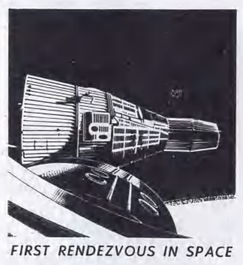
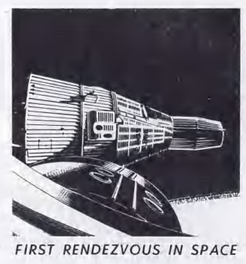
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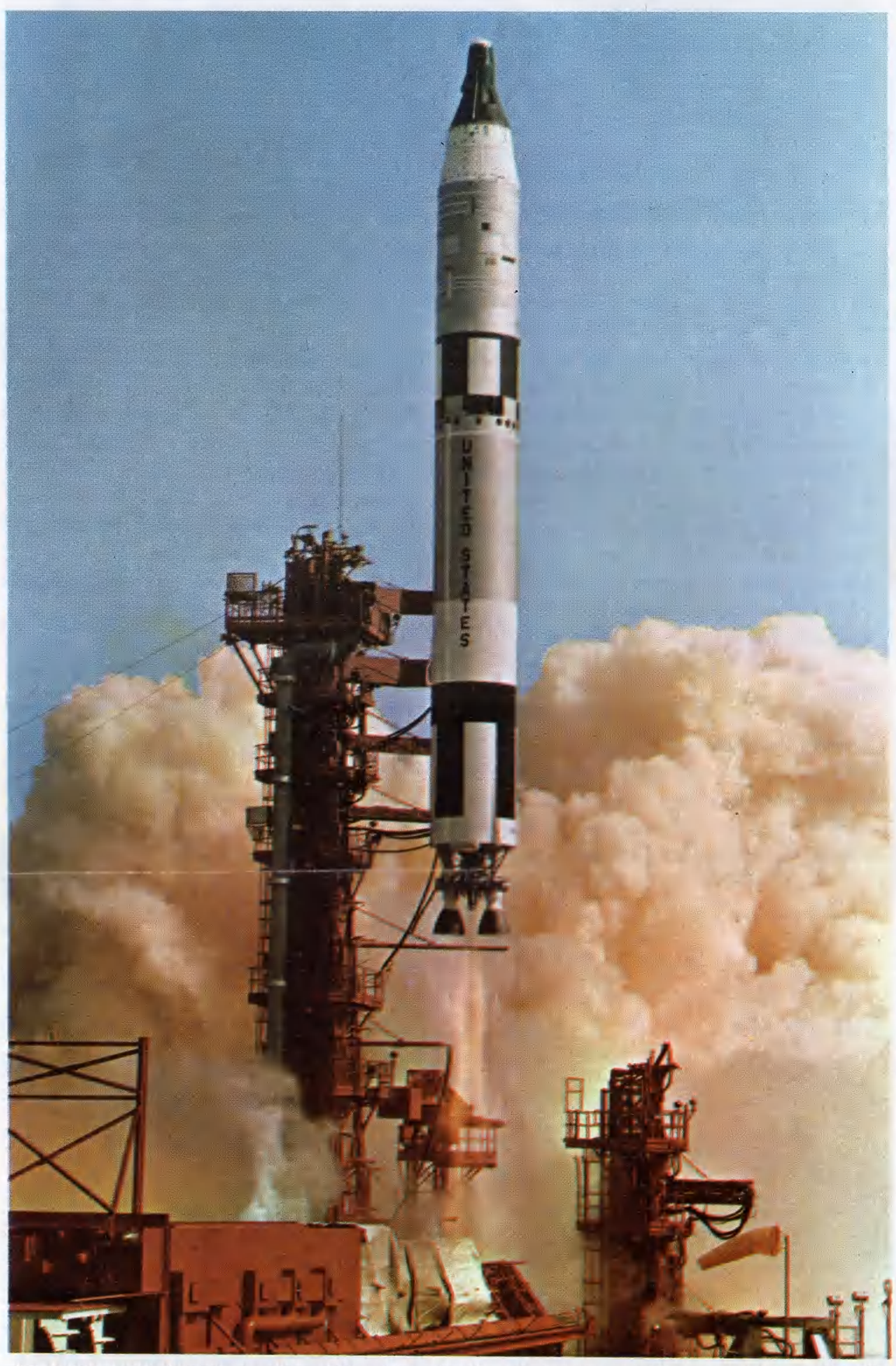

FIRST RENDEZVOUS IN SPACE

MCDONNELL Airscoop


FIRST RENDEZVOUS IN SPACE

VOLUME XXV—NO. 10 MCDONNELL COMPANY, ST. LOUIS, MISSOURI December, 1966

Gemini—Saga of Space Pioneering


GEMINI LIFTOFF! Amidst billowing clouds of orange smoke, a McDonnell-built Gemini carrying two astronauts rides atop a fire-spewing Martin Titan II rocket as it is hurled skyward by 430,000 pounds of thrust from Launch Pad 19 at Cape Kennedy. These launches, with their initial moments of expectancy, their brilliant pyrotechnics and the drama of the joined vehicles (combined height of 109 feet and weight of more than 327,000 pounds) rising smoothly and gradually out of sight, were among unforgettable sights of the Gemini series. Thousands of spectators gathered at the Cape to watch them, millions around the world thrilled to them on television.

Ten Straight Two-Man Flights Rewarding Triumph for Mankind

Project Gemini, hailed as the most successful manned space venture thus far in history and for which McDonnell Company was the prime contractor, came to a triumphant conclusion November 15. The bull's-eye splashdown of the last of 12 Gemini Spacecraft, returning astronauts James E. Lovell, Jr., and Edwin E. Aldrin, Jr., safely to Earth, ended the pioneering series of two-man space explorations that put the United States firmly on the path that leads to the moon.

The Gemini program's 12 giant steps on the quarter-million-mile journey to the moon followed closely on the smaller but no less important steps represented by the one-man flights of Mercury Spacecraft which McDonnell also designed and built for the National Aeronautics and Space Administration.

Even Greater Returns

Originally conceived as a Mercury program expansion to test techniques of rendezvous and docking and the long-duration living in space needed for the Apollo lunar landing mission, Project Gemini produced even greater returns than anticipated. It gave the United States virtually every important record in manned space flight (for compilation of these records see page 5).

Records Enhanced

And the flight of Gemini 12, under the expert performance of Jim Lovell and "Buzz" Aldrin, handsomely enhanced these records. For Command Pilot Lovell, 38-year-old Navy Captain, it gave him, including his 14-day Gemini 7 mission, more time in space than any other man. To Pilot Aldrin, 36-year-old Air Force Major, a rookie space traveler who holds a doctorate in space technology from Massachusetts Institute of Technology, it brought the distinction of having spent the most time outside an orbiting spacecraft.

Gemini 12 was launched by a Titan II rocket from Cape Kennedy

(Continued on Page 8)

12 McDonnell Teammates Get NASA Gemini Awards

Twelve McDonnell teammates were among representatives of Project Gemini industrial firms accorded Presidential and National Aeronautics and Space Administration recognition November 23 in Texas. There were two separate award ceremonies, at noon at the LBJ Ranch and one in the afternoon at the Manned Spacecraft Center in Houston.

Recipients of the NASA Public Service Award included Mr. Mac, Board Chairman; President David S. Lewis; Walter F. Burke, Vice President and General Manager for Spacecraft and Missiles, and John F. Yardley, Gemini Program Technical Director.

President Johnson's Thanks

Mr. Mac and Mr. Burke, along with NASA and other Gemini industry leaders, flew to the LBJ Ranch to receive special recognition from President Lyndon B. Johnson. In the ceremonies at the ranch, Mr. Mac and Mr. Burke were introduced by NASA Administrator James E. Webb to President Johnson, who, in turn, presented their awards and gave his personal thanks for their Gemini leadership.

(Continued on Page 2)



Mr. Mac and President Lyndon B. Johnson engage in handshake just after the President had presented Mr. Mac the NASA Public Service Award in special ceremonies at the LBJ Ranch. Mr. Mac at the time was wearing a protective patch over his right eye following minor surgery. At center is Jack L. Bowers, General Manager of the Convair Division of General Dynamics, who accepted the NASA PSA for General Dynamics President Roger Lewis. Just beyond President Johnson is Daniel J. Haughton, President of Lockheed Aircraft Corp., who also received the NASA PSA. Another PSA recipient present was George M. Bunker, President of Martin Marietta Co.

An End and a Beginning

Courageous men, through centuries, have passed on to later generations a heritage of discovery and knowledge. America's astronauts continued this fine tradition when 19 of them — seven of whom flew twice — journeyed into space and returned safely after almost 18 million miles of extraterrestrial travel.

Mercury and Gemini missions stimulated millions and revolutionized our technology as our spacecraft soared above the confines of Earth in one of the most ambitious and awesome adventures ever conceived by man.

Mercury taught us how to launch precisely on predetermined schedules, to orbit, reenter, and land. Gemini demonstrated that we could maneuver and rendezvous vehicles in space, join them together at will, and operate in a hostile environment for extended periods of time.

Through Mercury and Gemini we have developed accurate, reliable guidance, navigation, and communication systems for deep space operations.

Mercury and Gemini did what they were designed to do because of the dedicated efforts of thousands of men and women who created and backed up every spacecraft, who expended infinite care on every detail, and did their jobs well, however small.

