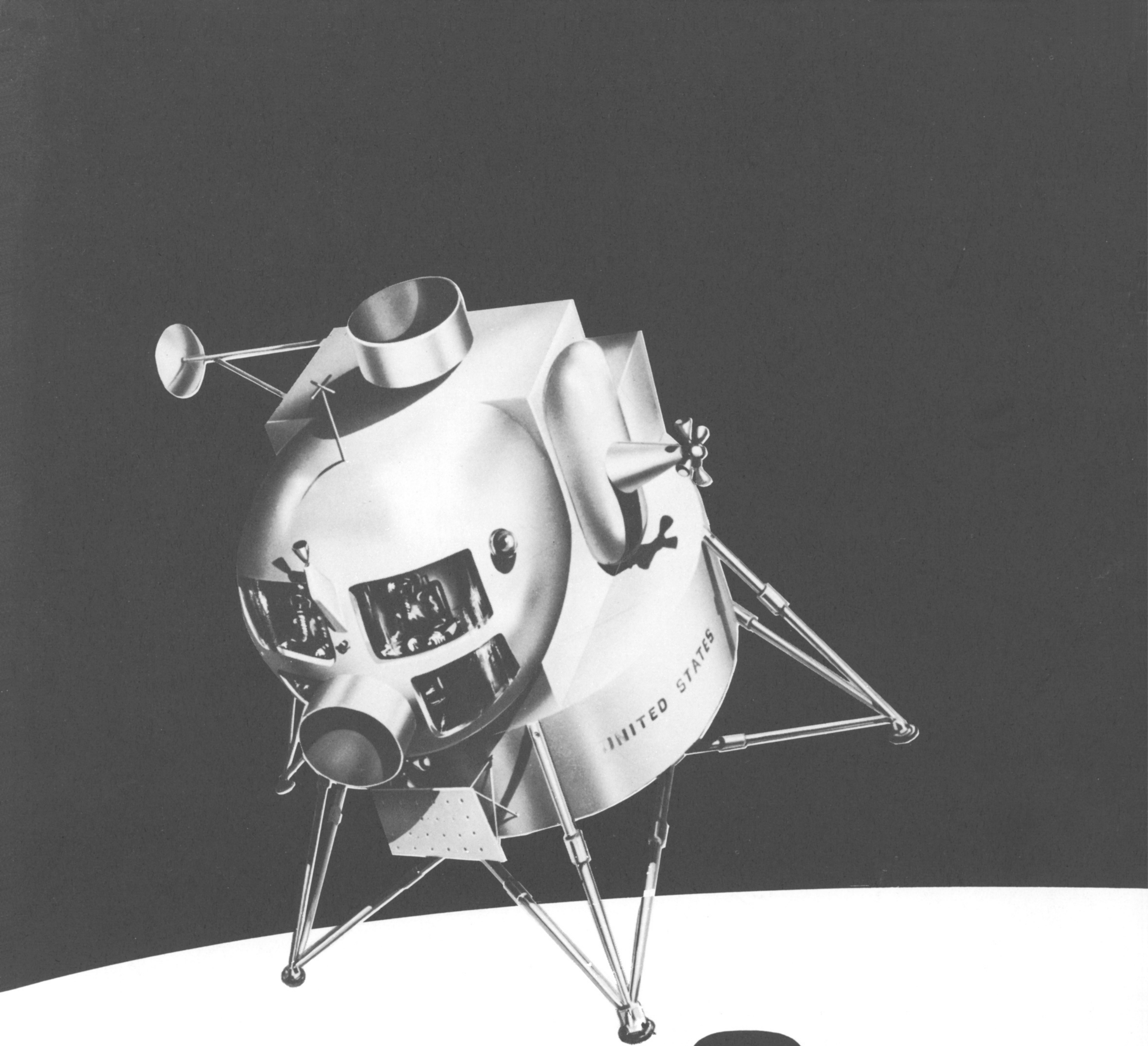

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LUNAR ORBITAL RENDEZVOUS

A PATHWAY TO THE MOON

A PATHWAY TO THE MOON . . .

