Langley Researcher

SOUVENIR ISSUE | LANGLEY RESEARCH CENTER | APOLLO 11

LUNAR ORBIT RENDEZVOUS KEY ELEMENT IN SUCCESS OF MOON LANDING; ENGINEERING, ECONOMIC ADVANTAGES OF CONCEPT PROVED BY LANGLEY

In establishing the basic fundamentals and mission concepts of lunar orbit rendezvous-- one of the central elements of Apollo-- the Langley Research Center was instrumental in giving America the technique it needed to accomplish a successful manned moon landing in this decade.

Two dates are of particular importance in considering Langley's role in manned space flight:

One was October 1958 when this country's first manned space flight venture-- Project Mercury-- was born here.

The other was July 11, 1962, the day the National Aeronautics and Space Administration announced at a news conference its plans to use the lunar orbit rendezvous (LOR) procedure as the prime mission mode in carrying out the initial moon landing.

This disclosure was another research milestone in the history of Langley, where a group of staff members had been working as a team the previous three years in studying analytically and in the laboratory the concept of rendezvous in space.

Langley proved the feasibility of rendezvous in space and revealed the important engineering and economic advantages of a manned moon landing through LOR. This was followed by research in later years to develop techniques for LOR as it applied to the operation of Apollo.

The Langley group which was engaged in LOR research at the start of this historic decade never claimed to have invented the concept. But the team believed it was first to recognize the fundamental significance and advantages of LOR and then fostered it, nurtured it, and fought for it.

The early research information generated as a result of the Langley group's efforts was considered significant in the analysis of the Apollo mission modes and in the national policy discussions which ultimately led to the decision to go to the moon through the use of LOR.

James E. Webb, who at the time was NASA Administrator, cited the reasoning behind the decision released at the 1962 news conference by announcing: "We are putting major emphasis on lunar orbit rendezvous because a year of intensive study indicates that it is most desirable, from the standpoint of time, cost and mission accomplishment."

At the 1962 news conference, the NASA's Manned Space Flight Management Council announced it had unanimously recommended LOR-- giving four reasons:

It provides a higher probability of mission success with essentially equal mission safety.

It promises mission success some months earlier than other modes.

It will cost 10 to 15 per cent less than the other modes.

It requires the least amount of technical development beyond existing commitments while advancing significantly the national technology.

Dr. Robert C. Seamans, former NASA Deputy Administrator, pointed out in 1962 that one of the first places he visited when he joined NASA was the Langley Research Center, where he reviewed work relating to rendezvous and what a man could do at the controls under simulated conditions, as well as the possibility of LOR. (Continued on page 8)

TODAY'S DREAM: TOMORROW'S REALITY

Statement by Edgar M. Cortright, Director of the Langley Research Center, following the historic Apollo 11 mission:

"Americans, and indeed all men, can view the successful lunar landing of Apollo 11 with immense pride and satisfaction. It was a noble mission. It spoke well for what mankind can accomplish, given the goal and the will to attain it.

"That the dream of today can become the reality of tomorrow was once again demonstrated in eloquent fashion. The world needed such a demonstration to help restore its faith in a future where even more difficult tasks loom large.

"Many people played a role in this 'giant leap for mankind.' The Langley Research Center was fortunate to have the opportunity to participate more than most. In consonance with its role as a research center, the Langley contributions reflected concepts, techniques, supporting research, and some of the men to implement them. As Neil Armstrong wrote during his last visit to practice landings: '...Best wishes and thanks for all the Langley effort in support of Apollo 11.'

"So as we extend our heartfelt congratulations to astronauts Armstrong, Aldrin, and Collins, and to the entire manned space flight team that carried out the Apollo Program with such distinction, we can justifiably reflect with the aid of this special issue of the 'Researcher' on some of the ways in which we helped."

ILLUSTRIOUS EXPLORERS: Apollo 11 astronauts (from left): Neil A. Armstrong, Commander; Michael Collins, Command Module pilot; and Edwin E. Aldrin Jr., Lunar Module pilot.

BIRTHPLACE: America's manned space flight program, which reached a dramatic climax with the successful Apollo 11 mission, was born at the Langley Research Center-- the general location of which is indicated by the white circle in the middle of an Apollo 9 photograph of the east coast. The Center's former administration building (right) served as headquarters for the NASA Space Task Group from late 1958 to mid-1962 for the conduct of Project Mercury, this country's pioneering manned space flight effort which was conceived by Langley. The main area of the Langley Research Center (top) includes a variety of wind tunnels, simulators, and other specialized laboratories which are used in research in support of the manned space flight program. The gantry of the Lunar Landing Research Facility, where the Apollo 11 crew and other NASA astronauts train, is shown in the upper left. The Center also conducts research in the fields of unmanned space flight and aeronautics. The Apollo 11 mission was carried out in the 52nd year of Langley's existence as the first national laboratory devoted to the advancement of the science of flight in this country.

