," he said. "We monitored the circuits for communications between the two modules until they were loud and clear."

In the Network Control Center, too, the separation required even more vigilance from the controllers stationed there.

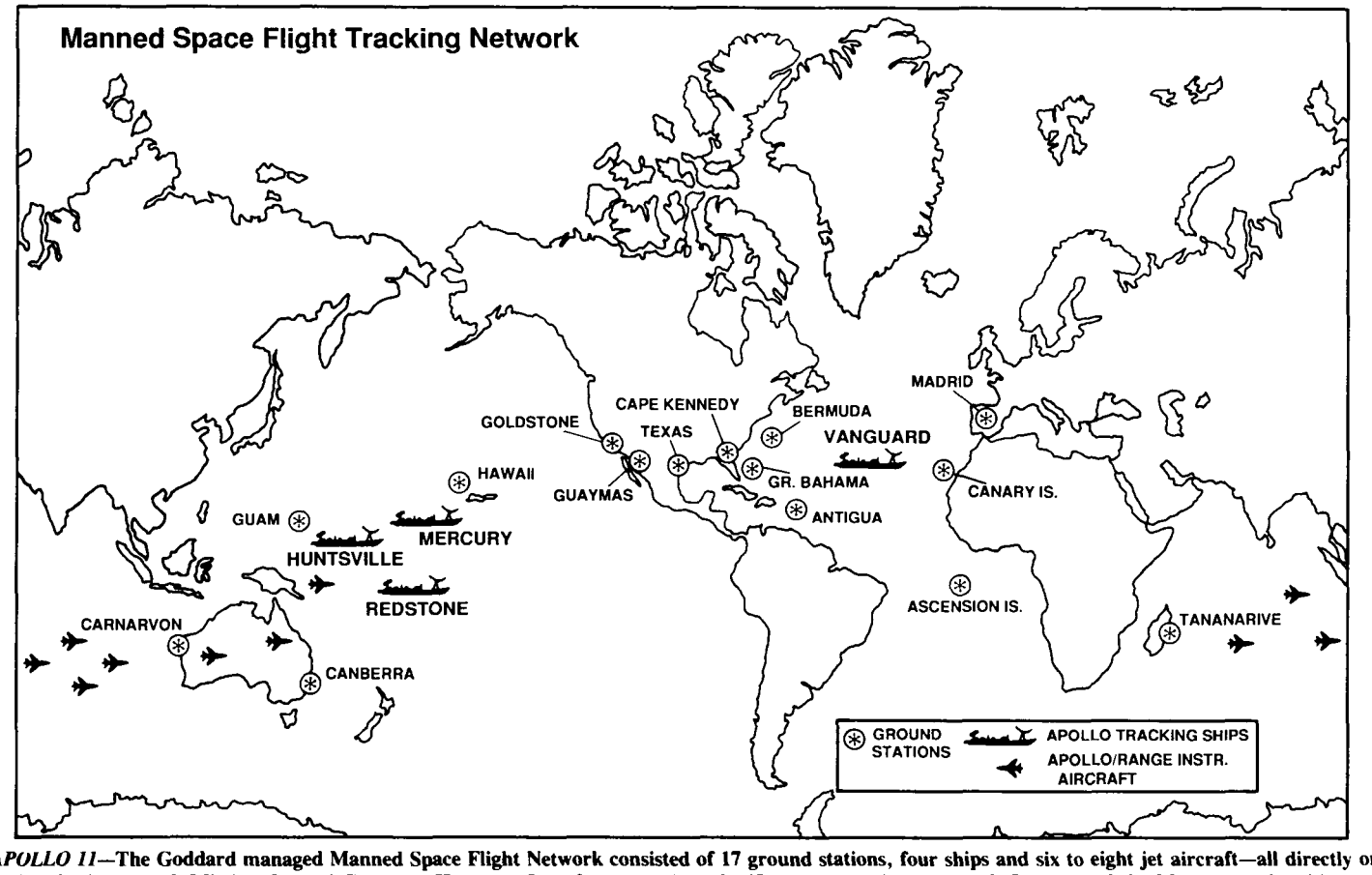
"When the Eagle separated from the Columbia, our workload in the control room doubled," said Iuliano. "And we knew then that man was really going to land on the Moon."