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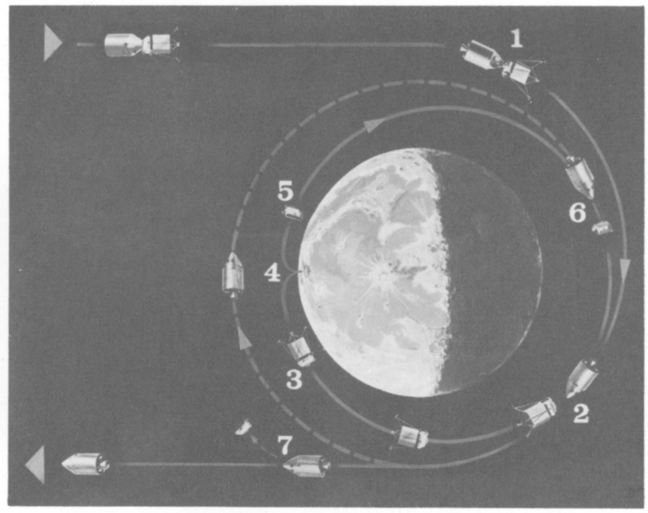
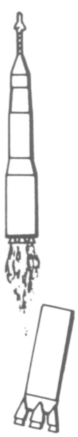




The first Americans will pull free from Earth's gravity and head for the Moon by the thrust of a powerful Saturn V rocket.

When President Kennedy set a manned lunar landing in this decade as a national goal, it called for a vehicle much larger than the Saturn I, then under development.

This advanced Saturn, or Saturn V, is now in early development under the direction of NASA's Marshall Space Flight Center at Huntsville, Alabama. The first launching is scheduled in 1966, operational launchings about two years later.

The Saturn V will be able to place more than 120 tons into Earth orbit, or send more than 45 tons to the vicinity of the Moon. It will consist of three stages, with the first stage having 7.5 million pounds of thrust.

The booster, or S-IC stage, under development by Marshall and the Boeing Company, will use five F-1 engines, burning liquid oxygen and kerosene to produce a total thrust of 7.5 million pounds. The F-1 has been static fired many times at full thrust by Rocketdyne for full flight duration. It produces 1.5 million pounds of thrust for about 2½ minutes.

The second, or S-II stage, is under development by North American Aviation, Inc. It will use five J-2 engines, burning liquid oxygen and liquid hydrogen. The J-2 engine, now in the static firing phase of development, will provide 200,000 pounds of thrust.

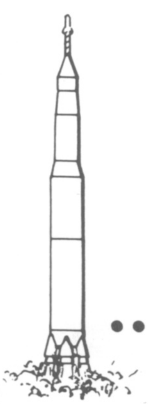
The third, or S-IVB stage, will have a single J-2 engine. This stage is under development by Douglas Aircraft Company.

NASA's program for the manned exploration of the Moon is known as Project Apollo. The Lunar Orbital Rendezvous Mode was selected by NASA in July, 1962, as the best method of meeting the goals established by the President.

The lunar spacecraft in Project Apollo is being developed under direction of NASA's Manned Spacecraft Center at Houston, Texas. The spacecraft will have three elements: a command module, a propulsion module, and a lunar excursion vehicle. The command module carries the three-man crew, plus guidance and control instrumentation. The service module contains instrumentation to which the crew does not need access during flight and the primary spacecraft propulsion system. The lunar excursion vehicle is the only part of the spacecraft that lands on the Moon.

The 3,000-ton Saturn with its precious cargo will be launched from Merritt Island, Florida. The first, second, and third stages are fired in succession to place the third stage and the spacecraft into a "parking" orbit around the Earth. The first and second stages are jettisoned after cutoff, and the escape tower is discarded after second stage ignition.