ADVANCED RESEARCH AND TECHNOLOGY SUPPORTED APOLLO MISSION FROM LAUNCH PAD TO RETURN HOME AFTER MANNED LUNAR LANDING

The spectacular accomplishment of the first manned lunar landing climaxed an exciting and dramatic era which began with the birth at the NASA Langley Research Center of America's pioneering project to send astronauts on voyages into the new ocean of space.

This country's first manned space flight effort was the one-man Mercury, which began at Langley in 1958 when the National Aeronautics and Space Administration was created by Congress to broaden United states efforts in aeronautics and space.

Mercury's triumphs were followed with the successful two-man Gemini and the history-making three-man Apollo, which has carried this nation to new heights in the realm of lunar exploration and enhanced man's hopes for interplanetary travel in the future.

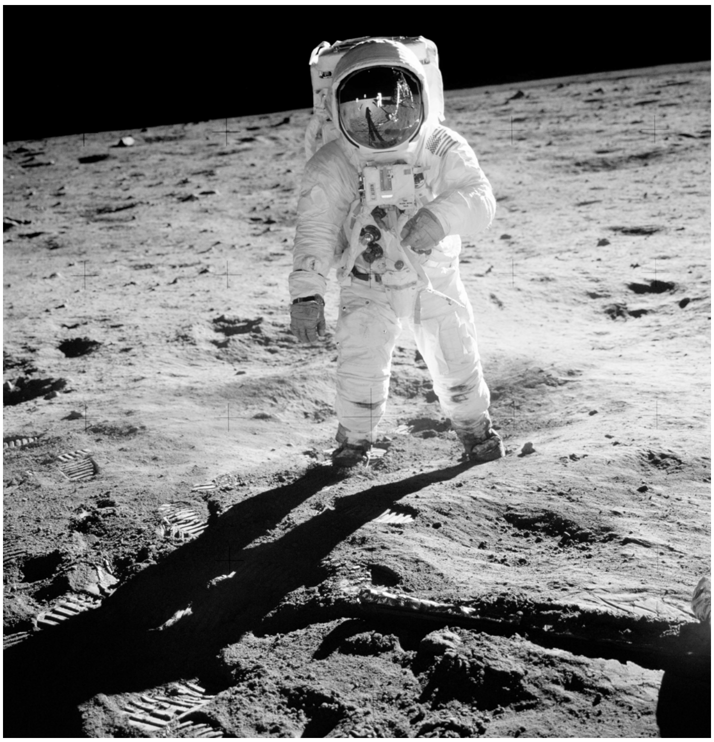
In addition to conceiving Project Mercury, Langley has extensively supported each of the three manned space flight projects through the operation of unique simulators, specialized laboratories, and major flight research activities.

Langley facilities have made it possible for engineers and scientists to duplicate some of the conditions of space to develop techniques for such crucial Apollo events as lunar landing, walking on the moon, other extravehicular activity, rendezvous and docking in lunar orbit, reentry, and earth landing.