Thanks in part to President John F. Kennedy, whose foresight and dramatic proposal to the Congress on May 25, 1961, gave impetus to public acceptance of our national goal to land an American astronaut on the Moon within this decade, we have progressed far in an exceedingly short time.

When America's astronauts glided overhead, seeing thousands of miles of our Earth's surface at a glance and looking over the limb of our blue planet into the deep black of space beyond, we began to perceive how such achievements would immeasurably transform our society.

Man's curiosity has always led him down untrodden paths, leaving a heritage of progress for those who followed on. When he stopped wandering and settled down, when he commenced to farm the land and build towns, stabilized societies and cultural creativity could begin. When he developed tools and evolved machines to do tasks previously accomplished by his muscles, the dimensions of life began to expand. When he utilized his brains to propel himself into space, he began to advance in every realm of human endeavor. Spinoffs in industrial, technological, medicinal, educational, cultural, and social areas are already beginning to benefit mankind.

Throughout recorded time, man has ceaselessly searched for ideas to improve the world of his time. His questing soul has sought answers in law and politics, in philosophy and literature. Now it seeks them in technology and science. The creative energy being released and the proliferation of ideas being generated will incalculably alter human existence in the future.

The medieval renaissance permanently revamped the maps of the world and forever shifted the set of men's ideas. The manned exploration of space is forever reshaping and conditioning attitudes in human affairs. Mercury and Gemini have helped to ignite a 20th century renaissance that will inexorably influence our progress toward whatever we are destined to become.



WHERE DO WE GO FROM HERE? Mr. Mac talks with two key NASA officials, Dr. Robert R. Gilruth (center), Director of the Manned Spacecraft Center at Houston, and George M. Low, MSC Deputy Director. Setting: Viewing room of the MSC Mission Control Center.

Through the ages, thoughtful men have studied the movements of the heavenly bodies rotating in space. They have recognized the Sun as a source of life and power. They have dreamed of capturing the energy of the Sun, of climbing the mountains of the Moon, of crossing the canals of Mars.

Today, because of Mercury and Gemini, we are only an Apollo trip away from the ridges and craters of the Moon, just a Voyager ride away from the mysteries of Mars. Because of Mercury and Gemini, we are closer to a realization of some of man's most ancient dreams and are working toward answers to some of his oldest and most profound questions.

As the world watched our Mercury and Gemini astronauts soar into space to scan the heavens with an ever brighter view of the universe, all of us here at McDonnell, NASA, our subcontractors, and the entire aerospace industry were contributing to man's storehouse of knowledge and were helping provide means for the betterment of his lot everywhere.

As our country prepares to land American astronauts on the Moon, in the next stage of manned flight to the stars, we feel privileged to have pioneered in such a brave adventure.

NASA Gemini Awards

(Continued from Page 1)

At the Houston ceremony, the Manned Spacecraft Center Certificate of Commendation was presented to McDonnell's Robert N. Lindley, Engineering Manager - Gemini; Logan T. MacMillan, Companywide Project Manager-Gemini Special Operations and Reliability; William Dubusker, Manufacturing Manager-Spacecraft.



David S. Lewis

Four members of the company's Gemini team at the Cape were presented the John F. Kennedy Space Center's Certificate of Appreciation: Ray D. Hill, Base Manager; William Mosley, Assistant Project Engineer; Thomas W. Turner, Superintendent of Manufacturing; Huelen H. Leutjen, Senior Project Design Engineer. Guenter Wendt, Pad Leader for McDonnell at the Cape, received the MSC Certificate of Commendation.



John F. Yardley

Among recipients of the NASA Superior Achievement Award were William H. Gray, NASA Resident Manager at McDonnell, and Andy Hobokan, Deputy NASA Resident Manager.

Language of Awards

The Public Service Award presented to Mr. Mac and David S. Lewis is "For outstanding contributions as a key leader of the government-industry team responsible for the exceptional success of the Gemini program."

The PSA for Mr. Burke is "For outstanding contributions to the Gemini Program in managing and directing the industrial team that developed and produced the Gemini Spacecraft; and for suggesting the use of a dual spacecraft rendezvous as a means for initial demonstration of rendezvous capability."

Mr. Yardley's PSA was "For outstanding contributions to the Gemini Program, especially in establishing the basic spacecraft flight worthiness checkout procedures and operations at Cape Kennedy during the early phases of the program and in leading the industrial team of engineers on the spacecraft during the critical period when major program objectives were first achieved."

The Certificates of Commendation to Mr. Lindley, Mr. MacMillan and Mr. Dubusker were "For (his) contributions to the advancement of manned space flight through hardware development for the Gemini program." The one for Mr. Wendt was "For outstanding and valuable services throughout the Gemini program. His dedication and enthusiasm in insuring the readiness of the spacecraft for flight and his assistance to the astronauts on the launch pad have been of great benefit to the United States manned spaceflight effort."



Robert N. Lindley



Ray D. Hill



Logan T. MacMillan



Huelen H. Leutjen

The KSC Certificates of Appreciation to the four members of the McDonnell team at the Cape were "For outstanding service to the manned space program and technical competence exhibited during the Gemini launch operation."

'Mark of Excellence'

President Johnson's remarks at the Gemini awards ceremony at the ranch included: ". . . The splendid performance of man and machine in Gemini has been a product of the American system at its best . . . On the way to the moon, we are also finding a way to a better world . . . These are stirring times. All of you who have contributed to the brilliant success of Gemini have left your mark of excellence on this age in which we live. You have helped to steer the course of history in the direction that we want it to go."



William Dubusker



Guenter Wendt



William Mosley



Thomas W. Turner

How Company Met Gemini Challenge

Ingenuity, Hard Work, Team Effort Brought Many Breakthroughs

By Walter F. Burke
PRESIDENT, MCDONNELL ASTRONAUTICS COMPANY

Six years ago, the United States had yet to accomplish a manned space flight. Today, Projects Mercury and Gemini stand meritoriously as the first two chapters in the Free World's history of space exploration.

The last of NASA's Gemini flights, which concluded on November 15 with a bull's-eye splashdown in the Atlantic, closed the books on a 20-month program of manned flights that put 20 astronauts into space. Each astronaut returned safely, each contributed immeasureably to the steady progress being made in the mastery of space travel.

In Project Mercury, six manned flights were made for a total space flight time of 51 hours and 40 minutes. In Project Gemini, 10 manned flights were made for a total space flight time of 969 hours and 56 minutes. If manhours are used rather than elapsed time in space, a total of 1991 manhours of space flight have been accumulated by both the Mercury and Gemini programs.

All Objectives Met

Specific objectives of the Gemini program, all of which were met, included:

- **Earth orbital flights of up to 14 days duration.**
  This was accomplished with Spacecraft 7, and showed that man has complete capability in the space environment for periods up to 14 days. (The longest duration mission originally planned at the start of the program was for four days.)
- **Demonstrate rendezvous and docking with a target vehicle in earth orbit, using various rendezvous techniques.**
  Rendezvous was first achieved by Gemini 6; docking by Gemini 8
- **Develop spacecraft countdown techniques and operational procedures for accomplishing rapid launch pad turnaround.**
  In order to rendezvous and dock, it was necessary to launch almost precisely on time. This objective was consistently accomplished throughout the program.
- **Demonstrate controlled reentry and landing to a predetermined touchdown area.**
  First accomplished by Genimi 6.
- **Provide a test bed for "in-space" experiments.**
  Experiments were carried on all spacecraft, first with Gemini 3.
- **Demonstrate maneuvering in earth orbit using the Agena target vehicle for propulsion.**
  First achieved with Gemini 10.

