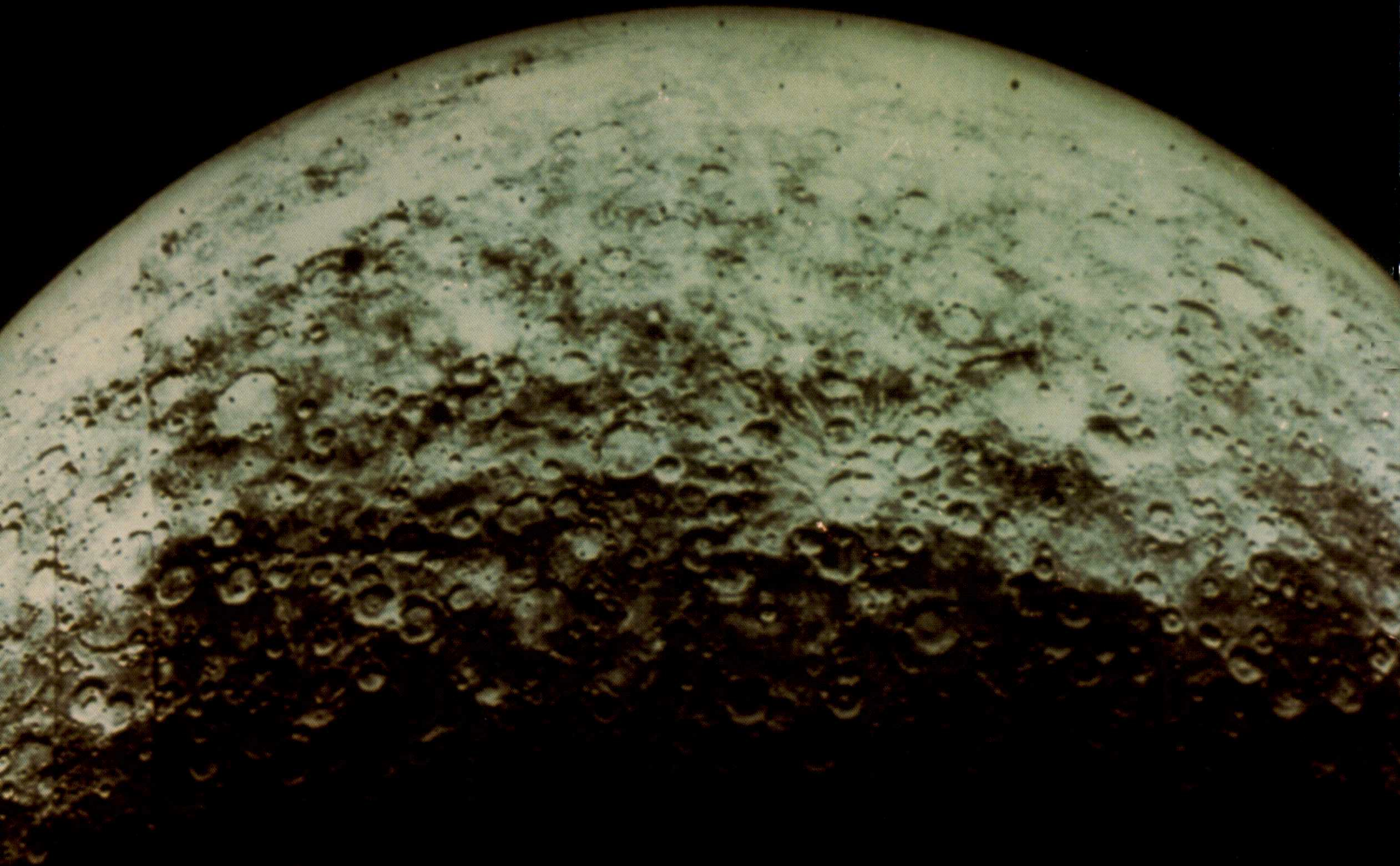
The American Society of Mechanical Engineers

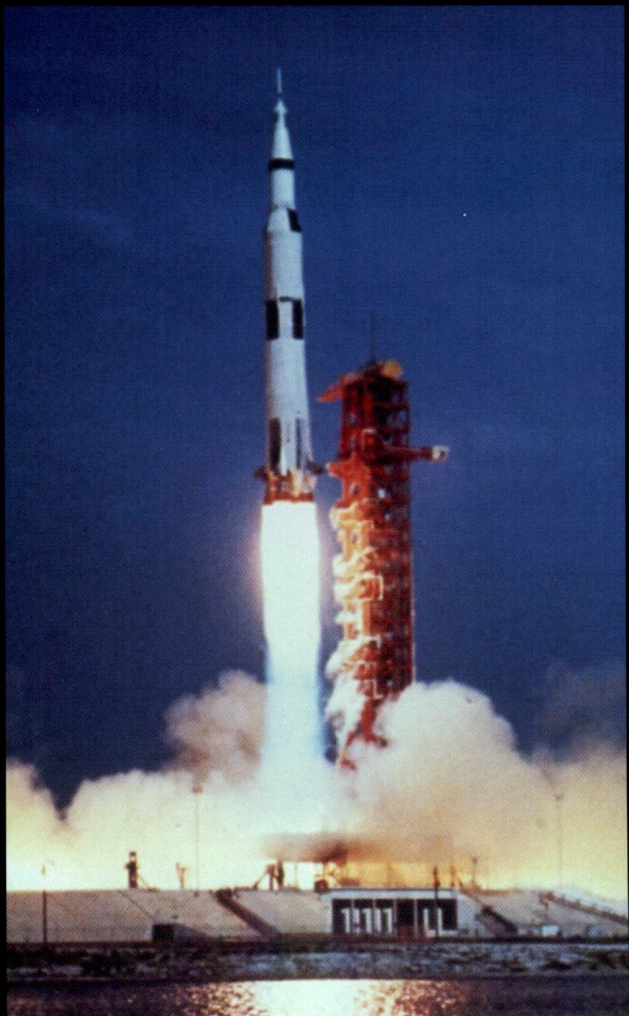
The Lunar Module: A National Historic Mechanical Engineering Landmark

Nassau County Cradle of Aviation Museum
Garden City, Long Island, NY

April 19, 2002

NORTHROP GRUMMAN
Integrated Systems





The year was 1969. At the end of a tumultuous decade that had begun in Camelot and was ending in a quagmire called Vietnam, three men, thousands of miles from home, were poised on the threshold of history.

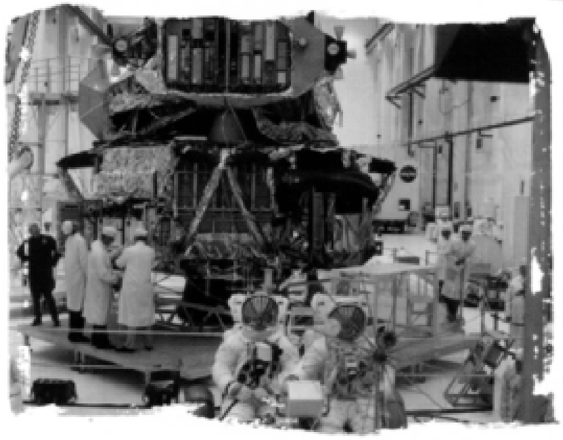
"Houston, Tranquility Base here. The Eagle has landed. "

These words were the capstone on the United States' manned space program. Seemingly in response to President Kennedy's challenge that the U.S. put a man on the moon before the end of the decade, LM pilot Edwin "Buzz" Aldrin and mission commander Neil Armstrong gently landed the Apollo 11 Lunar Module (LM) Eagle on the lunar surface. In the late hours of July 20, 1969, with millions tuned in worldwide via television or radio, Neil Armstrong slowly descended the LM boarding ladder and, with the now famous words, "One small step for man, one giant leap for mankind," became the first person to set foot on the moon. Nearly 22 hours later, the LM returned Aldrin and Armstrong to the Apollo 11 Command Module where they rejoined pilot Michael Collins for the long ride back to Earth.