Providing Network Support

The Network Support Team (NST) was a group of experts centralized at Goddard in the NST room located under the Network Control Center (NCC – now called the Operations Control Room, or OCR) to provide whatever technical assistance was necessary to the tracking stations.

"Our role was to make sure that all systems in the network were on top of any problems they had," said NST Team Chief Fidel Rul. There were three Network Sta-

Continued on page 8



***APOLLO 11*—The Goddard managed Manned Space Flight Network consisted of 17 ground stations, four ships and six to eight jet aircraft—all directly or indirectly linked with Mission Control Center in Houston. Only for approximately 45 minutes as the spacecraft flew behind the Moon in each orbit, was link with Earth out of reach.**

The Logical Climax

Continued from page 2

goal, "not because it is easy, but because it is hard."

In support of this goal, development of a heavy-lift vehicle originally suggested in 1957 was accelerated. Throughout the progression of the Gemini missions, NASA continued to develop the largest rocket vehicle ever to fly, the mammoth Saturn V, composed of three stages with a combined total thrust of 8.7 million pounds.

> ***". . . I believe that this Nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth. No single space project in this period will be more exciting, or more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish. . ."*** **President John F. Kennedy, Special Message to Congress, May 25, 1961**

Meanwhile, development of plans and technology for a spacecraft guidance and navigation system, and a separate lunar module for landing on the moon, were underway. By the time the first manned Gemini flight was launched in 1965, the first phase of the Saturn launch vehicle program was complete, with an unprecedented 100 per cent launch success record.

Project Apollo—Tragedy and Triumph

On January 27, 1967, tragedy struck the space program when a fire erupted inside an Apollo spacecraft during ground testing at Complex 34 on Cape Canaveral, FL, resulting in the deaths of astronauts Virgil I. "Gus" Grissom, Edward White, II, and Roger Chafee. Investigation revealed that electrical arcing from the spacecraft wiring in an oxygen-rich environment induced a flash fire.

But NASA followed up with detailed descriptions of corrective actions, schedule modifications, and cost estimates necessary to get the program back on track.

On November 9, 1967, the Apollo spacecraft was flight tested—unmanned—aboard the Saturn V launch vehicle. Designated Apollo 4, this flight proved the restart-in-orbit capability of its third stage, the ability of the Apollo spacecraft to reenter Earth's atmosphere at lunar mission return speeds, the overall performance of the integrated space vehicle, and the operational readiness of Kennedy Space Center Launch Complex 39.

But two more unmanned launches—Apollo 5 and 6—were required to prove the readiness of the lunar module and confirm launch vehicle and spacecraft performance.

The first manned Apollo launch, Apollo 7, lifted off from launch complex 34 aboard a Saturn 1B rocket on October 11, 1968, and splashed down in the Atlantic Ocean 11 days later after providing the first live television broadcast from a manned space vehicle. Manned by Astronauts Walter Schirra, Don Eisele, and Walt Cunningham, the mission was dubbed "101 per cent successful" by NASA.

History's first manned flight from Earth to another planetary body took place two months later, when Astronauts Frank Borman, William Anders, and James Lovell, Jr. performed a half-million-mile space flight in Apollo 8 which included ten lunar orbits, lunar and Earth photography, and live television broadcasts.

Two more successful flights of the Apollo/Saturn V space vehicle proved the capabilities of the Lunar Module and the feasibility of the planned maneuvers in a dress rehearsal for the actual lunar landing.