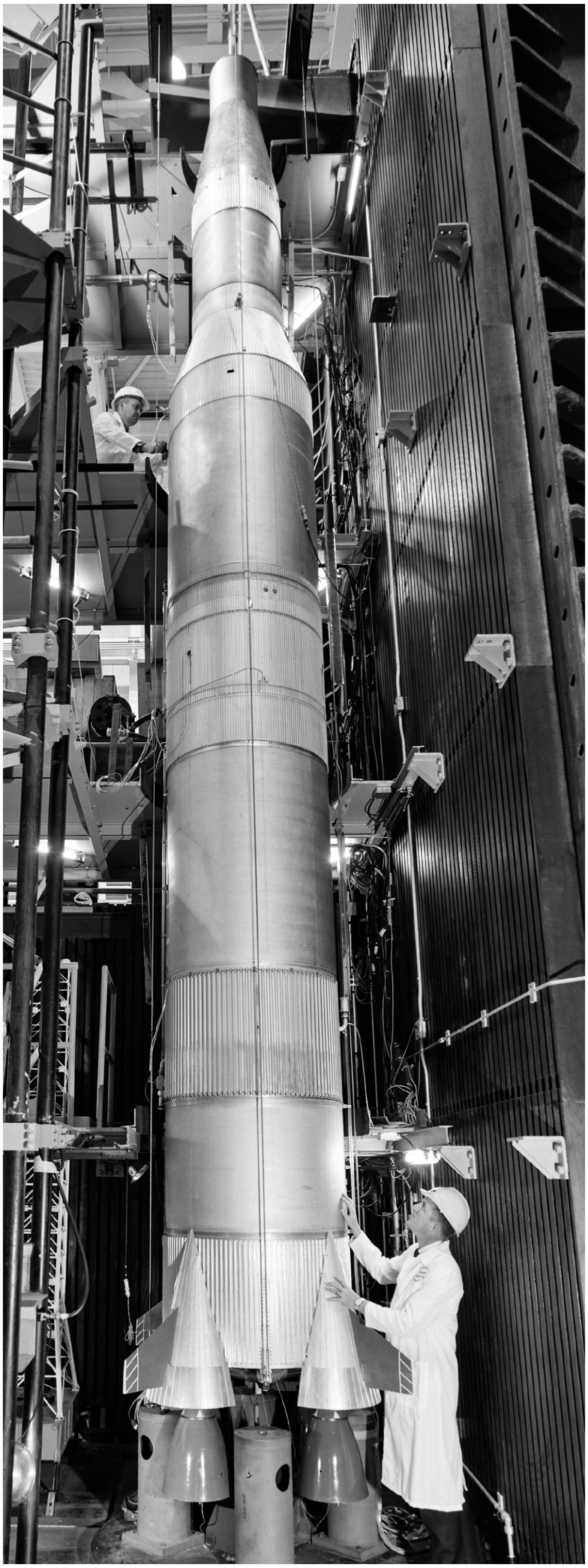
NASA astronauts have worked with the Langley staff in operating facilities concerned with research on lunar landing, lunar walking, and rendezvous and docking-- following up Langley investigations in the early 60's which proved the feasibility of the lunar orbit rendezvous mode in accomplishing a manned moon landing.

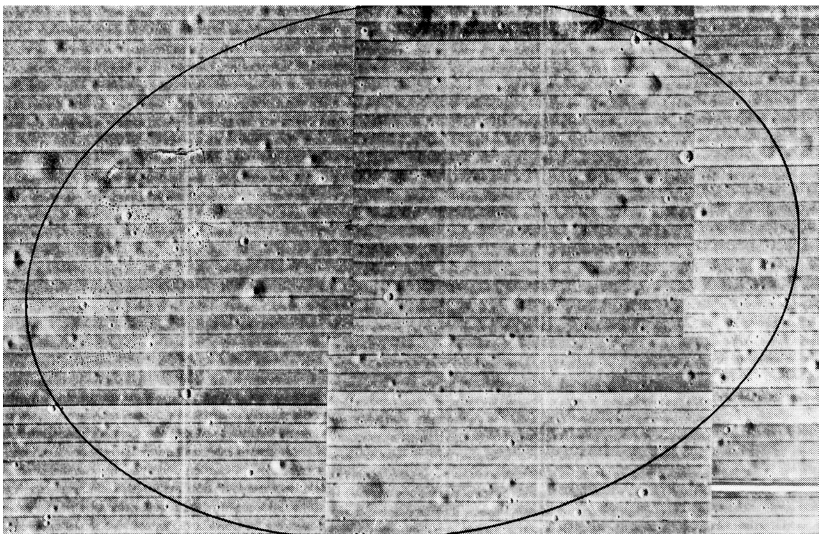
Many individuals and organizations at Langley have served as consultants and in other capacities in helping to solve various general problems concerned with the design, development and operation of Apollo.

Although Langley is heavily involved in manned and unmanned space research, it also has played a key role for over half a century in advancing aeronautics in this country. In fact, the basic knowledge of aeronautics, acquired by Langley over the years, has evolved into solutions to many of the problems of space flight-- helping to assure this country of continued progress on man's great voyage of exploration.