In 1957, only 12 engineers were working on long-term, space-related activities at the Grumman Aircraft Engineering Corporation's Bethpage, N.Y., facility. On October 4, 1957, these activities, as well as those at a myriad of aerospace and government locations, suddenly became focused on the near-term, as Russia initiated the "race for space" with the launch of Sputnik, the world's first satellite.

The Sputnik launch created shock waves in the United States. Image-wise, Sputnik spelled disaster for the U.S. In 1957 most Americans considered Russia to be "technologically challenged" or living in a technical Stone Age. The launch not only showed Russia's ability to launch spacecraft, it meant that they had boosters strong enough to launch intercontinental ballistic missiles. The space race had taken on a new and much darker visage. In the words of one of those early Grumman engineers, "When the Sputnik came along, it just gave impetus to what we were doing…It was like being able to give the government a prod to do what you thought they should be doing all along." John Coursen, then Grumman Lunar Module program manager, recalls "It came up over the horizon exactly as scheduled, and absolutely amazed me…and it made me feel bad inside because it wasn't ours. It was somebody else's, and I couldn't understand how they could do that and we could not, or had not."

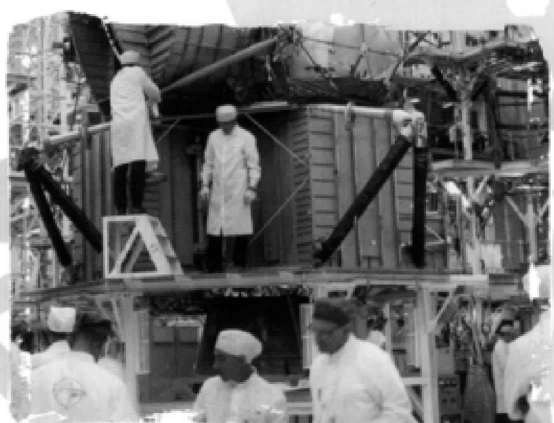
In 1961, the newly inaugurated president, John F. Kennedy, saw Russian missile advances as a direct challenge. While not ready to extend the



existing space program through to the planned successor, the Apollo program, President Kennedy did approve development of a larger booster rocket, the Saturn. Several weeks later the Soviet Union again raised the stakes when it put the first human in earth orbit, Cosmonaut Yuri Gagarin. Shortly after Gagarin's flight, the United States put its first man in space on May 5, 1961.

Although suborbital and not much more that a rocket-enhanced toss of 116 miles, Alan Shepard's brief sojourn had a tremendous emotional impact. Unlike the Soviets, the United States allowed the world to watch Shepard's flight. With the successful recovery of Shepard and his capsule from the Atlantic Ocean, the United States entered what would become known as the space race. In a speech before Congress on May 25, President Kennedy announced his vision of the finish line to that race: "I believe that this nation should commit itself to achieving the goal, before the decade is out, of landing a man on the moon and returning him safely to Earth."

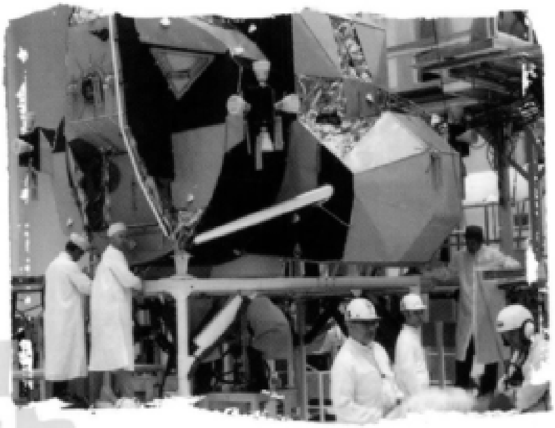
Studies on manned space flight were now being conducted in earnest at Grumman. When interviewed for a documentary marking the 20th anniversary of the lunar landing, Thomas J. Kelly, who served as the engineering manager and eventually deputy program manager for



the Lunar Module Program at Grumman recalled, "When the original idea of going to the moon was conceived, NASA hadn't really pinned down exactly how they were going to go to the moon... the details of how you were going to actually go out to the moon and return were undecided, even up to the point where the contract was let for the Command and Service modules."

As the studies progressed, three approaches to landing and retrieving men from the moon were proposed: a direct ascent, an Earth orbit rendezvous, and a lunar orbit rendezvous. By mid-1962, the Grumman engineering team was convinced that the lunar orbit rendezvous was the best method. This approach called for the Lunar Module to orbit the moon attached to the Command and Service modules, then separate from them, descend to the lunar surface, and, when the mission was complete, to ascend and allow the astronauts to rejoin the remaining orbiting modules for the return trip to Earth. Kelly further recalled that "the lunar orbit rendezvous approach was selected because it was more economical. One of the main advantages...was that it allowed you to specialize the spacecraft...specifically, the Command Module could be specialized for re-entry which was a very demanding environment [and] the Lunar Module was able to be specialized for operations in space and on the moon."

NASA was also convinced that this approach, which was originally derived by John Houboldt of NASA, was superior. Requests for proposals for a moon lander design were issued by NASA, with Grumman submitting its response in September of 1962. Joseph G. Gavin Jr., then a vice president of Grumman and eventual President of Grumman Corp., remembers the bid process clearly: "The request for bid on the Lunar Module was unique...in that it did not ask



for a specific design. It was almost like a game of 'Twenty Questions.' You answer these questions, and if we think you know what you're talking about, we'll talk to you later."

On November 7, 1962, NASA announced that the Grumman-proposed engineering concept had been chosen as the winning design. Eleven days later, a team of Grumman engineers was on-site in Houston. (The actual contract would be signed on January 14, 1963.) In March 1969, the first crewed mission of the Lunar Module took place; 2 months later, the Lunar Module entered lunar orbit for the first time. On July 20, 1969, the Lunar Module made its first lunar landing. During the Apollo Program, Grumman built 13 Lunar Modules, with six of those landing on the moon. The 13th and final Lunar Module was never flown and is on permanent loan from the Smithsonian Institution to the Cradle of Aviation Museum, located in Garden City, N.Y. Said Kelly, "There was a dedication and a drive on the Lunar Module program that I haven't seen equaled since. We're talking about thousands of people here that were swept up in the enthusiasm and the historic importance of this endeavor. People who were doing some pretty routine and mundane jobs were doing it with great pride and great enthusiasm...Remember, there are six descent stages today sitting on the moon... with a "Made in Bethpage, New York" nameplate on them. And that's something that thousands of Grummanites take great pride in."