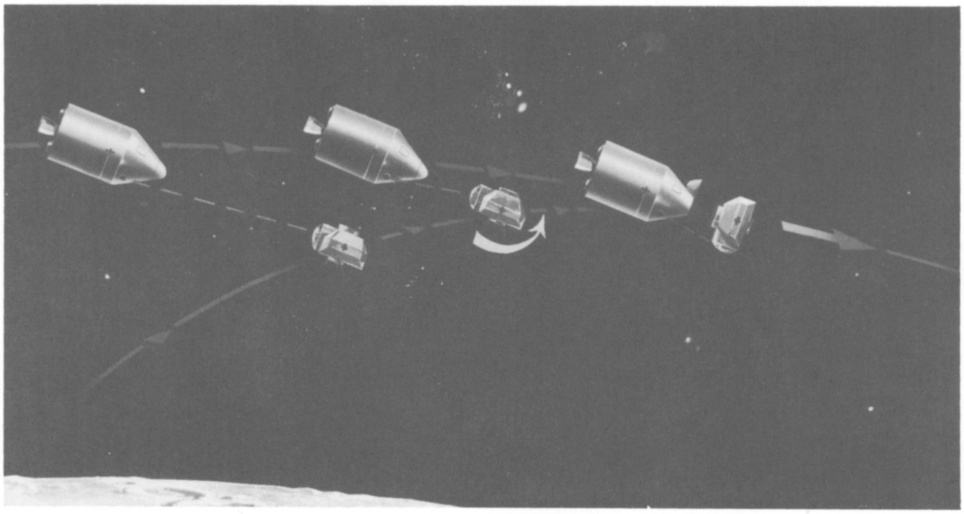
After the spacecraft has been checked out in Earth orbit, the third stage is restarted, boosting it to escape velocity, about 25,000 miles per hour. The command and service modules separate, and the shroud surrounding the



The line drawings around the border of these pages illustrate the steps of a manned Moon mission.

lunar excursion module splits open clam-like and falls away. The nose of the command module then docks with the lunar excursion module, and the spent third stage falls away.

The pull of Earth's gravity will slow the spacecraft's speed to about 6,500 mph at the end of one day, and to about 1,500 mph after two days. As the spacecraft approaches the Moon, the propulsion unit in the service module ignites, slowing the whole assembly into a precise orbit about 60 miles above the Moon's surface. Two astronauts crawl through the nose of the command module into the lunar excursion module. Its engine is ignited and it goes into a low trajectory to inspect the launch site. The command and service modules remain in a circular orbit of the Moon.



On the next trip around, if everything is all right, the lunar excursion module, or Bug, will land. A large glass area allows the two astronauts to have a clear view of the touchdown site. With retrorocket firing and legs extended, the vehicle descends to within 100 feet of the lunar surface. The vehicle will be able to hover for almost a minute or move laterally for about 1,000 feet for choosing the best touchdown point.

After the lunar landing, the excursion vehicle is first checked out to determine its readiness for a lunar take-off. Only then does exploration of the Moon begin. Most of this exploration will be geologic in nature. It will include mapping, photography, observation of surface characteristics, core and surface sampling, and seismic and radiation measurements.