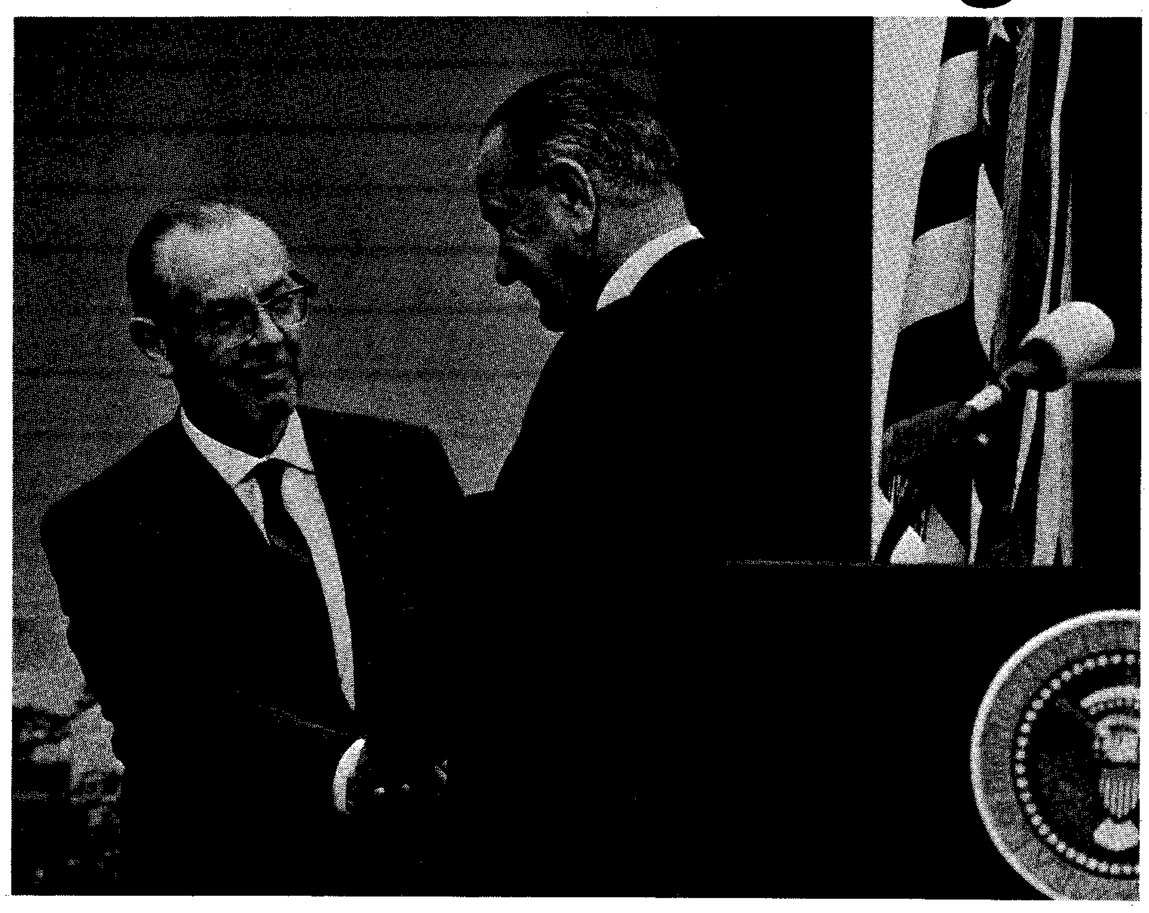
The specific details of each Gemini flight and the records set by the Gemini program are summarized on pages 4 and 5. In summary, the Gemini program has confirmed that there are no technological barriers to be faced in getting a man to the moon and returning him to Earth.

The program was completed ahead of schedule and below the anticipated cost that was estimated in mid-1964 when the contract was converted from a cost-plus-fixed-fee contract to an incentive contract.

Philosophies Changed

A number of philosophies changed going from the Mercury program to the Gemini program. During the Mercury period, we were really exploring the unknown. After spacecraft were delivered to Cape Kennedy, they underwent modification resulting from information obtained from preceding flights. One spacecraft went from an unmanned to a "chimp" configuration while it was at the Cape.

In Gemini, the goal set at the outset was delivery of flight-configured, flight-qualified, flight-ready and checked-out spacecraft to Cape Kennedy. As a result, it was not necessary to repeat at the Cape every test that had been completed in St. Louis.



McDonnell's Walter F. Burke receives warm handshake from President Lyndon B. Johnson just after the President had presented Mr. Burke with the NASA Public Service Award at the LBJ Ranch November 23. Mr. Burke, Vice President and General Manager for Spacecraft and Missiles, had been invited to the ranch along with Mr. Mac to receive the PSA in special ceremonies.

Lessons From Mercury

All the lessons learned during Mercury were applied directly to the Gemini program. Gemini spacecraft were developed as versatile, general purpose vehicles for accomplishing space missions of increasing complexity. Each spacecraft was designed to accommodate *mission changes up to the last minute*. This was made possible by the modular design of spacecraft systems and the easy accessibility of all equipment.

Everyone on the project paid the strictest attention to accessibility of equipment, and a close relationship was maintained between the engineering design group and the production people to insure that this accessibility of equipment was never compromised. This operational modular design, one of the major pioneering efforts introduced on the Gemini program, resulted in spacecraft that were easy to build, easy to test, easy to operate and easy to change.

The vital importance of this spacecraft flexibilty was demonstrated many times throughout the program. The Gemini 12 mission was totally changed and replanned in a two-week period. The Gemini 7/6 was possible because the R & R section of Spacecraft 7 could be removed and modified to include a transponder. Earlier, after the flight of Gemini 5 — an eight-day mission that was the longest duration flight to that time — it became apparent that a number of spacecraft changes would have to be made before Spacecraft 7 could remain in orbit for the entire 14 days of its planned mission.

40 Days Available

Gemini 5 did not splashdown until August 29, 1965, and Gemini 7 was scheduled for delivery to Cape Kennedy on October 9. This meant that only 40 days were available to install additional cyrogenic storage tanks and a crossover valve between the fuel cell Reactant Supply System and the Environmental Control System, as well as to make other modifications based on the Gemini 5 experience.

Normally, changes of this magnitude would take a minimum of six months by the time all parties concerned reached agreement on what changes were necessary. Because of the excellent working relationship

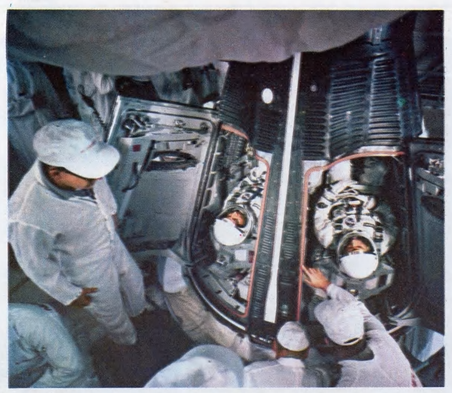
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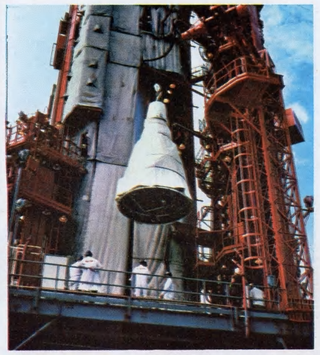
GEMINI CREWMEN AT AWARDS CEREMONY. **On auditorium stage at Manned Spacecraft Center, Houston, 15 astronauts who served as crewmen in Gemini flights listen to congratulatory remarks by NASA Administrator James E. Webb (at rostrum) before he presented each of them a special NASA commendation. Astronauts are, from left: Richard F. Gordon, Jr., David R. Scott, Michael Collins, Neil A. Armstrong, Eugene A. Cernan, Walter M. Schirra, Jr., Thomas P. Stafford, Charles P. Conrad, Jr. (behind Webb), L. Gordon Cooper, Jr., James A. Lovell, Jr., Edwin E. Aldrin, Jr., James A. McDivitt, Edward H. White, II, John W. Young and Virgil I. Grissom. Astronaut Frank Borman, also a Gemini crewman, was unable to be present for the November 23 ceremony because of an official assignment.**

NASA/McDonnell—Ten Historic Gemini Manned Space Flights

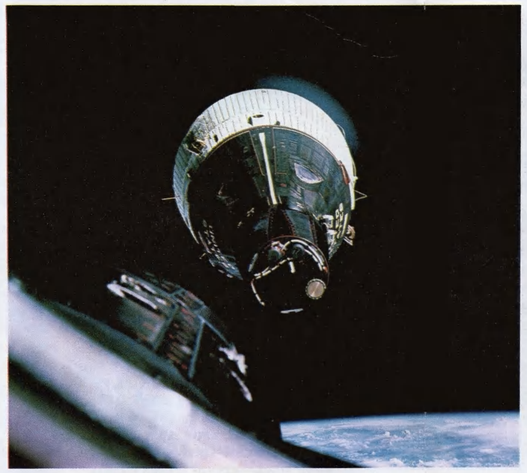
March 23, 1965, to November 15, 1966



GEMINI 3. In white room atop Launch Pad 19 at Cape Kennedy, McDonnell and NASA technicians prepare astronauts for first U. S. two-man mission.



GEMINI 5. Spacecraft, shrouded for protection, is hoisted up gantry of Launch Pad 19 preparatory to mating with its Titan II booster.



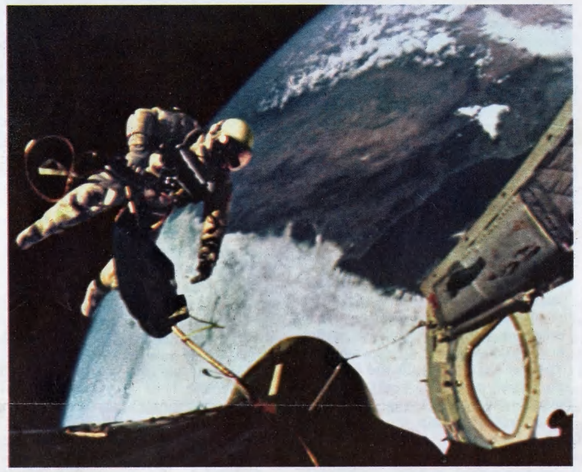


GEMINI 8. Astronauts Armstrong and Scott and para-rescue men await pickup by destroyer Mason in Pacific.

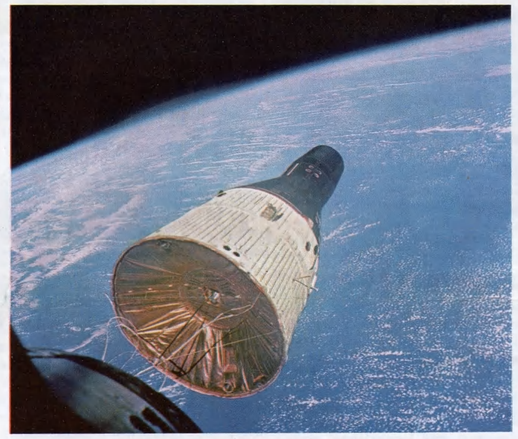


GEMINI 9. Pilot Eugene Cernan at his station in crew compartment during flight. Just beyond him is spacecraft window and EVA camera. Photo was made by Command Pilot Thomas Stafford.