Vehicle	Mission	Flight Dates	Description
LM-1	Apollo 5	22 January 1968	1st test flight. Verified ascent and descent stage propulsion systems in earth orbit.
LM-2			Designed for flight test–mission never flown. Now located at the NASM in Washington, D.C.
LM-3	Apollo 9	3 March to 13 March 1969	1st crewed flight to test the entire integrated system in Earth orbit.
LM-4	Apollo 10	18 May to 26 May 1969	Test of spacecraft operations in lunar orbit.
LM-5	Apollo 11	16 July to 24 July 1969	1st lunar landing
LM-6	Apollo 12	14 Nov to 24 Nov 1969	2nd lunar landing
LM-7	Apollo 13	11 April to 17 April 1970	Mission aborted in trans-lunar phase due to loss of service module electrical power. LM-7 served as a rescue lifeboat for the astronauts.
LM-8	Apollo 14	31 Jan to 9 Feb 1971	3rd lunar landing
LM-9			Backup spacecraft orginally scheduled for Apollo 15– never flown. Now located at the Kennedy Space Center, FL.
LM-10	Apollo 15	26 July to 7 August 1971	4th lunar landing. LM designed for extended stay.
LM-11	Apollo 16	16 April to 27 April 1972	5th lunar landing
LM-12	Apollo 17	7 Dec to 19 Dec 1972	6th and final lunar landing
LM-13	Appollo 18		Mission was cancelled and LM-13 is on display at the Cradle of Aviation Museum, Garden City, NY.

When NASA awarded Grumman Aircraft Engineering Corporation the contract to design the system that would transport astronauts to and from the lunar surface, the complexity of the tasks ahead was not readily apparent. Simply put, the engineers assigned to the effort had no reliable data on which to base their design. Indeed, the first 3 months were spent establishing a shape for the vehicle that would accommodate the internal subsystems. Tom Kelly had been working on Grumman's Apollo Program-related efforts since 1960. Reflecting on the problems encountered by the engineers, Kelly said, "We didn't know anything about space anymore than most people did at that time. But we did know a lot about producing reliable flying machines that had to operate in a very hostile and demanding environment. The skills that we had available...were very directly applicable to the design of the Lunar Module."

Originally estimated as a 6- to 9-month effort, the design of the Lunar Module would take nearly 2 years to complete, continuously evolving as changes were made to the Command and Service Modules and to the Saturn booster rocket. The biggest changes were to the external design of the module itself. The basic design as proposed, a two-stage vehicle with a variable-thrust descent engine and a fixed-thrust ascent engine, would remain. The descent stage would also serve as a launch pad for the ascent stage when the lunar mission was complete. However, almost everything else changed.

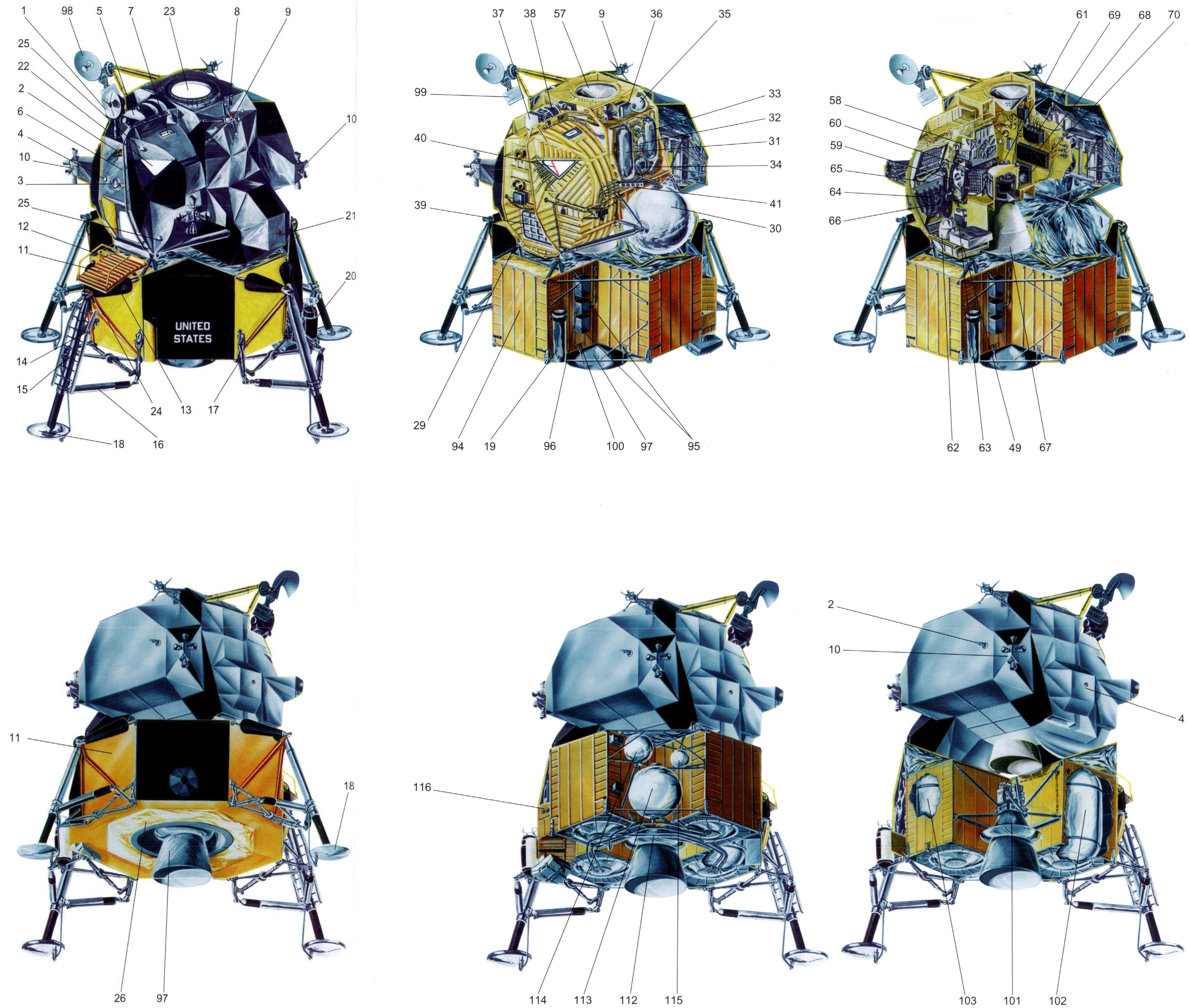
The close cooperation between customer and contractor became clear during April 1963 meetings at which NASA officials and Grumman engineers presented their designs. While some design elements were evident in both configurations, design differences in such crucial areas as the size and shape of the cabin and the fuel tank location were worked out during detailed discussions between Grumman and NASA. One critical area still to be resolved was the astronaut cockpit configuration, which in the early design had the astronauts seated.