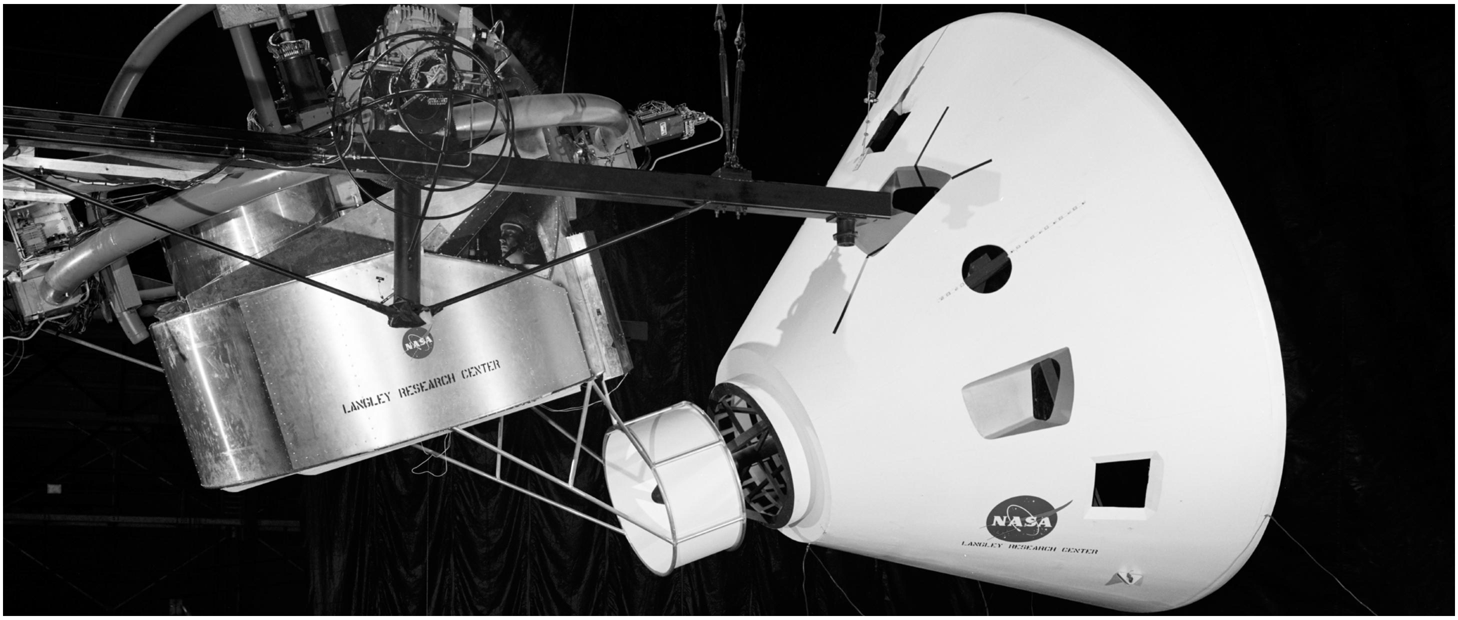


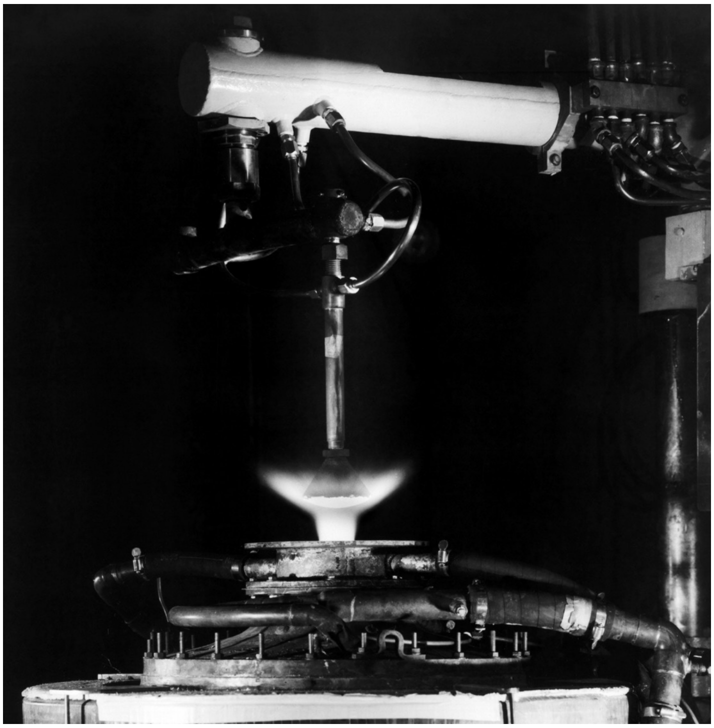
LAUNCH OF APOLLO 11 (left) from NASA Kennedy Space Center, Florida, July 16, was followed four days later by the first manned lunar landing. Neil A. Armstrong, first moon walker, photographs Edwin E. Aldrin Jr., nearing the lunar surface (right) and exploring (center). Armstrong and Eagle are reflected in Aldrin's face mask. During this period, Michael Collins orbited the moon in Columbia. Recovery in the Pacific Ocean (top) took place July 24.