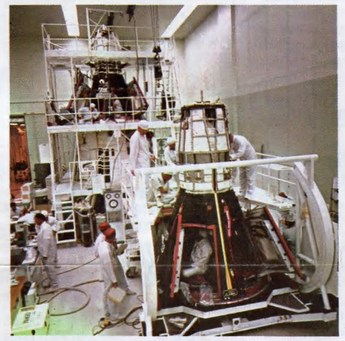




GEMINI 4. Astronaut Edward H. White, II, takes America's first walk in space, with Gemini's open hatch at right. The 20-minute extra vehicular activity (EVA) took place June 3, 1965.



GEMINI 7/6. Rendezvous of these two spacecraft, Dec. 15, 1965, stands among most spectacular achievements thus far in man's exploration of space. Spacecraft, traveling 17,500 mph, were 185 statute miles above Western Pacific. In photo above, Gemini 6 nose is 43 feet from that of its sister spacecraft; the distance was later closed to within one foot. For six hours, the Gemini pair engaged in station keeping, or formation flying, at distances from six to 200 feet apart. Oblique view of Gemini 7 (photo left) shows adapter section's gold-colored plastic thermal blanket for protecting equipment. Adapter is 37 feet from Gemini 6 window from which photo was made.



GEMINI 10. In clean room of McDonnell Space Center, technicians and inspectors work on spacecraft Nos. 10 (foreground) and 9.



GEMINI 11. Splashdown at instant of spacecraft's contact with Atlantic; main parachute begins to collapse. For Astronauts Conrad and Gordon it was another of the precise or "mill pond" landings which marked later Gemini flights.

GEMINI 12. Wide angle view of spacecraft docked with Agena target was taken by Astronaut Edwin Aldrin during stand-up EVA. Photo shows portion of EVA hand-rail (left center) extending from between hatches to docking cone and EVA work station on Agena. Later, while on unbilical EVA, Aldrin attached 100-foot tether, stowed on Agena, to the Gemini docking bar. After separation, the two vehicles engaged in a 4 hour, 17 minute tether exercise.

JOURNAL OF GEMINI MANNED FLIGHTS

(Eastern Standard Time and statute miles are indicated in all instances)

GEMINI 3 — March 23, 1965

Astronauts: Virgil I. Grissom, Command Pilot; John W. Young, Pilot.

Liftoff: 9:24 a.m.

Initial Orbit: Perigee 100 miles, Apogee 139.5 miles.

Splashdown: 2:17 p.m., Atlantic Ocean off Grand Turk Island, 58 miles from aiming point.

Recovery: Astronauts picked up by helicopter, flown to carrier Intrepid, aboard at 3:30 p.m.

Duration: 3+ revolutions; 4 hours, 53 minutes.

Distance Traveled: 80,000 miles.

Highlights: Demonstrated satisfactory operation of all major systems and controlled maneuvering; first spacecraft to change plane and size of orbit.

GEMINI 4 — June 3-7, 1965

Astronauts: James A. McDivitt, Command Pilot; Edward H. White, II, Pilot.

Liftoff: 10:15:59 a.m.

Initial Orbit: 100 miles by 175 miles.

Splashdown: 12:12:30 p.m., 390 miles east of Cape Kennedy, 45 miles from aiming point.

Recovery: Astronauts flown by helicopter to carrier Wasp, aboard at 1:09 p.m.

Duration: 62+ revolutions; 97 hours, 56 minutes, 31 seconds.

Distance Traveled: 1,609,700 miles.

Highlights: U. S. experience with weightlessness extended to four days; in first U. S. "space walk," Astronaut White became first to use maneuvering gun for EVA attitude control.

GEMINI 5 — August 21-29, 1965

Astronauts: L. Gordon Cooper, Jr., Command Pilot; Charles P. Conrad, Jr., Pilot.

Liftoff: 9 a.m.

Initial Orbit: 100.6 miles by 217.3 miles.

Splashdown: 7:56 a.m., 760 miles east of Cape Kennedy, 103 miles from aiming point.

Recovery: Astronauts flown by helicopter to carrier Lake Champlain, aboard at 9:25 a.m.

Duration: 119+ revolutions; 190 hours, 56 minutes.

Distance Traveled: 3,338,000 miles.

Highlights: Extended U. S. experience with weightlessness to eight days; accomplished successful station-keeping with second stage of Titan launch vehicle; first utilization of fuel cell as electrical power source.

GEMINI 7 — December 4-18, 1965

Astronauts: Frank Borman, Command Pilot; James A. Lovell, Jr., Pilot.

Liftoff: 12:30:03 p.m.

Initial Orbit: 100.3 miles by 203.6 miles.

Splashdown: 9:05:06 a.m., 700 miles southwest of Bermuda, "within seven miles" of aiming point.

Recovery: Astronauts flown by helicopter to carrier Wasp, aboard at 9:37:35 a.m.

Duration: 205+ revolutions; 330 hours, 35 minutes, 17 seconds.

Distance Traveled: 5,716,900 miles.

Highlights: Extended U. S. experience with weightlessness to 14 days, establishing existing world record for manned space flight; served as rendezvous target for Gemini 6.

GEMINI 6 — December 15-16, 1965

Astronauts: Walter M. Schirra, Jr., Command Pilot; Thomas P. Stafford, Pilot.

Liftoff: 8:37:26 a.m.

Initial Orbit: 100 miles by 161.4 miles.

Splashdown: 10:29:09 a.m., 630 miles southwest of Bermuda, "6.4 miles uprange and one-half mile left" of aiming point.

Recovery: Spacecraft with astronauts lifted aboard carrier Wasp at 11:37 a.m.

Duration: 16+ revolutions; 25 hours, 51 minutes, 43 seconds.

Distance Traveled: 449,800 miles.

Highlights: Achieved historic first rendezvous in space at 2:27 p.m. December 15 over the Pacific when orbital speed was matched with that of Gemini 7; first successful guided reentry.

GEMINI 8 — March 16, 1966

Astronauts: Neil A. Armstrong, Command Pilot; David R. Scott, Pilot.

Liftoff: 11:41:02 a.m.

Initial Orbit: 100 miles by 169 miles.

Splashdown: 10:23:08 p.m., 690 miles southwest of Okinawa, within seven miles of aiming point.

Recovery: Astronauts picked up by destroyer Mason, aboard at 1:28 a.m. March 17.

Duration: 6+ revolutions; 10 hours, 42 minutes, 6 seconds.

Distance Traveled: 181,450 miles.

Highlights: Rendezvous with Agena target followed by world's first docking on March 16, 1966, with another satellite in orbit; utilization of on-board computer program to achieve on-target landing in Pacific recovery area.

GEMINI 9 — June 3-6, 1966

Astronauts: Thomas P. Stafford, Command Pilot; Eugene A. Cernan, Pilot.

Liftoff: 8:39:33 a.m.

Initial Orbit: 98.9 miles by 165.6 miles.

Splashdown: 9:00:47 a.m., 345 miles east of Bermuda and .4 mile from aiming point.

Recovery: Spacecraft with astronauts lifted aboard carrier Wasp at 9:50 a.m.

Duration: 45+ revolutions; 72 hours, 21 minutes, 14 seconds.

Distance Traveled: 1,255,630 miles.

Highlights: Gemini used three separate rendezvous techniques to accomplish multiple rendezvous with Augmented Target Docking Adapter; Astronaut Cernan performed a day-night EVA; landing was most precise in Gemini program.

GEMINI 10 — July 18-21, 1966

Astronauts: John W. Young, Command Pilot; Michael Collins, Pilot.

Liftoff: 5:20:26 p.m.

Initial Orbit: 99.7 miles by 167 miles.

Splashdown: 4:06:11 p.m., 529 miles due east of Cape Kennedy, three miles from aiming point.

Recovery: Astronauts flown by helicopter to carrier Guadalcanal, on board at 4:34 p.m.

Duration: 44+ revolutions; 70 hours, 46 minutes, 45 seconds.

Distance Traveled: 1,223,370 miles.

Highlights: Achieved first dual rendezvous, first with Agena 10, then with Agena 8; recovered experiment from Agena 8 which had been orbiting in space for four months; fired large Agena 10 rocket while docked to raise and then lower apogee.

GEMINI 11 — September 12-15, 1966

Astronauts: Charles P. Conrad, Jr., Command Pilot; Richard F. Gordon, Jr., Pilot.

Liftoff: 9:42:26 a.m.

Initial Orbit: 100 miles by 177.1 miles.

Splashdown: 8:59:34 a.m., 701 miles east of Miami, Fla., and 1.5 miles from aiming point.

Recovery: Astronauts flown by helicopter to carrier Guam, aboard at 9:22 a.m.

Duration: 45+ revolutions; 71 hours, 17 minutes, 8 seconds.

Distance Traveled: 1,232,530 miles.