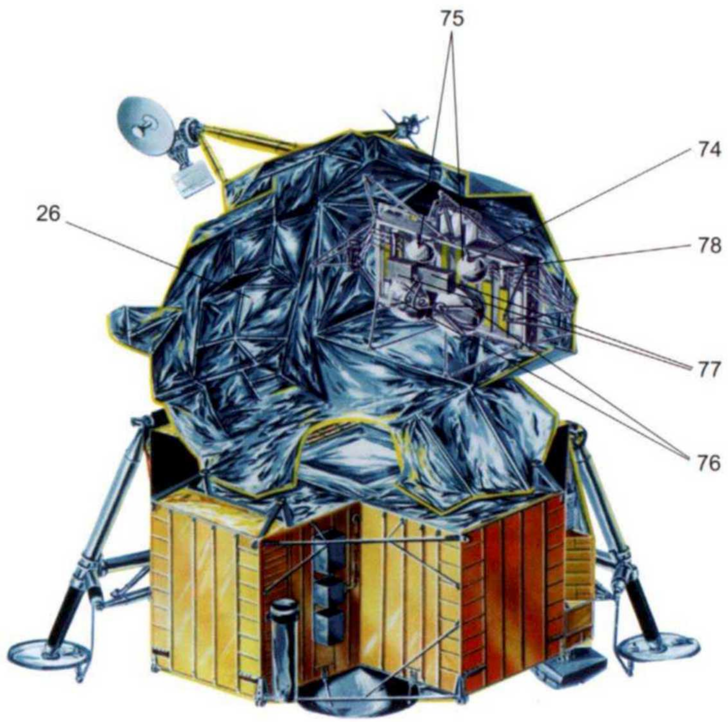
Another major obstacle in the design was the vehicle's overall size and weight, which mandated how much fuel would be needed to guide the Lunar Module to the lunar surface and then return it safely to the Command Module. The agreed upon design had the Lunar Module structure wrapped around the fuel tanks. Therefore, as the need for more fuel mandated an increase in fuel tank size, the module itself would also require expansion to accommodate that change. While engineers wrestled with this problem, the Marshall Space Center began discussions about increasing the lift capability of the launch vehicle, the Saturn V rocket. With increased lift, the proposed 9,000 kg target weight of the Lunar Module could be increased to between 12,700 and 13,600 kg, thereby accommodating the envisioned increase in vehicle size.

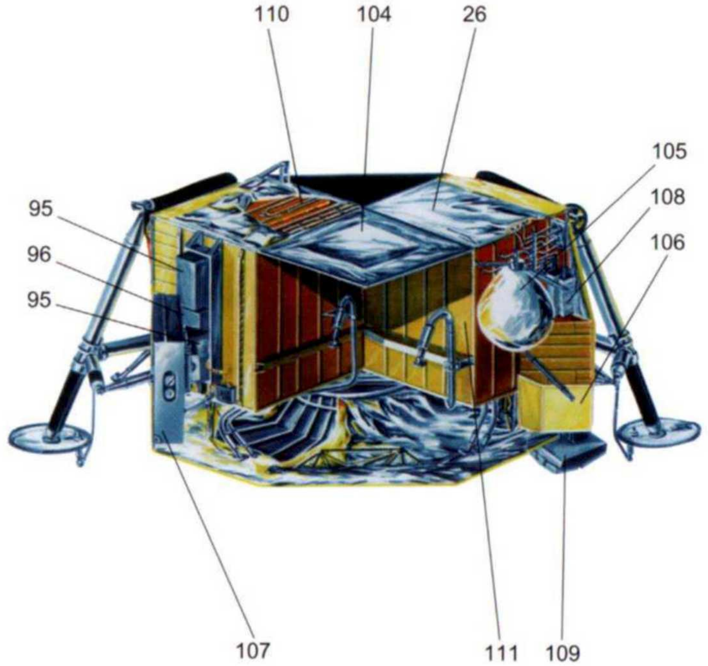
Paramount to the "look" of the ascent stage were its windows, which were the basic means of observation for the astronauts. The Lunar Module was controlled manually, and the windows would prove crucial for choosing a landing site, determining whether a mission should be aborted, and for maneuvering the module for docking with the Command Module. Visibility had been a point of emphasis in the Grumman proposal, which had featured a design with four large windows that enable the crew to view forward and downward. Unfortunately, windows this large would require extremely thick glass, which would impose a weight problem; additionally, the large windows provided grater potential for thermal imbalance, thereby impacting the environmental control system. Eventually, two smaller, triangular windows (canted downward and inward) replaced the four-window design, yet provided the astronauts with the same field of view because they stood rather than sat. This change in window dsign impacted the entire design of the module, which went from a spherical shape to one that was cylindrical.