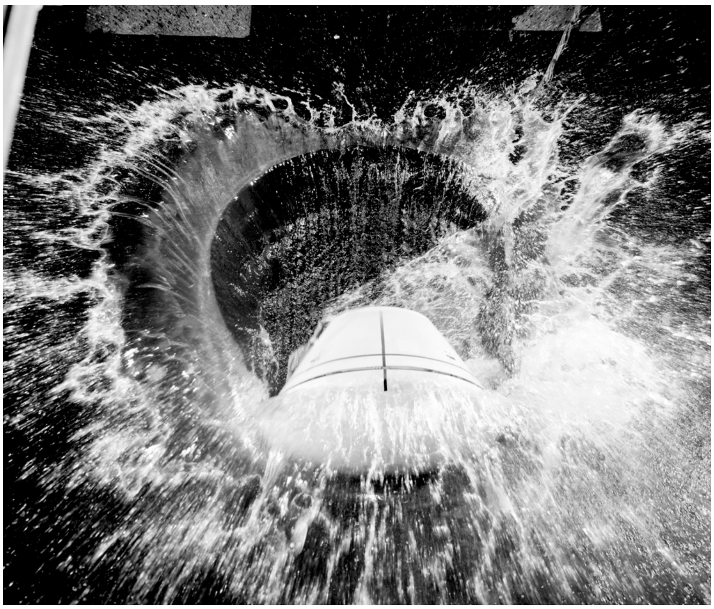




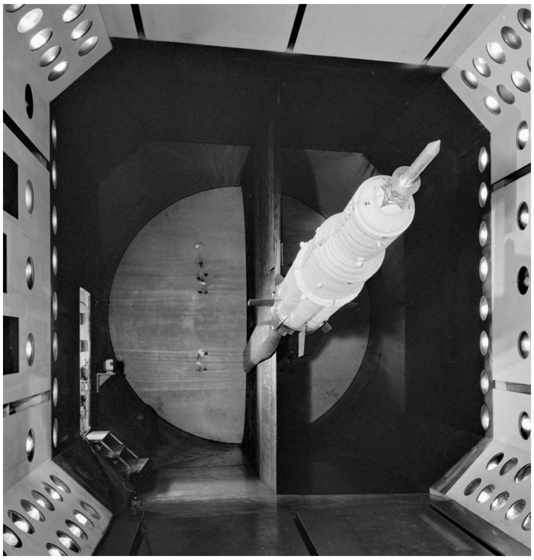
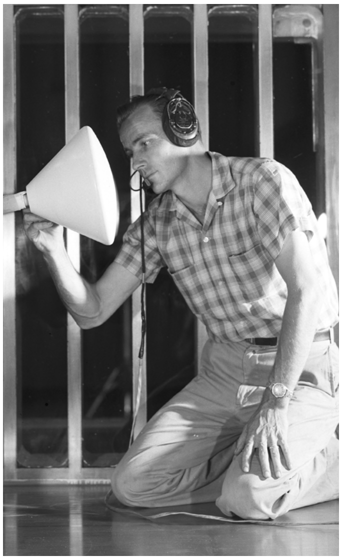
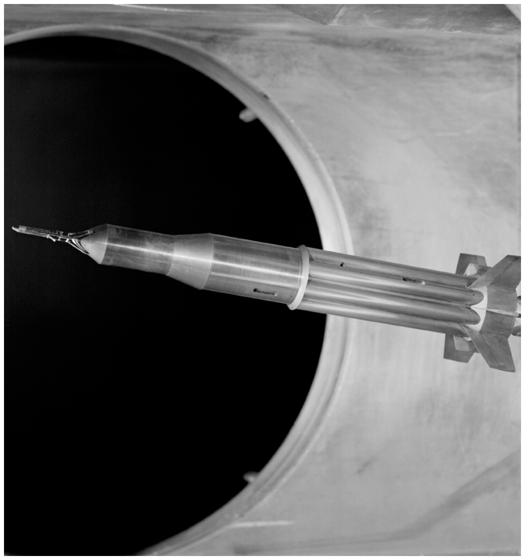
THE DYNAMICS of the Saturn-Apollo are studied (left) in a Langley laboratory where the vehicle is free to vibrate as it might while flying. The one-tenth-scale model is 36 feet high. Lunar Landing Research Facility (top) provides a controlled simulator to explore and develop techniques for landing the rocket-powered Lunar Module on the moon's surface, where the gravity is only one-sixth as strong as on earth. Reduced Gravity Simulator (center) is used to study an astronaut's ability to walk, run, and perform other self-locomotive tasks required in lunar exploration activities. The site of the world's first lunar landing (above) was selected as one of five by NASA on the basis of Langley's Lunar Orbiter photography. The Apollo landing site was in the Sea of Tranquility.