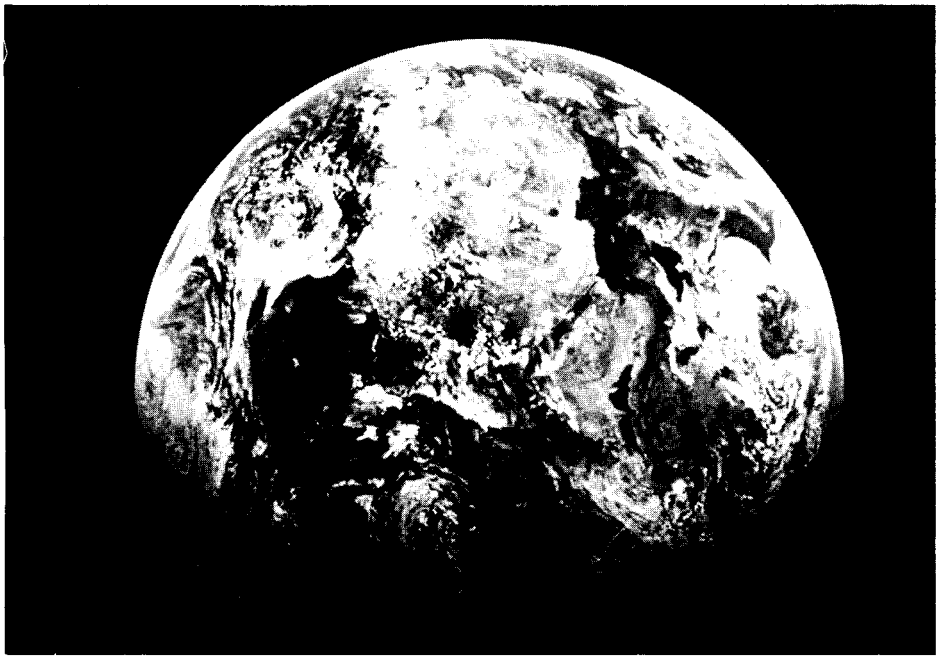
At 4:18 p.m. (EDT) on July 20, 1969, the Apollo Lunar Module touched down on the surface of the moon. Approximately six hours later, at 10:56 p.m., Astronaut Neil Armstrong took his "one small step for a man, one giant leap for mankind," and stepped out onto the surface of the moon, followed by Lunar Module Pilot Edwin E. "Buzz" Aldrin, Jr.

While Command Module Pilot Michael Collins orbited above in the command module conducting scientific experiments and taking photographs, the crew's activities were viewed around the world by the largest television audience in history.

Five more Apollo crews landed on the moon after Apollo 11 (six were planned but a Command and Service Module power failure prevented Apollo 13 from landing).

The Apollo Program concluded when Apollo 17 splashed down in the Pacific Ocean on December 19, 1972, after a 12-day mission during which the crew broke the record for lunar surface time by spending 22 hours and four minutes exploring its landing site, placing geophysical instruments, and collecting more than 240 pounds (108 kilograms) of samples.

The 12-year-long program cost $25 billion, including rockets, engines, spacecraft, tracking and data acquisition, operations, operations support, and facilities and provided the United States with a wealth of data, in addition to attaining the national goal to landing a man on the moon, and returning him safely, before the end of the decade.



***GREAT BLUE MARBLE*—Most of Africa and portions of Europe and Asia can be seen in this spectacular photograph taken from the Apollo 11 spacecraft during its translunar coast toward the Moon. Apollo 11 was already about 98,000 nautical miles from Earth when this picture was taken.**

Goddard Heard It First

Continued from page 6

tion Teams, one for each shift; each consisted of a Team Chief and a crew of experts in radar, data, computers, acquisition, tracking, C-band, communications, TV/video, and recording.

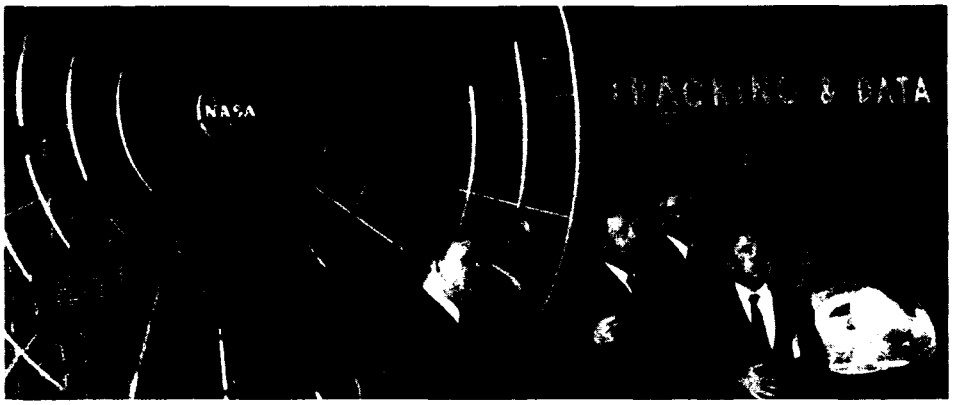
"There was a tremendous esprit de corps among the Network Support Teams," said Rul, "like nothing you've ever seen. We recognized the importance of the network as a vital link to the astronauts. And there was a very high level of excitement, pride and dedication among the teams."