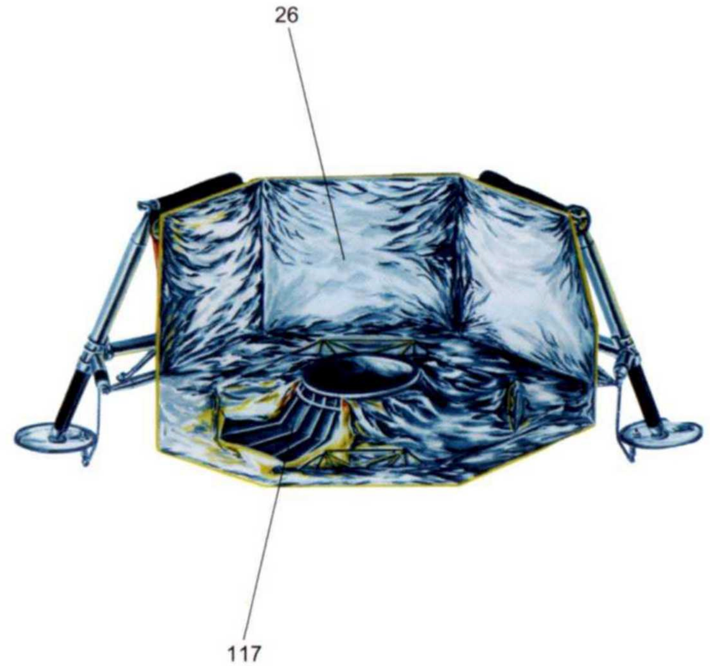
The Lunar Module

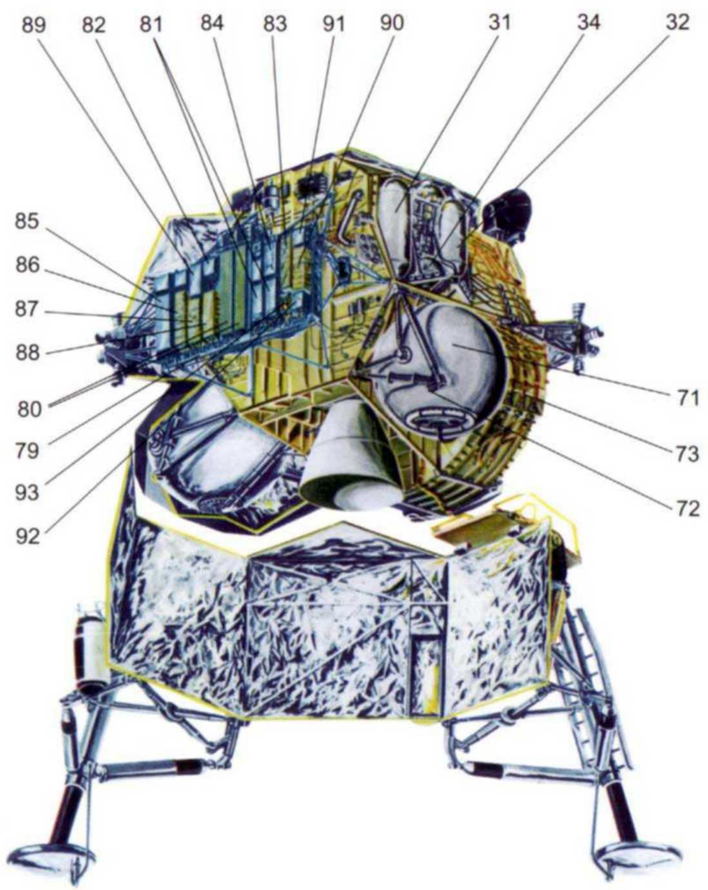
1. Rendezvous Radar
2. S-Band In-Flight Antenna
3. Tracking Light
4. Docking Light
5. Alignment Telescope
6. EVA Rail
7. Docking Window
8. Docking Target
9. VHF In-Flight Antenna
10. RCS Thrusters
11. Ingress/Egress Platform & Rails
12. MESA "O" Ring Release
13. Upper Outrigger Venting Shield
14. Ingress/Egress Ladder
15. Primary Shock Absorber Strut
16. Secondary Shock Absorber Strut
17. Deployment Truss & Down-Lock Mechanism
18. Landing Pad
19. S-Band Erectable Antenna (Lunar Surface)
20. Radioisotope Thermal Generator
21. Docking Light (Port Side)
22. Forward-Vision Window
23. LM/CM Docking Hatch
24. Outrigger Strut
25. Insulation Vent
26. Thermal Insulation Blankets
27. Lunar Surface Sensing Probe
28. Insulation Support Frame
29. Interstage Connection Points (4)
30. Ascent Fuel Tank
31. Reaction-Control Oxidizer
32. Reaction-Control Fuel
33. Helium Pressurization Unit
34. Reaction-Control Helium
35. Water Tank
36. Relay Box
37. Abort Sensor
38. Inertial Measurement Unit (IMU)
39. Ingress/Egress Hatch
40. Landing Point Designator
41. Oxidizer Service Panel
42. Ascent Engine Cover
43. Alignment Optical Telescope
44. Upper Hatch
45. Commander's Main Flight Panel
46. LM Pilots Main Flight Panel
47. Commander's EV Visors (Stowed)
48. Commander's Circuit Breaker Panel & Side Console
49. PLSS (Stowed)
50. Commander's Support & Restraint Reel
51. Commander's Armrest & Thrust Control
52. Main Panel/Cabin Floodlights
53. LM Pilot's Armrest (Stowed)
54. LM Pilot's Support & Restraint Reel
55. Anti-Bacterial Filter Stowage
56. Cabin Relief & Dump Valve
57. Docking Drogue (Removable for Access)
58. Suit Circuit Assembly
59. Water Control Module
60. Cabin Air Recirculation Fan
61. LiOH Canister
62. LM Pilot's EV Visor (Stowed)