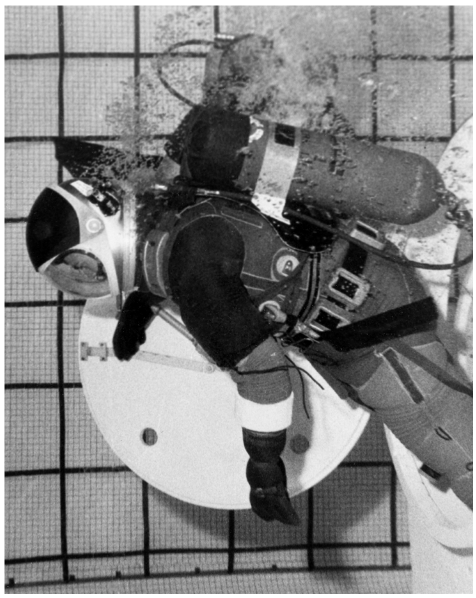


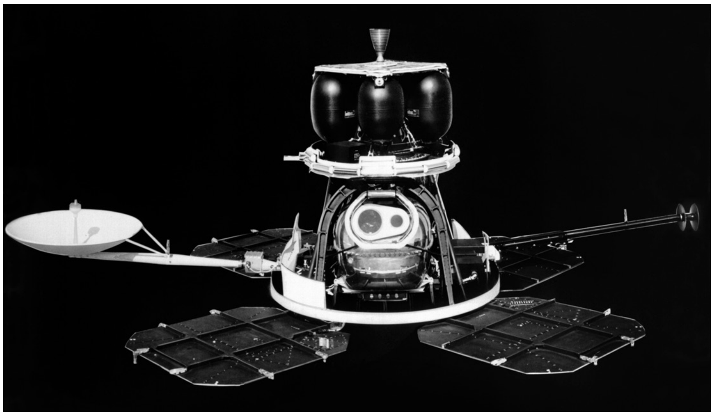


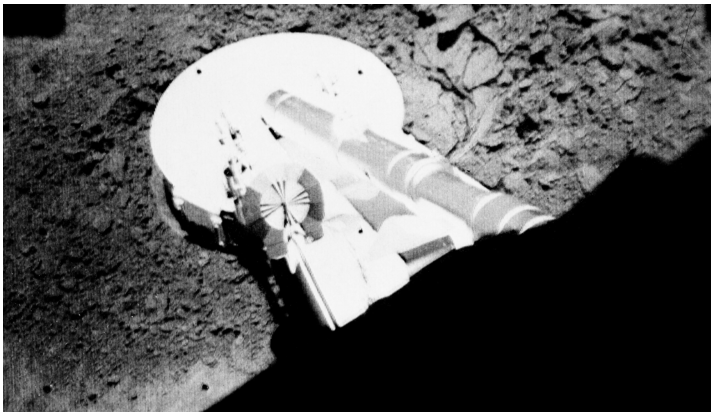
LUNAR EXPLORATION is followed by the takeoff and return of the Lunar Module to rendezvous and dock with the Command Module in lunar orbit, a maneuver which Langley studies in the Rendezvous Docking Simulator (top). The full-scale model at left simulates the Lunar Module's crew section, which represents about a third of the actual vehicle. Langley conducts atmospheric entry research both in the laboratory and in flight. Heat generated by friction during reentry is duplicated in an electric arc heater (left) to evaluate Apollo heat shield materials. Valuable Apollo reentry information was obtained in launches of Project Fire, a full-sized reentry model of which is shown (upper right) undergoing pre-flight wind tunnel research. Investigations of water landing characteristics are carried out (right) on a one-fourth scale Apollo spacecraft model.


THREE TYPICAL Langley wind tunnel studies (top row) helped determine aerodynamic characteristics of the Apollo and Saturn-Apollo vehicle. In early basic research, a one-sixth scale model of a lunar landing vehicle (center left) is investigated at an impact research facility. A NASA pilot (center right) operates a hydraulic analog simulator in research on human ability to control braking maneuvers for lunar landings. Laboratory apparatus (left) is operated in a vacuum facility to study problems from erosion of the lunar surface by blast of rocket engines during soft landings of space vehicles. Langley technique for simulating zero-gravity performance of a test subject in a pressurized suit by water immersion (right) is useful in studying astronaut capabilities and mobility in space.