Highlights: Rendezvous and docking accomplished in first orbit using on-board computation; multiple EVA; large Agena rocket fired to raise apogee to record 850 miles; tethered flight achieved artificial gravity.

GEMINI 12 — November 11-15, 1966

Astronauts: James A. Lovell, Jr., Command Pilot; Edwin E. Aldrin, Jr., Pilot.

Liftoff: 3:46:33 p.m.

Initial Orbit: 100 miles by 174.8 miles.

Splashdown: 2:21:04 p.m., 720 miles southeast of Cape Kennedy, 2.7 miles from aiming point.

Recovery: Astronauts flown by helicopter to carrier Wasp, aboard at 2:51 p.m.

Duration: 59+ revolutions; 94 hours, 34 minutes, 31 seconds.

Distance Traveled: 1,628,510 miles.

Highlights: On-board optical rendezvous accomplished; extensive EVA achieved all designated work tasks; rendezvous with solar eclipse shadow and tethered gravity-gradient test successful.

World Records for Manned Space Flight

1. Longest Duration Manned Space Flight: 330 hours, 35 minutes, 17 seconds by Frank Borman and James A. Lovell, Jr. of Gemini 7. Old record of 190 hours, 56 minutes, set by Gemini 5 astronauts, L. Gordon Cooper, Jr., and Charles P. Conrad on Aug. 21-29, 1965, had eclipsed that of 119 hours, 6 minutes flown by USSR's V. F. Bykovsky, Vostok 5, June 14-18, 1963.

2. Total Man Hours in Space for One Nation (elapsed time, liftoff to splashdown): 1993 hours, 43 minutes, 53 seconds by the United States, compared to 507 hours, 16 minutes for the Soviet Union.

3. Longest Multimanned Space Flight: 330 hours, 35 minutes set by Gemini 7, surpassing the 190 hours, 56 minutes set by Gemini 5, compared with 24 hours, 17 minutes by USSR's V. M. Komarov, K. Feoktistov, and B. B. Yegorov in Voskhod 1.

4. Most Miles Traveled on a Manned Space Flight: 5,716,900 miles by Gemini 7, surpassing the 3,338,000 miles by Gemini 5 and 2,050,000 miles by V. F. Bykovsky in Vostok 5.

5. First Rendezvous of Two Manned Maneuverable Spacecraft: Gemini 7 and Gemini 6 flew for 20 hours, 22 minutes within 62 miles of each other, including a minimum distance of within one foot.

6. First Docking of Two Orbiting Spacecraft: Gemini 8 with Agena 8.

7. Individual With Most Space Flight Time: Astronaut James A. Lovell, Jr., 425 hours, 9 minutes, 31 seconds, exceeding Frank Borman, 330 hours, 35 minutes; Charles Conrad, 262 hours, 13 minutes, 8 seconds; L. Gordon Cooper, 225 hours, 15 minutes, 47 seconds, all USA; and V. F. Bykovsky, 119 hours, 6 minutes, USSR.

8. Most Manned Space Flights: United States 16; Soviet Union 8.

9. Most Astronauts Making Space Flights: United States 26 (including seven who made two flights); Soviet Union 11.

10. Most Manned Flights in One Year by One Nation: United States, 5 in 1965 and again in 1966, exceeding old record of 3 Mercury flights by United States in 1962.

11. Most Men Sent into Space in One Year by One Nation: 10 by United States in 1965 and again in 1966, exceeding 3 by United States in 1962 and 3 by the Soviet Union in 1964.

12. Total Manned Spacecraft Hours: 1015 hours, 47 minutes, 40 seconds by United States; 432 hours, 40 minutes by Soviet Union.

13. Dual Rendezvous: Gemini 10 first achieved rendezvous with a cooperative target, Agena 10, and then, after a series of maneuvers utilizing Agena as well as Gemini maneuvering capability, achieved rendezvous with a passive target, Agena 8.

14. Altitude: Following a 40½ second burn of the Agena 11 primary propulsion system while docked, Gemini 11 reached a record high altitude of 850 miles at apogee on September 14, 1966, surpassing Gemini 10 altitude of 475 miles and Voskhod 2 altitude of 308 miles.

15. First Orbit Rendezvous: Rendezvous with Agena 11 was achieved by Gemini 11 spacecraft and crew two-thirds of way through the first revolution, with initial docking over southern United States.

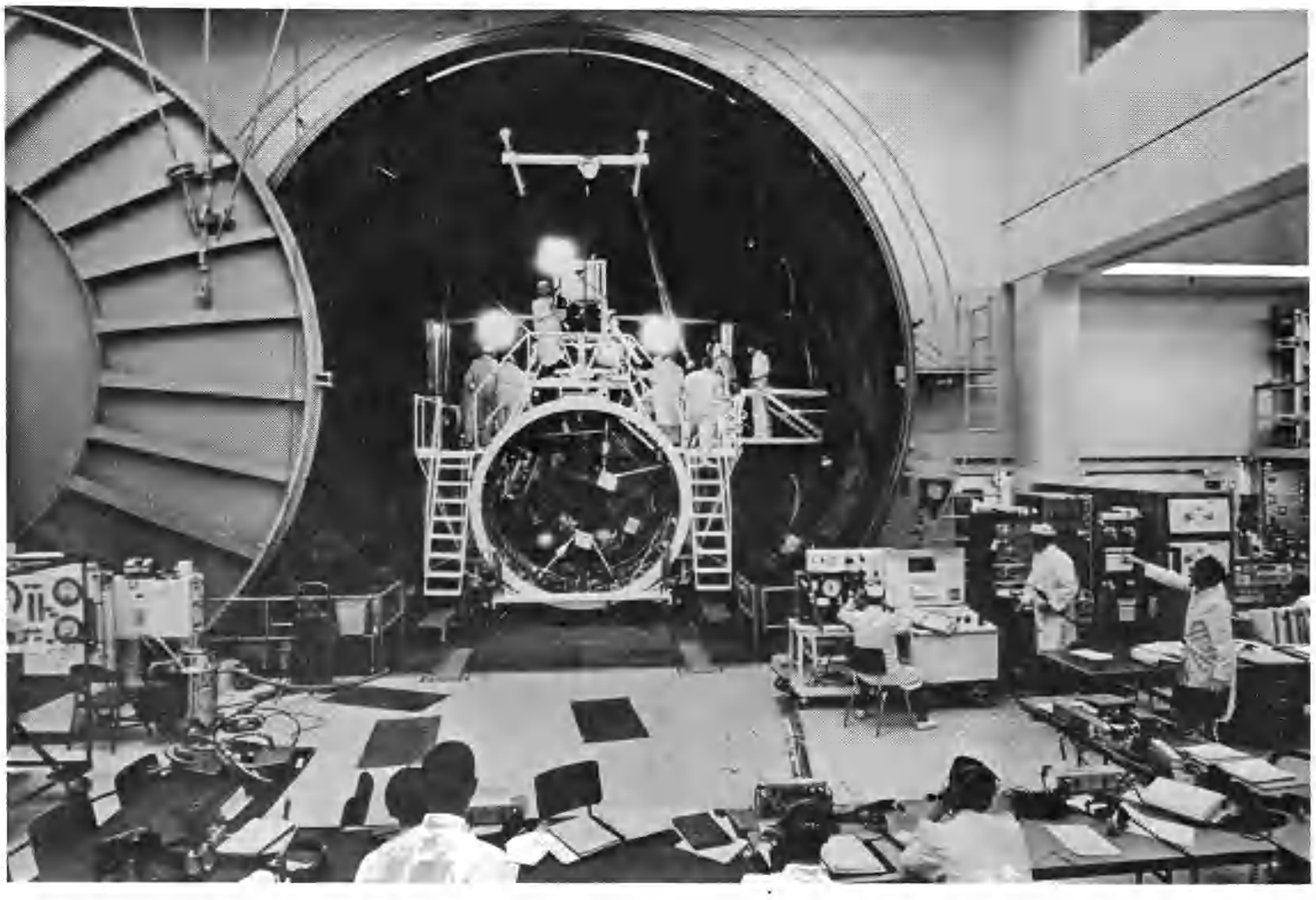
16. First Tethered Flight: After undocking from Agena 11, Gemini 11 was backed away 100 feet to the end of a tether, after which a downward thrust was applied to establish an essentially in-plane rotation. The centrifugal force between the tethered Gemini and Agena resulted in artificial gravity of approximately 0.00015 g.

17. Distance Traveled in Manned Space Flight: Mercury and Gemini combined, 17,616,810 miles, USA; Vostok and Voskhod, 7,419,000 miles, USSR.

18. Single EVA: Edwin E. Aldrin, Jr., two hours, 9 minutes outside Gemini 12 on November 12, 1966, surpassing Eugene Cernan's two hours, eight minutes on June 5, 1966.

19. Total EVA for One Flight: Edwin E. Aldrin, Jr., 5 hours, 37 minutes, Gemini 12.

20. Total EVA Time for Gemini Program: 12 hours, 31 minutes.



IN 30-FOOT FLIGHT SIMULATION CHAMBER at McDonnell Space Center, Gemini 12 is readied for a simulated mission into the frigid vacuum of outer space. Astronaut training brought both prime and backup crews to McDonnell to "fly" their assigned Gemini on simulated missions. Closing of chamber's sliding door creates a cylinder 30 feet in diameter, 36 feet in length.