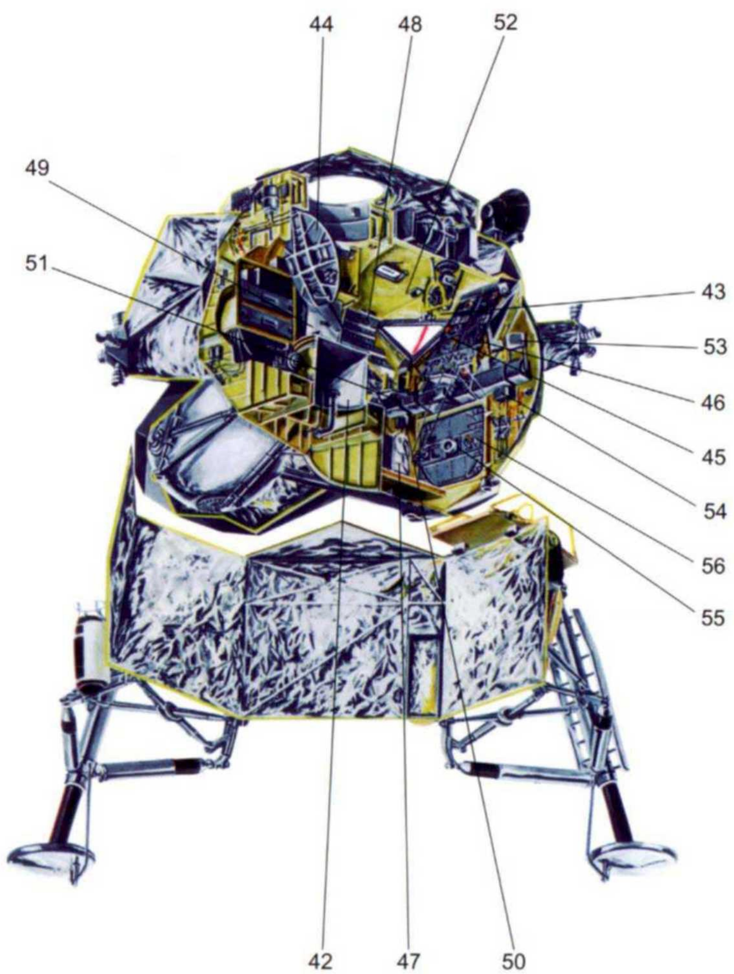


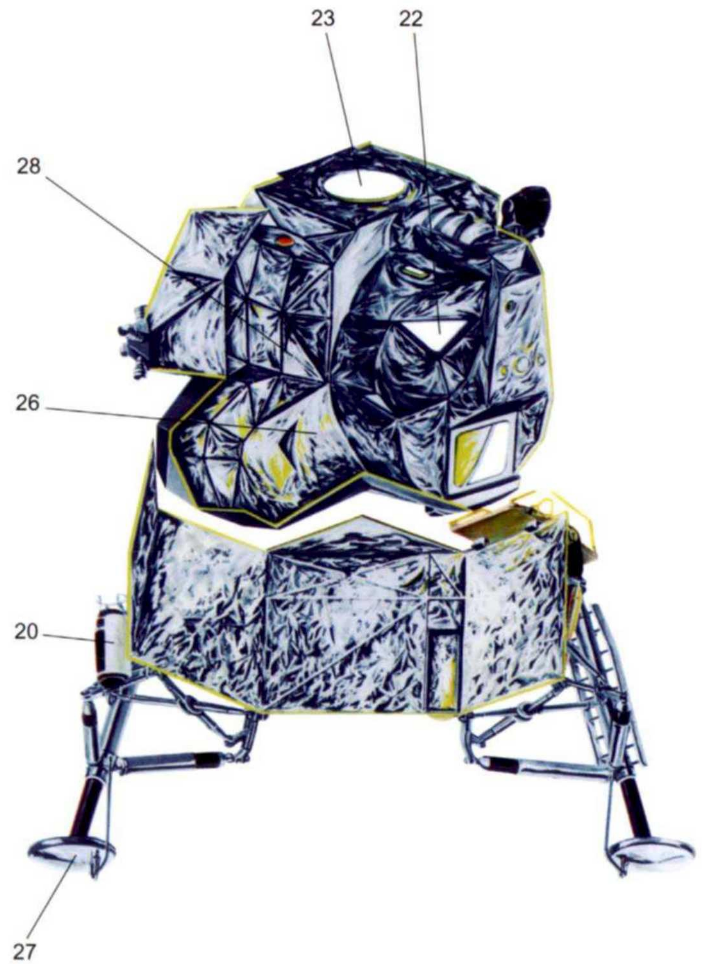












63. LM Pilot's Restraint Reel
64. Crew Equipment Storage
65. LM Pilot's Console & Circuit Breaker Panel
66. Oxygen Umbilical Hoses
67. Ascent Engine (3,500 lb Thrust in Vacuum)
68. Coupling Data Unit
69. Guidance Computer & Cold Plate
70. Power Servo Assembly
71. Ascent Oxidizer Tank
72. Descent/Ascent Section Explosive Attachment
73. Interrupt Connector Assembly & Wiring
74. Aft Equipment Bay
75. Gaseous Oxygen Tank
76. Helium Tank
77. Helium Pressurization Control Modules
78. Thrust Chamber Isolation Valves
79. Electronic Replaceable Assembly Rack
80. Batteries
81. Inverter
82. Electrical Control Assembly
83. Abort Electronics Assembly
84. Attitude & Translation Control Assembly
85. Rendezvous Radar Electronic Assembly
86. Signal Conditioning Electronics Replaceable Assembly No. 1
87. Pulse Code Modulation & Timing Equipment Assembly
88. Signal Conditioning Electronics Replaceable Assembly No. 2
89. Caution & Warning Electronics Assembly
90. S-Band Transceivers
91. S-Band Power Amplifier & Diplexer
92. Signal Processor
93. VHF Transceivers & Diplexer
94. Descent Structure
95. Batteries
96. Electrical Control Assembly
97. Descent Engine Skirt
98. S-Band Steerable Antenna
99. Electronics Package
100. Landing Gear Chock Mount
101. Descent Engine Throttleable (10,000 lb Approximate Thrust)
102. Descent Oxidizer Tank (Front & Aft)
103. Descent Fuel Tank (Port & Starboard)
104. Ascent Engine Blast Deflector
105. Water Tank
106. Scientific Equipment Boxes (2)
107. Specimen Return Container Assembly (MESA)
108. Landing Radar Electronics
109. Landing Radar
110. Fuel & Electrical Line Runs
111. Fuel Lines to Descent Engine
112. Fuel Lines (Descent Engine)
113. Supercritical Helium Tank
114. Ambient Helium Tank
115. Oxygen
116. Scientific Equipment Power Outlets
117. Descent Stage Skirt Structure
118. Thermal & Micrometeoroid Shield

ABBREVIATIONS USED IN LEGEND

EVA:	Extravehicular Activity
VHF:	Very High Frequency
MESA:	Modularized Equipment Stowage Assembly
RCS:	Reaction Control System
LM/CM:	Lunar Module/Command Module
PLSS:	Portable Life Support System

As challenging as the external design was, the design of the cockpit presented its own set of challenges. Not only did this area serve as the control room for the descent and ascent portions of the mission, it also was the astronauts' home during their time on the moon.

Particularly challenging to the design engineers was the seating arrangement, which differed radically from conventional cockpit design. With weight constraints always in mind, it quickly became apparent that conventional seats would be too heavy. Also of concern was the ease of mobility for the astronauts while wearing the bulky spacesuits necessary for the lunar mission. Several alternative seat designs were considered; all were rejected after careful study.

It was at this point that the window design and the seating arrangement problems merged. Further discussion raised the question as to why the module must have seats at all. The time spent in flight was to be short and the gravitational loads minimal. With these considerations in mind, it was decided to have the crew fly the Lunar Module from a standing position. From an upright position, the astronauts would be close to the windows, thereby enlarging their field-of-view by an estimated magnitude of 20. Engineers quickly realized that with the standing configuration, knee room did not need to be factored in. Therefore the cabin could be shortened, saving weight and improving structural integrity during descent. Astronaut Charles Conrad, who would later command the Apollo 12 mission, called the upright option the "trolley car configuration." Said Conrad, "We get much closer to the instruments without our knees getting in the way, and our vision downward towards the moon's surface is greatly improved."

Entrance to and egress from the Lunar Module from the Command Module was accomplished through the upper docking tunnel, located on the top of the Lunar Module. Originally designed with two docking hatches (the additional one being located on the module's front face), discussions between NASA and Grumman in the spring of 1964 led to the elimination of the front hatch as a docking interface; because of weight concerns it would, however, remain as a crew hatch and be used for access to the lunar surface. Experimentation with several methods of gaining the lunar surface led to the installation of a ledge just outside the front hatch and a ladder on the landing gear leg. It also was found that the astronauts had difficulty exiting the lunar module through the round hatch when wearing the bulky spacesuits; this was remedied by squaring off the hatch to enable easy access.

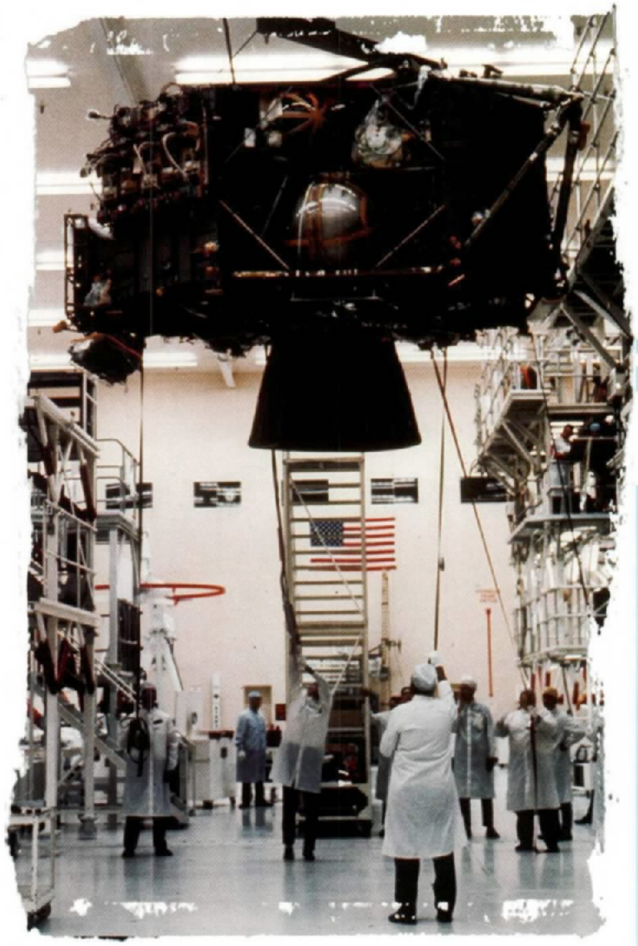
When considering the design of the module's landing gear, engineers were once again faced with the unknown. What was the lunar surface like? Tom Kelly remembers, "The design of the landing gear was influenced by the theories as to what the lunar surface might consist of, and the theories varied all the way from a very light powdery dust into which the module might sink...to that it was going to be ice, very slippery, very hard in some areas." Originally envisioned with five legs, the final, four-leg configuration was designed to handle the myriad of surface characteristics anticipated.

Also of concern was the impact upon landing. This challenge was met by using a crushed honeycomb material in the struts of the landing gear, thereby enabling the gear to compress on landing. This crushed honeycomb material was also used on the saucer-shaped pads on the end of each leg. This innovation turned out to be "greatly overdesigned," according to Kelly, "because the astronauts were very skillful in setting the vehicle down very softly. They set it down like a crate of eggs."