MOON SPACECRAFT: Langley's Lunar Orbiter provided broad photographic coverage of the moon and transmitted significant scientific information on characteristics of the lunar environment in support of Apollo. A Lunar Orbiter spacecraft is shown at left. Langley also participated in the NASA Jet Propulsion Laboratory's Surveyor project by being represented on a special science team formed to analyze the soil properties of the lunar surface on the basis of scientific and engineering measurements transmitted by the soft-landing spacecraft. Photograph at right is of a footpad of Surveyor VI on the lunar surface. Langley currently is looking beyond the moon-- to Mars. The center is managing Project Viking, designed to send dual scientific payloads both to orbit and to land on the distant planet. Launch of the unmanned spacecraft is planned for 1973.

FORMER LANGLEY STAFF MEMBERS HAVE KEY ROLES IN APOLLO 11

Nine former Langley Research Center staff members were listed by the National Aeronautics and Space Administration as having key roles in the Apollo 11 mission.

Langley alumni who were named under Apollo Program Management included Dr. Robert R. Gilruth, Director of the NASA Manned Spacecraft Center at Houston, Texas, and Gerald M. Truszynski, Associate Administrator for the Office of Tracking and Data Acquisition (OTDA) in Washington, D.C.

MSC is responsible for development of the Apollo spacecraft, flight crew training and flight control.

OTDA directed the program of tracking and data flow on Apollo 11.

Under Saturn/Apollo officials were listed the following former Langley employees:

Christopher C. Kraft Jr., MSC Director of Flight Operations.

Milton L. Windler, MSC, Apollo 11 flight director (Maroon team).

G. Merritt Preston, Director of Design Engineering at the NASA John F. Kennedy Space Center, Florida, which is responsible for Apollo/Saturn launch operations.

Walter J. Kapryan, Deputy Director of Launch Operations for KSC.

H.R. Brockett, Deputy Associate Administrator for OTDA.

Charles A. Taylor, Director of Operations, Communications, and ADP Division of OTDA.

H. William Wood, Head of the Manned Flight Operations Division at the NASA Goddard Space Flight Center in Greenbelt, Maryland, which manages the Manned Space Flight Network and Communications Network.

Other elements of the Apollo Program, the responsibility of the NASA Office of Manned Space Flight in Washington, include the NASA Marshall Space Flight Center at Huntsville, Alabama, which develops the Saturn launch vehicles, and the launch, tracking and recovery operations teams of the Department of Defense, which supports NASA.

★★★★

SOUVENIR ISSUE: This Apollo 11 edition of Langley Researcher illustrates a part of the extensive support of the manned lunar mission by the Langley Research Center, National Aeronautics and Space Administration, Hampton, Virginia 23365.
Editor: Ruth Angel Verell.

EXAMPLES SHOW DIRECT SUPPORT BY CENTER OF HISTORIC MISSION

Two examples of Langley Research Center support of the manned lunar mission in general and Apollo 11 in particular have been noted.

One concerns research which has been carried out over a long period on the mathematical representation of the gravitational field of the moon, orbit determination studies, and orbit prediction analyses.

As a result of this research, the mathematical representation of the gravitational field of the moon developed at Langley from analyses of Lunar Orbiter tracking data, was used by Mission Control at the NASA Manned Spacecraft Center in Houston, Texas, for design and timing of critical operational maneuvers during the Apollo 11 flight.

The other example is of research in which surface tension effects are utilized for gas separation. A gas separator, which separates hydrogen gas from the water coming from the fuel cell, was incorporated on Apollo 11. This device uses hydrophilic and hydrophobic materials to separate the hydrogen from the fuel cell water and prevents this hydrogen from becoming trapped in the food bags. The device is based on data and design concepts originated at Langley.

Personnel from Langley provided working models to demonstrate the principles involved, and test data showing the capability of the unit to separate gases from liquids in zero g without moving parts. A flight unit was constructed by Manned Spacecraft Center personnel and was tested at Langley. In addition, Langley personnel participated in zero g flight tests of the unit at Wright-Patterson Air Force Base in Ohio, prior to its installation and use on Apollo 11.

NATION ANALYZED LUNAR MISSION MODES BEFORE TAKING LOR ROUTE TO MOON

(Continued from page 1)

Dr. Seamans said it was explained to him at that time that, by not taking certain of the essential elements down to the lunar surface and back to a spacecraft in orbit around the moon, it would be possible to scale down the launch vehicle requirements in the ratio of roughly two to one.

"It was clear to us. . .that the key to such a mode involves a rendezvous that must be carried out with very high regard to reliability and safety considerations," said Dr. Seamans.

NASA was carefully considering manned flights beyond Project Mercury, Dr. Seamans recalled in 1962.