. . . How Company Met Gemini Challenge

(Continued from Page 3)

with NASA, customer approval was received within a week. The design of the necessary modifications, fabrication of test specimens, testing in the laboratories, fabrication of the flight articles and the installation and test in the spacecraft were achieved within the limited time available, and Spacecraft 7 was ready for launch on the originally scheduled date.

Most of the objectives set for the Gemini program were accomplished during the Gemini 7/6 mission which, to the minds of many, was the highlight of the entire program.

The idea for the Gemini 7/6 mission was formed on October 25, 1965, minutes after the first scheduled Gemini-Agena rendezvous mission was cancelled. The Gemini 6 spacecraft countdown stood at T-42 minutes, and the Agena target was lost before achieving orbit.

Gemini 7/6 Suggestion

Within five minutes of the Agena loss, the suggestion was made to NASA that since Spacecraft 7 was already at the Cape, why not launch it on its scheduled 14-day flight, then accelerate the reactivation of the pad and put Gemini 6 up to rendezvous with its spacecraft twin? Four days later, after thorough analysis and study of the problems involved, and approval by all NASA officials, including James E. Webb, NASA Administrator, President Johnson announced the Gemini 7/6 rendezvous mission. "Spirit of 76" was the name given to the mission by the group headed by Christopher C. Kraft, Jr., Flight Operations Director, Manned Spacecraft Center.

Now the hard work began in earnest. Gemini 7 had been scheduled to go on the pad in late October for its scheduled December 4 launch. That would put December 18 as recovery date for the 14-day mission. The scheduled launch date of December 4 had been moved ahead two weeks so that the Department of Defense recovery forces would be available in strength.

Despite this two-week acceleration in the schedule, Spacecraft 7 had to be modified for installation of a radar transponder and acquisition lights to serve as an active radar target for Spacecraft 6 during the rendezvous. In addition, the entire flight plan had to be re-worked.

Team Enthusiasm

Working against these odds, a tremendous amount of work went into the task of transforming the 7/6 flight from an idea to a reality and it was made possible only by the tremendous enthusiasm of all members of the Gemini team. The 7/6 mission was a ray of light shining through the darkness of a failure and the morale of the entire team was high. Everyone believed the challenge could be met and everyone worked feverishly to bring about the flight.

The 10-day schedule between launch of Gemini 7 and launch of Gemini 6 was cut to nine days. The McDonnell crew, however, was ready in eight days, only to have a booster shutdown mar the preparations. The spacecraft and launch vehicle were recycled in three days (although it had taken all of 41 days to recycle the unmanned Gemini 2 flight after the launch was scrubbed 1.7 seconds after ignition by a launch vehicle engine shutdown due to loss of hydraulic pressure). All of this Gemini 6 work, of course, had to be accomplished in the hard glare of international publicity, keeping in mind always that the safety of the astronauts was of paramount concern.

Stress on Safety

Safety, was one of the cardinal principles of McDonnell philosophy on the Gemini program. All design concepts were based on the premise of absolute intolerance of a single-point failure in any system that would endanger the lives of the astronauts. In addition, the entire Gemini program was marked by a dedicated perseverance in tracking down failures and applying failure analysis so that they could not occur again.

Rigid standards of quality assurance, high performance and inspection standards and a strongly motivated Zero Defects program contributed immeasurably to the success of the Gemini project.



FORMING OF THE GEMINI HEAT SHIELD required precise machining, careful and frequent inspection to maintain the close tolerances that were an absolute necessity. Here a team of McDonnell machinists, inspectors and foremen perform one of many detailed inspections of a 90-inch-diameter, dish-shaped heat shield.

Among Gemini Inputs

Statistics such as the following help point up the story of our company's significant participation in the Gemini Program:

- 11⅓ million engineering man-hours.
- 7¾ million manufacturing man-hours.
- 6¼ million support personnel man-hours.
- 5,322 McDonnell personnel, in 138 different job classifications, at peak of program.
- 352,000 square feet of floor-space at peak of program.
- 3500 hours of wind tunnel time.
- 19,000 hours of computer time.
- 16 trillion computer computations at a quarter million computations per second.

NASA Cooperation

One key to the remarkably successful series of Gemini spacecraft flights was the tremendous teamwork between all interdivisional levels of the Gemini project at McDonnell and the enthusiastic cooperation of our counterparts at the National Aeronautics and Space Administration. Since teamwork is a hallmark of the McDonnell philosophy, a close relationship between ourselves and NASA was inevitable.

Dr. Robert R. Gilruth, Director of the Manned Spacecraft Center, and James A. Chamberlin, who was then with the Mercury program office at MSC, deserve credit for originating the idea of a Gemini program. They asked for advanced design studies and strongly favored this program.

A large measure of the credit for the excellent teamwork between NASA and our people must go to Charles W. (Chuck) Mathews, Gemini Project Manager. He had the ability to develop the rapport necessary to make the program roll and both the authority and the capability to make decisions during the course of the program.

George M. Low, Deputy MSC Director, who worked closely with Chuck Mathews as a team, and Kenneth S. Kleinkenecht, Assistant Program Manager, who handled the day-to-day business and did an outstanding job, warrant great credit.

Another key member of the NASA Gemini team, Chris Kraft, whose world-wide tracking network functioned perfectly flight after flight, and whose operations staff did an outstanding job in handling each flight, is worthy of commendation.

At the headquarters level, Mr. James E. Webb, Dr. George E. Mueller, NASA Associate Administrator, and Dr. Robert C. Seamans, Jr., Deputy Administrator of NASA, provided dynamic leadership, full and continued support, and creative management suggestions.

Gemini was a team effort all the way, and all divisions within the company contributed to the success of the program.

Gemini Heat Shield

The Gemini heat shield, for example, was a McDonnell designed and developed product. The General Engineering Division laboratories had been doing considerable work in

(Continued on Next Page)

inventing and developing new ablative compounds and the company had patented the ablative material used to form the heat shield. But it took the combined skills of Research, Materials and Process, GED, design, thermal and stress departments to make this development a success. The McDonnell heat shield resulted in a saving of 125 pounds over the Mercury-type shield which was obtained from a subcontractor.

Making of Coldplates

Another McDonnell contribution to improved spacecraft fabrication was the manufacturing technique devised for the 24 coldplates on which electronic equipment is mounted. These coldplates serve as heat exchangers to maintain proper temperatures. Originally, the coldplates were contracted to a supplier who was unable to produce these items to spacecraft specifications.

McDonnell had to bring this work back into its own plant and, through another team effort, develop the required tooling and production techniques. This system, incidentally, performed flawlessly through the 12 Gemini flights.

The brazing of all plumbing lines in the propulsion system was another McDonnell development, and one which was pushed by Engineering Manager Bob Lindley. Brazing, it was known, would eliminate fasteners which have a tendency to leak, but for this particular work new brazing tools had to be invented by our tooling engineers. Testimony to the importance of this work is the fact that not a single leak developed in any plumbing line on any Gemini flight.

Separate Fabrication

Another McDonnell innovation on Gemini was an early decision to fabricate the wire bundles separately from the spacecraft and make all terminations before the bundles were installed. This gave us the ability to run continuity and quality tests before installation, and minimized the possibility of error in electrical hookups. This wire bundle technique, a carryover from our F-4 Phantom experience, gave us the flexibility to change the wiring more easily as the mission planning changed on each flight.