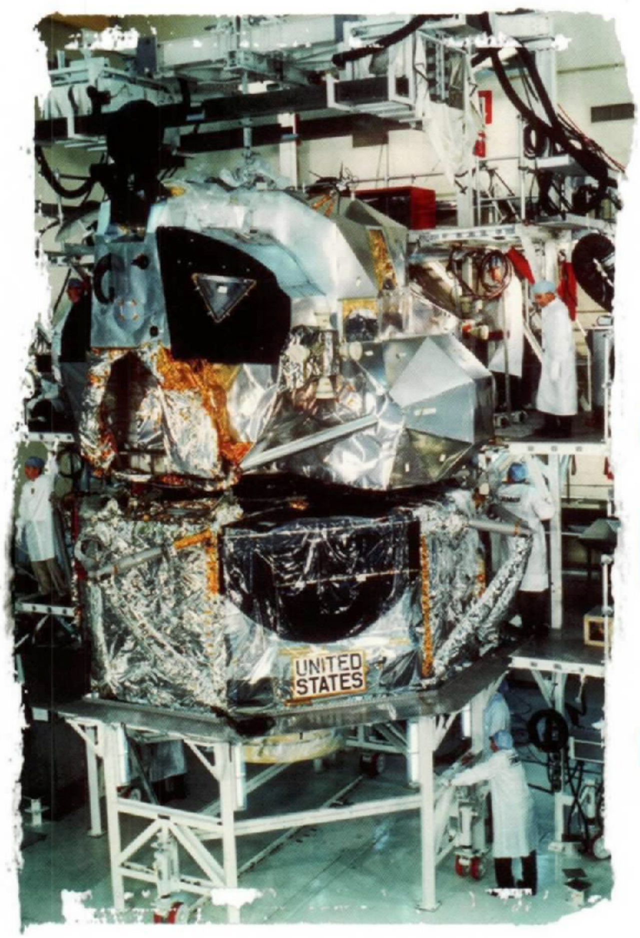
The lunar landing of July 20, 1969, was the culmination of the efforts to land a man on the moon and successfully met President Kennedy's challenge. Five more Apollo missions would successfully repeat that historical achievement, the final being Apollo 17 in December 1972. Although advances have been made in space exploration since then, the Lunar Module remains an historic mechanical engineering landmark.

Designing the Lunar Module was a monumental undertaking. Both its interior and exterior designs were unlike those of any previously developed spacecraft. Its total internal volume of 60 cubic meters made it the largest American spacecraft designed up to that time. No data existed on the lunar conditions in which the module would have to operate. Additionally, it had to perform successfully in the space vacuum, thousands of miles from Earth. The Lunar Module's maiden voyage was its test flight.

The module's prime function was to safely transport two astronauts to the lunar surface, and, when the mission was completed, propel them back into lunar orbit where they would rendezvous with the Command Module for the trip back to Earth. Because it would only operate in the vacuum of space, aerodynamic principles were not a factor in the design.



The Lunar Module is comprised of two stages – the ascent stage and the descent stage. The ascent stage is the part of the module designed for the crew. While on the lunar surface, the ascent stage provided shelter for the astronauts and served as a base of operations for the lunar mission. This stage contains a crew compartment, ascent engine, an electronic equipment bay, and a tank section. The descent to the lunar surface, the landing itself, and the eventual rendezvous with the Command Module are all controlled from the ascent stage.



Initial design configuration studies proposed two variants for the ascent stage – a small cockpit with externally mounted instruments, and a large cockpit with internal instrumentation. The ensuing design amounted to something between the two. Because the Lunar Module would be required to perform solely in the space vacuum, engineers could ignore aerodynamic requirements associated with Earth's atmosphere. The result was an aesthetically unappealing, yet functional, spacecraft.

The descent stage is unmanned and houses all the equipment necessary for a lunar landing and also serves as a launching pad for the ascent stage once the lunar mission is complete. Systems contained in the descent stage include the descent engine, landing radar, electrical power, fuel tanks and pyrotechnics. In the early spring of 1963, Grumman engineers presented drawings of several configurations to NASA for consideration. These drawings showed structural shapes, arrangement and placement of the fuel tanks, and hatch locations. The basic spacecraft that emerged from the ensuing design meetings contained four propellant tanks in the descent stage and a cylindrical cockpit in the ascent stage. (The ascent stage also was designed to contain four fuel tanks.) However, even after extensive design discussions several design questions remained unresolved, including visibility, access and egress, docking structures, hatch design, and the design of the descent engine skirt (which could not impact the lunar surface upon landing).

Grumman engineers were confronted with interesting challenges when designing the cockpit, because the Lunar Module would serve as both a transport vehicle and as the astronaut's home while on the lunar surface. Therefore, design of the cockpit would take 2 years to complete. A unique combination of features was necessary, including those required for rendezvous and docking, environmental systems to support living conditions, easy egress and access capability, and the ability to operate in low- or no-gravity conditions.

Dimensions of Basic Lunar Module Structure with Landing Legs Extended	
Overall Height	22 feet, 11 inches
Overall Width	14 feet, 1 inch
Diameter (measured diagonally across landing gear)	31 feet
Ascent Stage Height	12 feet, 4 inches
Descent Stage Height	10 feet, 7 inches
Earth Launch Weight (with crew and propellant)	36,222 pounds
Pressurized Cabin Volume	235 cubic feet
Cabin Environment	Temperature: 75°F; 100% Oxygen at 4.8 psia

Tom Kelly "Father of The Lunar Module" (1929-2002)

In the early 1960s, when Thomas J. Kelly, who died on March 23, 2002, after a 6-year battle with pulmonary fibrosis, was just past the age of 30, his mechanical engineering and propulsion concepts and designs helped shape NASA plans for the Apollo missions. For his outstanding contributions to NASA's Apollo Program, he became known as "the Father of the Lunar Module," In recognition of his achievements, the board of directors of the Grumman Aerospace Corporation elected him a vice president in May 1971.

Born in Brooklyn, New York, on June 14, 1929, and raised in Bellmore, New York, Mr. Kelly was one of the winners in 1946 of a Grumman engineering scholarship. With this scholarship, he earned a Bachelor of Mechanical Engineering degree from Cornell University in 1951. He continued his education at Columbia University, from which he earned a Master of Science degree in Mechanical Engineering in 1956. Mr. Kelly further pursued graduate studies at Ohio University and the Polytechnic Institute of Brooklyn. In 1969, he won a Sloan Fellowship to the Massachusetts Institute of Technology and in 1970 received a Master of Science degree in Industrial Management from the Institute.