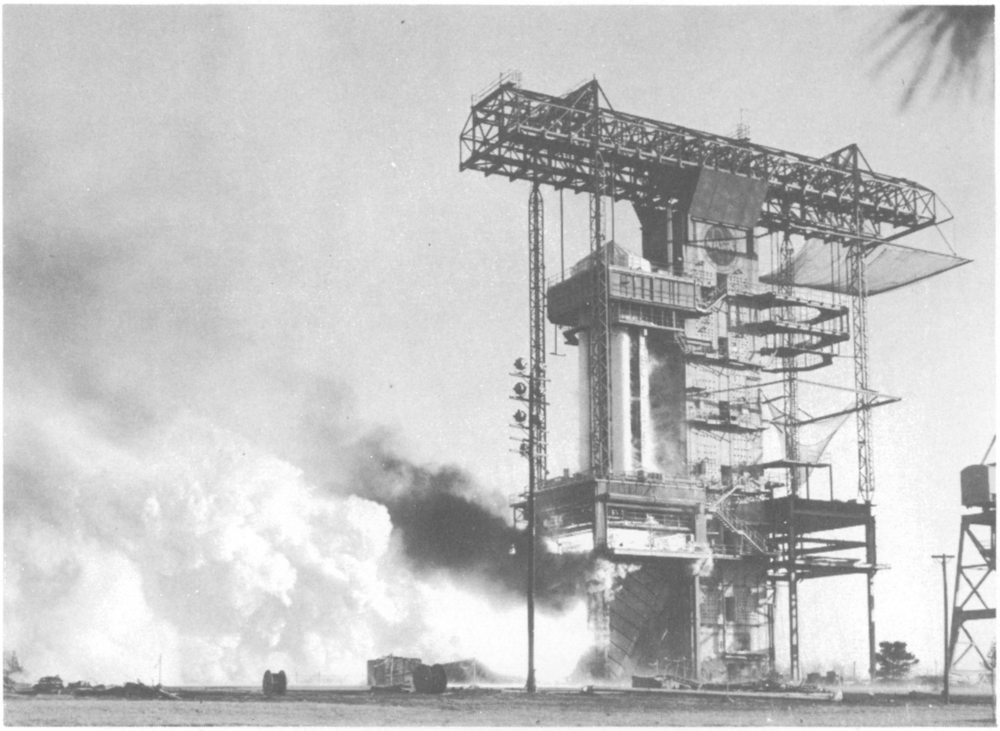
For the return trip to Earth the two astronauts ignite the upper portion of the excursion module, using the burned out landing stage as a launch pad, which remains on the Moon. The orbiting command module, containing the third astronaut, will be above the Moon's horizon when the the upper portion of the excursion module is launched. Radar and visual contact are maintained between the two vehicles, and docking will be made under a high degree of manual crew control.

After docking, the two astronauts transfer back to the command module. The lunar excursion module is jettisoned and remains in orbit about the Moon. After checkout of the spacecraft, the propulsion system of the service module is ignited, injecting the command and service modules into a trans-Earth trajectory. After the spacecraft attains the necessary velocity and performs a mid-course correction, the propulsion module is jettisoned.

The command module is turned around for re-entry. It must return to Earth at a very precise trajectory, depending upon the Earth's atmosphere to slow it down for a landing. The re-entry corridor is only 40 miles in depth. Too shallow an approach, and the Earth is missed entirely; too steep an approach, and the spacecraft plunges directly into the atmosphere and burns up.

Traveling at 25,000 miles an hour, the module enters the atmosphere at an angle. It encounters heating rates several times higher than those encountered during project Mercury re-entries.

The blunt end of the command module heats up like a fireball. Pressure and friction of the atmosphere and then a drogue chute slow the module, and at 10,000 feet the main parachutes open to bring it to a safe ground landing. Radar and optical instruments track its descent, and helicopter recovery teams proceed immediately to pick up the three crewmen.



MARSHALL SPACE FLIGHT CENTER

The home of Saturn is the George C. Marshall Space Flight Center, located at Huntsville, Alabama. It is directed by Dr. Wernher von Braun.

The Marshall Center's major task for the next several years is to furnish Saturns for Project Apollo, the manned lunar exploration program of the National Aeronautics and Space Administration. In addition, the Center is responsible for studies of future launch vehicle systems, and related research.

The Center was formed July 1, 1960, by transfer of employees and facilities from the U. S. Army at Redstone Arsenal to NASA. Growing steadily, it now employs about 7,000 people.

Current projects include the Saturn I, Saturn IB, and Saturn V vehicles. These use the H-1 and F-1 engines, which burn the conventional liquid oxygen and kerosene fuel combination, and the RL-10 and J-2 engines, which use high energy liquid hydrogen and liquid oxygen.

Because of its unique laboratories and testing facilities, the Marshall Center is the nation's most complete establishment for the development of large rockets. It can carry a rocket program from the note pad to the launch pad. The Marshall Center does not attempt to perform its huge developmental tasks alone, however. More than 90 per cent of its budget goes to contractors in industry and to universities.