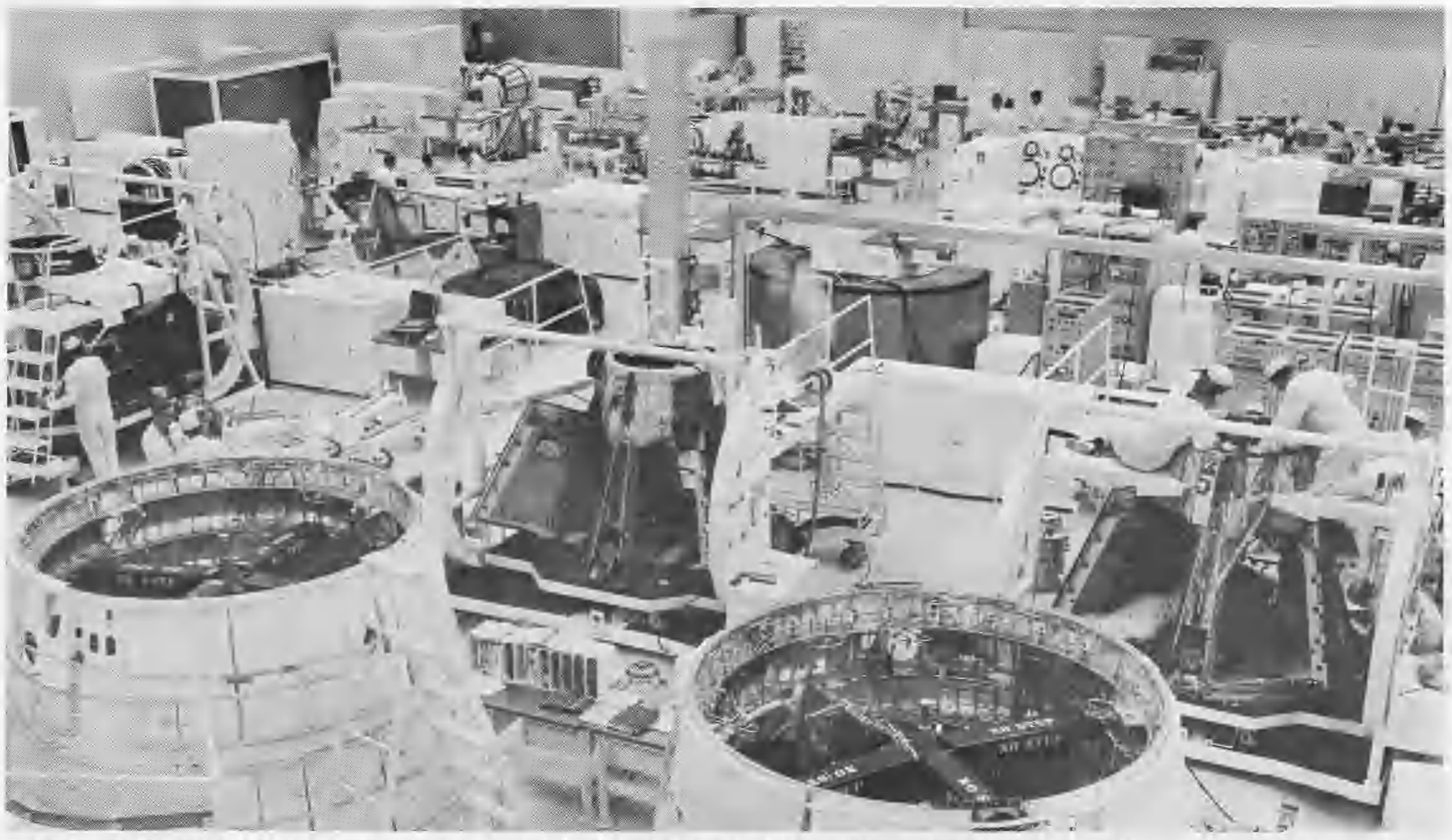
The Gemini Time Reference System, consisting of an electronic timer, a time correlation buffer, an event timer, a digital elapsed time clock, and a GMT clock displaying Greenwich Mean Time in hours and minutes, was designed and initially built by McDonnell's Electronic Equipment Division, then later built by one of our subsidiaries, Conductron-Missouri.

New Tooling Techniques

Development of new tooling techniques for forming and welding continuous magnesium-thorium tee-bulb extrusions was another significant development. These extrusions served both as stiffening stringers and as a closed passage for the coolant that converts the equipment adapter to a radiator.

McDonnell also developed a number of thermal coatings necessary for thermal balance of the spacecraft and its equipment. The proper coatings were selected after numerous tests by the GED laboratories and the Research Division, using furnaces and vacuum chambers and ultraviolet radiation to simulate the space environment for periods equivalent to two weeks.

Although space walking or extravehicular activity (EVA) was not an original objective of the Gemini program, this achievement was made possible by the design of personnel hatches, contoured to the shape of the conical cabin, and located on top of the spacecraft. Mechanical latching devices on the Gemini hatch permitted opening and closing of the hatches manually by the astronauts from inside the cabin. It was this arrangement that made EVA possible when this requirement was added to mission planning for the first time on Gemini 4.



FINAL GEMINI FABRICATION was performed in Space Center's huge clean room where temperatures and humidity are carefully controlled. Clean room's powerful filtration systems remove virtually all dust and other minute particles from the air.

Also conceived by McDonnell was the Gemini escape system, using ejection seats to provide safe escape of the astronauts in an emergency that might occur while the launch vehicle was still on the pad, during lift into orbit or after spacecraft reentry. This system eliminated the need for an escape tower such as was used on Mercury flights.

The McDonnell-developed concept of delivering the Gemini spacecraft from factory to pad in a launch-ready condition, with the exception of installation of pyrotechnics and some interface tests such as mating with the Agena, was a major factor in reducing the launch cycle time.

St. Louis GSO

A Gemini Spacecraft Operations (GSO) organization was created at McDonnell in St. Louis to function similarly to the launch group at the Cape. The St. Louis GSO group, responsible for getting each spacecraft initially ready for launch before actual delivery, had close liaison with the team at Cape Kennedy and thereby eliminated the need for industrial testing at the Cape.

The fixed-base Gemini simulator at McDonnell, using hybrid computer systems, made a major contribution to mission planning efforts and development of astronaut techniques.

In working with NASA, McDonnell had a philosophy of *Action Without Debate*. Our position was "Let's put forth an all-out effort to make the program work." McDonnell pioneered the incentive contract negotiated between NASA and ourselves. This contract made it necessary for each party to define what was important to the success of the program. It created discipline and brought the program objectives into focus. It is significant that each spacecraft covered by this agreement was delivered by McDonnell at least 30 days ahead of schedule.

Most Pleasing Aspect

The most pleasing aspect about Gemini is that not a single astronaut was harmed in any way during the entire program of 10 manned flights; each crew was successfully recovered and each astronaut was recovered in excellent physical condition.

One of the big factors in the success of the Gemini program and especially in reducing the time required between flights, was the improvement in our testing capabilities. The quality of the equipment in the spacecraft was very high and as we developed the skills of the checkout crews both in St. Louis and at the Cape, we were able to cut the time span between flights without sacrificing one iota of safety. Most of the problems that did show up on check-out proved to be in the ground equipment which, due to mission changes, was changed more than spacecraft equipment from flight to flight.

Thanks to Many

I would like to pay tribute to each and every member of our Gemini team for a job "well done." Without the collective skills and dedication of everyone, from technician to Engineering Manager and Technical Director, the accomplishments of Gemini would have been impossible. To list the names of all who deserve credit is not possible in the space allotted.

And I would be remiss in not giving due credit to the nearly 3500 subcontractors and suppliers who worked so splendidly with us in the Gemini program. These participants represented 46 states, the District of Columbia, Canada and England. About two-thirds of them were small business firms.

In making our participation possible, we all owe a real debt of gratitude for the constant support of our Chairman, Mr. Mac. Without his leadership, encouragement and enthusiasm, our role in this great program could not have succeeded.

Gemini for me was a "fun" program — one that I would not have missed — and I shall be ever grateful for the opportunity to have participated in the Free World's all-important first two pioneering stages of space exploration.

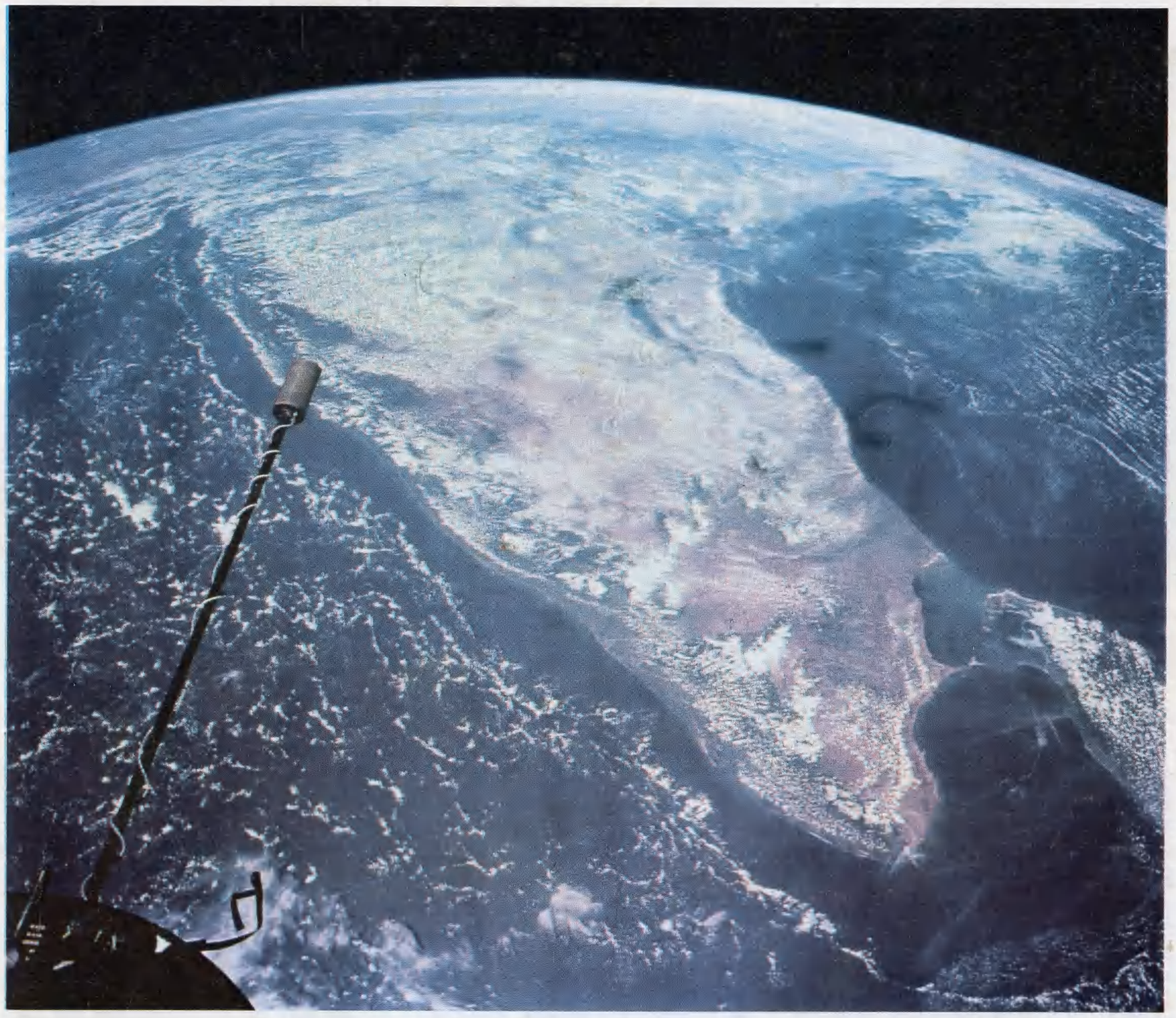
How Many Gemini Parts?