Expanding Scientific Horizons

In addition to the single great achievement of landing a man on the Moon, the Apollo 11 program also provided a wealth of scientific information for the space program.

The astronauts placed a package of experiments known as the Early Apollo Seismic Experiment Package (EASAP) on the lunar surface to measure both the seismic activity inherent in the Moon, and the movement of the ground associated with the activity of the astronauts footsteps and the lunar lander.

Ed Ambrose was the Network Operations Manager in charge of EASAP, which required its own team of controllers, in three shifts, to monitor and switch special circuits dedicated to transmitting instructions and receiving data from the seismic experiment.



***MISSION ACCOMPLISHED*—A "thank you" tour of Goddard by Apollo 11 Commander Neil Armstrong followed the successful mission to the moon. Pictured from left to right are Eugene Wasielewski, Goddard Associate Director; Ozro M. Covington, Director of Manned Flight Support; Armstrong, Henry F. Thompson, Deputy Director of Manned Flight Support; and H. William Wood, Chief of the Manned Flight Operations Division.**

"Although we were just as excited as everyone else to see Neil Armstrong step out onto the Moon, our team was geared toward the deployment of our experiment, about six hours later," said Ambrose.

During Apollo 11 the astronauts also placed retro-reflectors on the Moon. Twenty years later, scientists working for Goddard's Crustal Dynamics Project and the University of Maryland still bounce lasers off these reflectors to get measurements of the movements of tectonic plates under the Earth's crust—and they still achieve the same six-inch accuracy made possible when Apollo astronauts placed the first reflectors on the Moon. Laser ranging to the Moon has provided information on relative characteristics of the Earth and Moon: the Moon's shape, structure and orbit, and the Earth's rate of rotation and the orientation of its magnetic pole.

One Small Step for a Man

Neil Armstrong spoke these historic words—via Goddard's network—to an expectantly hushed world upon taking his first steps on the Moon's surface: "This is one small step for a man, one giant leap for mankind."

With that, Neil Armstrong became the first human being to stand on the surface of the Moon, at 10:56 p.m. (EDT) on July 20, 1969.

It was an exciting time to be a part of the Nation's space program, as many who are still at Goddard can attest.

"It was just fantastic—that's all you can say," said Ralph Banning, a Data Services specialist in the control room during the launch, whose job it was to monitor and catalog the tapes documenting all communications between Mission Control and the astronauts.

Then-NST Team Chief Fidel Rul said, "Those of us who were there in the control room on that day will never forget how it felt to be part of this great achievement."

Since then, other astronauts have visited the Moon, and NASA's vision has expanded to include a manned space station, the Mission to Planet Earth program, and scores of scientific and technology satellites and research programs. But for the NASA veterans who were a part of the event of the century—the Apollo 11 lunar landing and mankind's first steps upon another celestial body—nothing will ever replace the feeling of being there.

"Those of us who played even a small role in this great achievement still feel as though we're part of it today, no matter where we are or what we're doing," said Rul of his Apollo days.

Said Iuliano: "We were part of the mechanism that made a 5,000-year-old dream come true for mankind."

NASA
National Aeronautics and Space Administration
Goddard Space Flight Center

Special Edition
Goddard News

The GODDARD NEWS SPECIAL EDITION is published quarterly by the Office of Public Affairs, Goddard Space Flight Center, Greenbelt, MD 20771.

For additional information, contact Code 130, 286-7277.
The GODDARD NEWS SPECIAL EDITION staff is:

Managing Editor
Randee Exler

Contributing Editors:
Michael Braukus,
Carter Dove,
Jim Elliott,
Joyce Milliner,
and Carolynne White