"It was quite reasonable at that time we should not only consider the direct mode, which we did, but also the various types of rendezvous, both in orbit around the earth, in orbit around the moon, and on the lunar surface."

Lunar surface rendezvous involved a scheme in which Apollo would be landed on the moon and refueled there from a separately landing fuel supply.

It is of interest to recall that, at the time of the 1962 announcement, the concept of an Apollo manned lunar landing using the earth orbit rendezvous mode called for each moon mission to have earth launchings of two or more advanced Saturns.

One vehicle would boost into orbit a 60-foot tall liquid oxygen tanker weighing some 100 tons. It would rendezvous with the separately launched modular spacecraft attached to a fueled but unloxed third stage of the Saturn. The LOX would be transferred and the third stage would then power the spacecraft to the moon.

A three-man direct flight would have the same requirements as earth orbital rendezvous for the command and service modules and the lunar braking and touchdown stages, according to the 1962 version. In addition, this mode would require the immediate development of the Nova vehicle with a 12-million pound thrust first stage and upper stages employing the 1.2-million pound thrust hydrogen-oxygen M-l engines.

These mission modes were among those analyzed by the NASA planners, and which were considered during national policy discussions, before LOR was selected as one of the central elements in the successful accomplishment of a manned lunar landing and return.

With the successful flight of Apollo, it is appropriate to recount some of Langley's participation in the selection of LOR as the way to go to the moon and back.

Dr. John C. Houbolt was the head of a Langley committee which got started about 1959 on a study of the various technical aspects of rendezvous in space.

He and his Langley associates set about to establish that rendezvous in space was technically feasible; to place rendezvous on a firm scientific footing so that important decisions could be made; to conceive and plan an earth-orbit experiment to demonstrate and prove rendezvous; and to do mission research to show how various space missions could be performed by the use of rendezvous-- specifically the manned lunar landing mission.

Early in their theoretical studies and simulator research, it was decided to concentrate Langley's investigations on the concept of LOR. As a result, the group provided documentation which was reflected in the decision to go to the moon via the lunar orbit route.

Langley's first study of LOR was carried out by Clinton E. Brown and Dr. William H. Michael Jr., early in 1959 when the benefit of a parking orbit at the moon was examined. Brown, assisted by Ralph W. Stone Jr., subsequently formulated an LOR mission concept. In December 1959 this concept, along with research showing the feasibility of space rendezvous, was presented to the then incoming Associate Administrator of NASA, Dr. Seamans, by Dr. Houbolt, Brown, Max C. Kurbjun, and Dr. John D. Bird. During this time period, personnel of William H. Phillips' Guidance and Control Branch-- notably Arthur W. Vogeley, Kurbjun, Roy F. Brissenden, Dr. Edwin C. Foudriat, John M. Eggleston, Edgar C. Lineberry Jr., and Bert B. Burton-- did research in 1960 to prove the feasibility of space rendezvous. The LOR mission is substantially dependent upon this capability for its success.

Dr. Houbolt, Dr. Bird, Eggleston, and Richard A. Hord contributed to LOR mission design and to the analysis of rendezvous trajectories for the LOR mission, and Dr. Michael, Robert H. Tolson, and John P. Gapcynski made studies of lunar trajectories that would insure a free return capability to the earth in the event of failure of the engines to ignite properly at the moon. Early simulations of lunar landings were made by Dr. Manuel J. Queijo, and G. Kimball Miller Jr., and simulations to show the feasibility of orbital docking were made by Donald R. Riley and William T. Suit. Various features of the instrumentation, control, and life support systems for lunar missions were studied by William D. Mace, John A. Dodgen, Dan C. Popma, and Ralph W. Stone Jr., in order that system feasibility be established. The results of these and other Langley investigations were combined in a study report at the request of NASA Headquarters under the title of "Manned Lunar Landing Through Lunar-Orbit Rendezvous" in October 1961 for consideration by various NASA Headquarters study groups concerned with the selection of the mission mode for Apollo.

Early in 1962 the design of the rendezvous and docking simulator was begun by Vogeley and Brissenden, and Laurence K. Loftin Jr. and Phillips initiated design work on the Lunar Landing Research Facility which was carried out under the direction of Kurbjun, Amos A. Spady Jr., Thomas C. O'Bryan, and Tom M. Palmer. These facilities have been employed for much lunar mission research and astronaut training in the subsequent years.

(Note: Brown, Dr. Houbolt, Eggleston, Dr. Foudriat, Lineberry, and Burton have left Langley in the intervening period).

FLAG AND ASTRONAUT footprints are photographed before Eagle ascends to rendezvous and dock with Columbia.