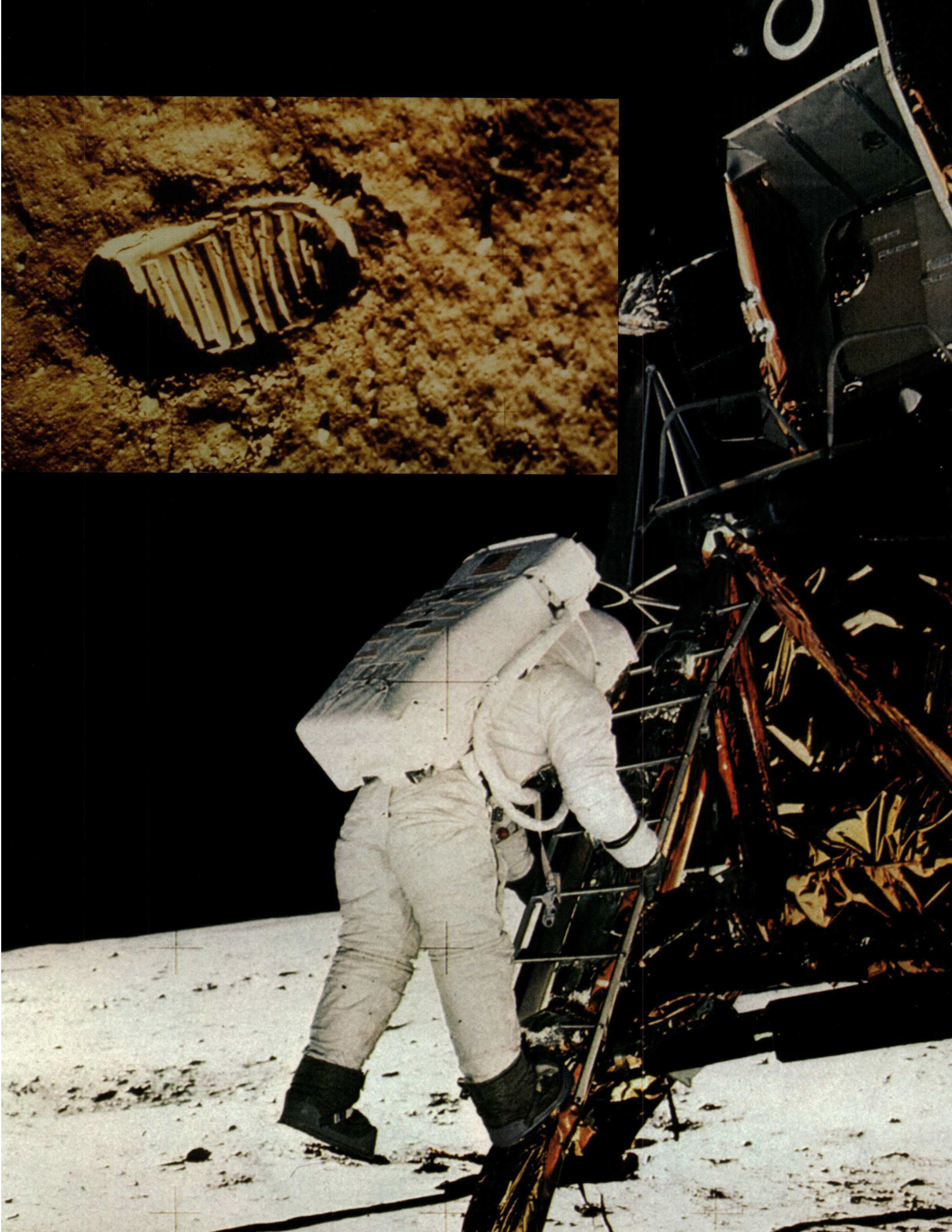
Mr. Kelly began his career at Grumman as an apprentice engineer during the summers of his undergraduate years. After completing his studies at Cornell University, he became a full-time employee of the corporation as a propulsion engineer on the Rigel Missile Program. From 1953 to 1956, he was a jet air induction group leader on the F11F and F11F-1F programs. From 1956 to 1958, he served as a First Lieutenant in the U.S. Air Force, assigned as a performance engineer at Wright-Patterson Air Force Base, Dayton, Ohio, where he worked on the prototype B-58, F-105, and Hound Dog Missile programs. After completing his military service, Mr. Kelly worked for one year at the Lockheed Aircraft Corporation as a group leader in rocket propulsion development.

Returning to Grumman in 1959, Mr. Kelly was assigned as Assistant Chief of Propulsion and a year later was made Engineering Project Leader on the Apollo and Lunar Module studies and proposals. In November 1962, Mr. Kelly was promoted to LM project engineer and in succeeding years was assigned increasing responsibilities and authority on the LM Program. Under his leadership, Grumman recommendations for designing "life boat" capabilities into the LM would prove fateful. The LM's capabilities would save the lives of the three astronauts of Apollo 13 after an oxygen tank ruptured in the service module, rendering the Command Module uninhabitable as the mission approached the moon.

Subsequent to his work on the Apollo and Lunar Module, Mr. Kelly served in a series of assignments in Grumman's Aircraft Systems and Data Systems divisions, including director of Space Programs and vice president of Information Resource Management. In 1991, he was elected president of the Space Station Integration division. Mr. Kelly retired from Grumman Aerospace in December 1992.

"Houston, Tranquility Base here. The Eagle has landed. ...That's one small step for man, one giant leap for mankind."

The Lunar Module remains a true engineering marvel. To this day, it is the only crewed transport vehicle designed to function solely in the vacuum of space. Designed to land men on the moon and return them safely to the Command Module orbiting above, the LM was never flight tested because the lunar environment couldn't be replicated. During the life of the Apollo program, 13 Lunar Modules were built by the then Grumman Aerospace Corporation (now the Northrop Grumman Corporation); of that number, six made lunar landings. The last in the series, LM 13, never flew; its mission (Apollo 18) was cancelled. Built on Long Island by Long Islanders, as all LMs were, it is now in its final resting place, the Cradle of Aviation Museum – on Long Island – where it serves as a permanent memorial to the men and women of Grumman whose dedication and technical expertise have made the Lunar Module an Historic Mechanical Engineering Landmark.



The History and Heritage Program of ASME International

The History and Heritage Landmarks Program of ASME International (the American Society of Mechanical Engineers) began in 1971. To implement and achieve its goals, ASME formed a History and Heritage Committee initially composed of mechanical engineers, historians of technology and the curator (now emeritus) of mechanical engineering at the Smithsonian Institution, Washington, D.C. The History and Heritage Committee provides a public service by examining, noting, recording and acknowledging mechanical engineering achievements of particular significance. This Committee is part of ASME's Council on Public Affairs and Board on Public Information. For further information, contact Public Information at ASME International, Three Park Avenue, New York, NY 10016-5990, 1-212-591-7740.

Designation

Since the History and Heritage Program began in 1971, 217 landmarks have been designated as historic mechanical engineering landmarks, heritage collections or heritage sites. Each represents a progressive step in the evolution of mechanical engineering and its significance to society in general. Site designations note an event or development of clear historic importance to mechanical engineers. Collections mark the contributions of a number of objects with special significance to the historical development of mechanical engineering.

The Landmarks Program illuminates our technological heritage and encourages the preservation of the physical remains of historically important works. It provides an annotated roster for engineers, students, educators, historians and travelers. It helps establish persistent reminders of where we have been and where we are going along the divergent paths of discovery.

The 125,000-member ASME International is a worldwide engineering society focused on technical, educational and research issues. ASME conducts one of the world's largest publishing operations, holds some 30 technical conferences and 200 professional development courses each year, and sets many industrial and manufacturing standards.

The Lunar Module 13 is owned by the Smithsonian Institution in Washington, D.C. It is on permanent loan to the Cradle of Aviation Museum.

Acknowledgement

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