For the oft-asked question as to how many parts in a Gemini Spacecraft, NASA has an estimated answer, and it is based on a breakdown by McDonnell engineers on the number of isolated molecular (individually formed) parts in each of the spacecraft's components:

The total figure: 1,230,000 parts, including every rivet, every everything.



FLASHBACK TO WELDING of Gemini Spacecraft in Building 1 before this important operation was moved to the Space Center. Welders are working on spacecraft's pressurized cabin section which was comprised of 85% welded-titanium assemblies. The welding of titanium to hold tolerances to ±.010 inch was one of the major McDonnell breakthroughs in the Gemini program.



Gemini's Spectacular Geography Lessons

Gemini flights brought to man the most remarkable photographic views thus far provided him of the Earth on which he lives. One such geography lesson from outer space is shown at left—India and Ceylon from 460 nautical miles high. The view is north, with the Bay of Bengal on right above Ceylon, the Arabian Sea on left of India. The Maldive Islands lie in distance to right of base of L-band antenna rising from Agena target vehicle docked to Gemini 11. India's city of Bombay is on coast just to right of can-shaped antenna; capital city of New Delhi is slightly more than two inches northeast of antenna. Scientists have proclaimed the value of Earth photos taken by Gemini astronauts. Among subjects observed from these photos are precise erosion patterns, rock types, extensive geologic fault systems, mineral patterns and ocean-bottom topography, and Gulf Stream currents. Gemini photos clearly showed the excess salinity of the soil of Texas cotton fields. A Gemini photo of California's Salton Sea that could be duplicated only by piecing 500 aerial pictures together even showed phenomena that do not appear in aerial photos. Among other phenomena photographed by Gemini astronauts: the mysterious glow in the sky called gegenschein; zodiacal light, or the line of light near the Earth's horizon at sunset and sunrise.

'Happy to End the Gemini Program With a Success' — Lovell

(Continued from Page 1)

on November 11, the first spacecraft to be put in orbit on a major holiday — Veterans' Day. It was a letter-perfect launch, as was that a little more than an hour and a half earlier of the Agena rendezvous vehicle. The first docking took place on the third Gemini revolution, over the tracking ship Coastal Sentry, south of Japan. It was the program's fourth Gemini-Agena rendezvous and docking.

A retrograde burn of 43 feet per second, using the Agena's secondary propulsion system, changed the orbit of the combined vehicles to 139 by 154 nautical miles, setting the spacecraft orbit to phase with the November 12 total eclipse of the sun over South America. Following a sleep period, there was another eclipse-phasing maneuver that enabled the crew to take, through their Gemini windows, the first solar eclipse photographs from space.

Aldrin then made the first of two stand-up extravehicular activities. While his hatch was open for two hours and 29 minutes, he completed several photographic tasks and scientific experiments.

Umbilical EVA

On the third day, activities revolved mainly around an umbilical EVA by Aldrin. Outside the spacecraft for two hours and nine minutes, on a 30-foot umbilical, he performed measured work tasks at the Agena docking adapter and at a work station in the Gemini adapter section. He also attached a 100-foot tether stored in the Agena adapter to the Gemini docking bar.

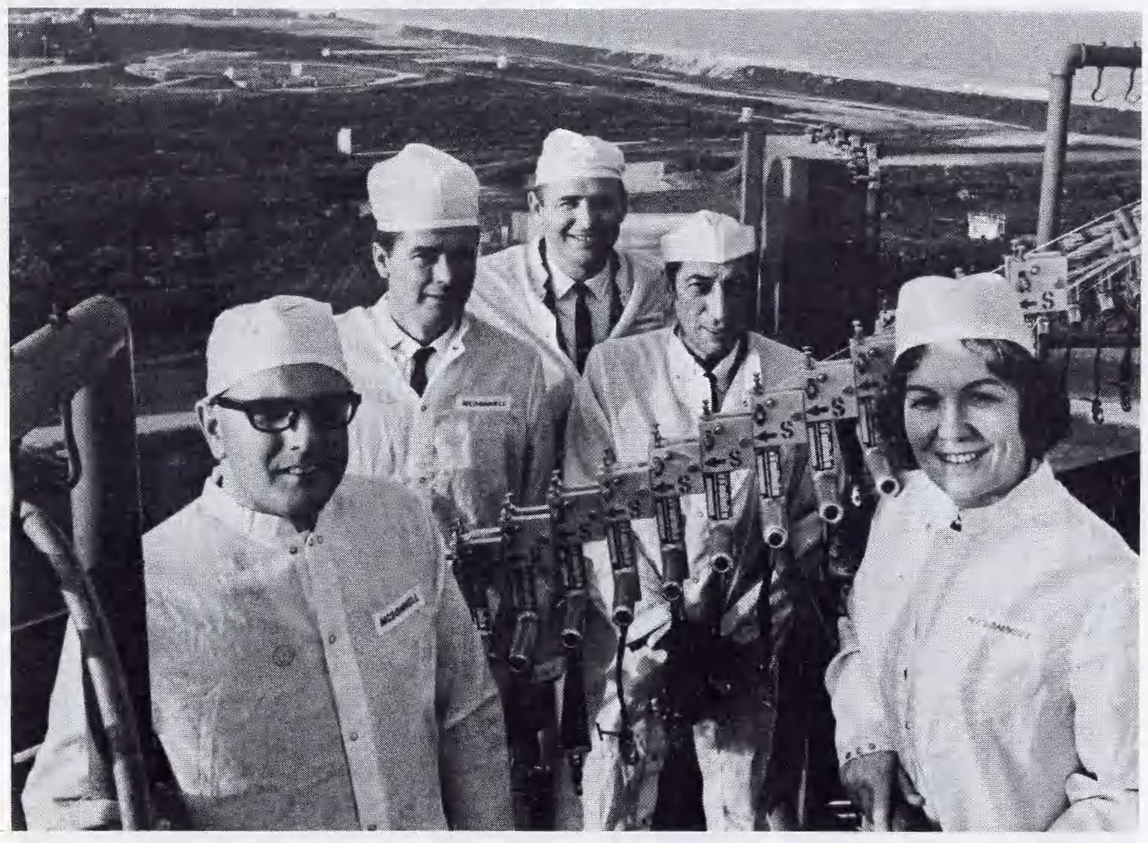
Gemini 12 backed out of the Agena docking collar and, one revolution later, gravity gradient had been established. The tether exercise lasted four hours and 17 minutes.

In his second stand-up EVA — lasting 59 minutes — Aldrin jettisoned unused equipment and conducted additional experiments and photography.

Covered by Television

The spacecraft's pinpoint automated splashdown in the Atlantic Ocean was three miles from the aircraft carrier Wasp. The entire show — landing, helicopter pickup of the astronauts and their joyous welcome aboard the carrier — was telecast live via the Early Bird satellite to an estimated 50 million Americans.

Astronaut Lovell, before microphones aboard the carrier, had a terse but appropriate statement for the 2700 Wasp crewmen and the television audience: "We're both happy to end the Gemini program with a success."



Five MAC/ZD Citation winners pose for group portrait just outside clean room atop the Launch Complex 19 erector at Cape Kennedy. Scenic backdrop shows other launch sites and Atlantic Ocean. The five citation winners were on an orientation visit to the Cape to observe McDonnell operations prior to the Gemini 12 launch. They are from left: Frederick L. Innes, Contract Coordinator; Vernon L. Hampton, Radio, Electrical and Electronics Inspector; Dale Johnson, Aircraft Maintenance Engineer; Marion Wolf, Experimental Mechanic; Mrs. Margaret Tisdale, Chief Telephone Operator. A similar trip to the Cape was made prior to the Gemini 11 launch by five other MAC/ZD Citation winners: James L. Bledsoe, Aerodynamics Engineer; Raymond W. Shelton, Flight and Service Inspector; Anthony "Tony" J. Matalonis, Radio, Electrical and Electronics Inspector; Walter L. Painter, Electrical and Electronics Mechanic; Neal A. Howard, Manufacturing Specialist.

Attention: Castor & Pollux

Gemini. The name of the United States' second phase of space exploration is also the name of the third constellation of the Zodiac. From Greek mythology derives the legend that the god Zeus, after the death of his twin son, Castor, agreed to let the other twin, Pollux, share his brother's immortality by placing them both in the heavens as the twin stars of Gemini, charged with giving divine protection to distant voyagers.

Knowledgeable of this background, when writing at the conclusion of the Gemini program, a friend of the company wryly concluded his letter with: "Though the exploits of the McDonnell Twins are now history, Castor and Pollux will never again be the sole proprietors of Gemini."

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