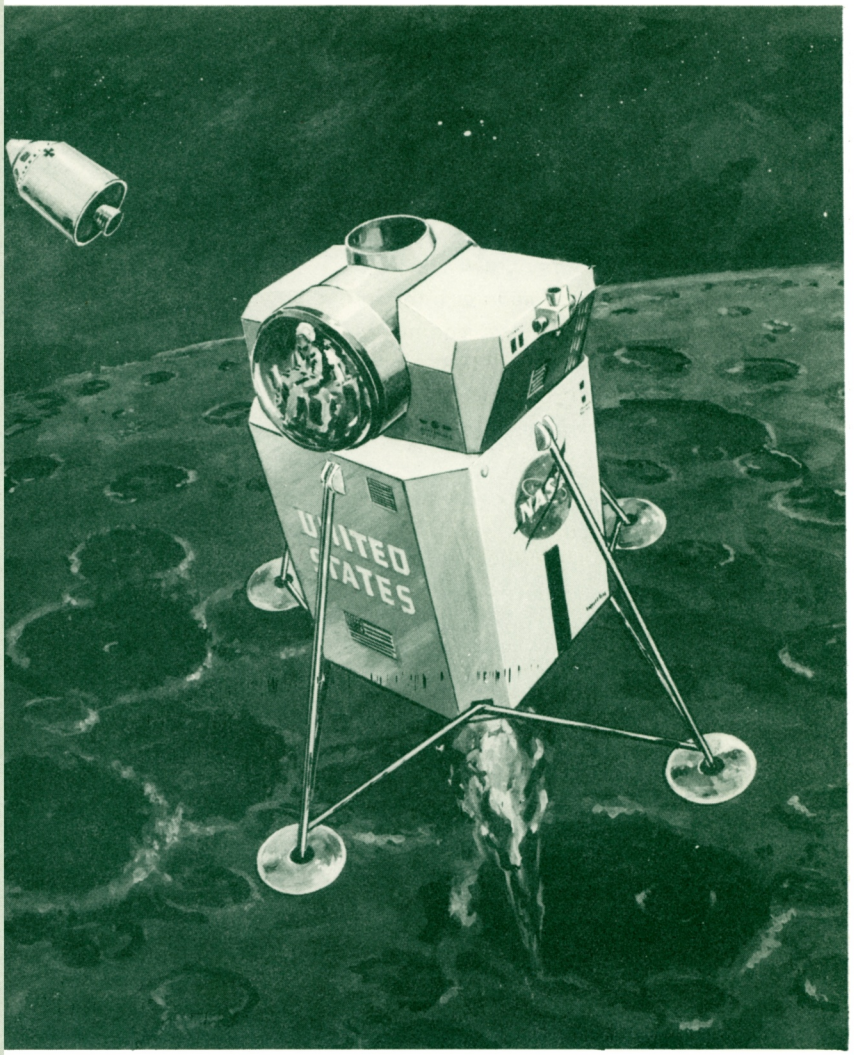
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



LOR

LUNAR ORBITAL RENDEZVOUS

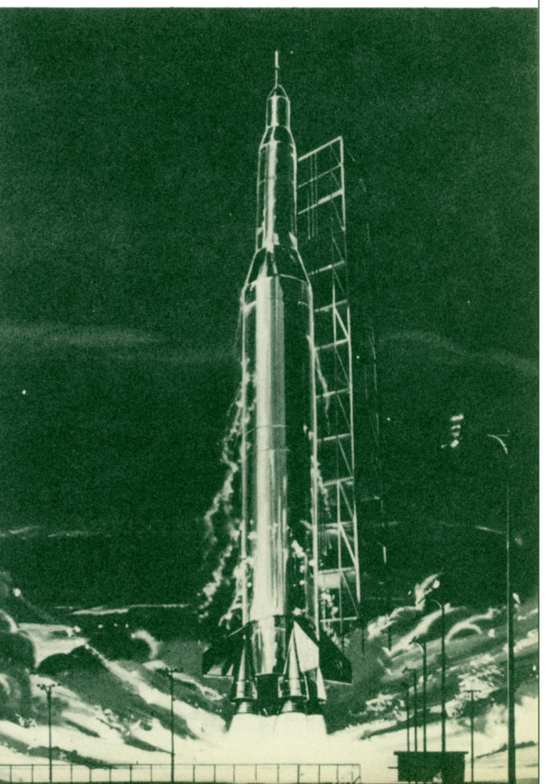
" A Pathway to the Moon "

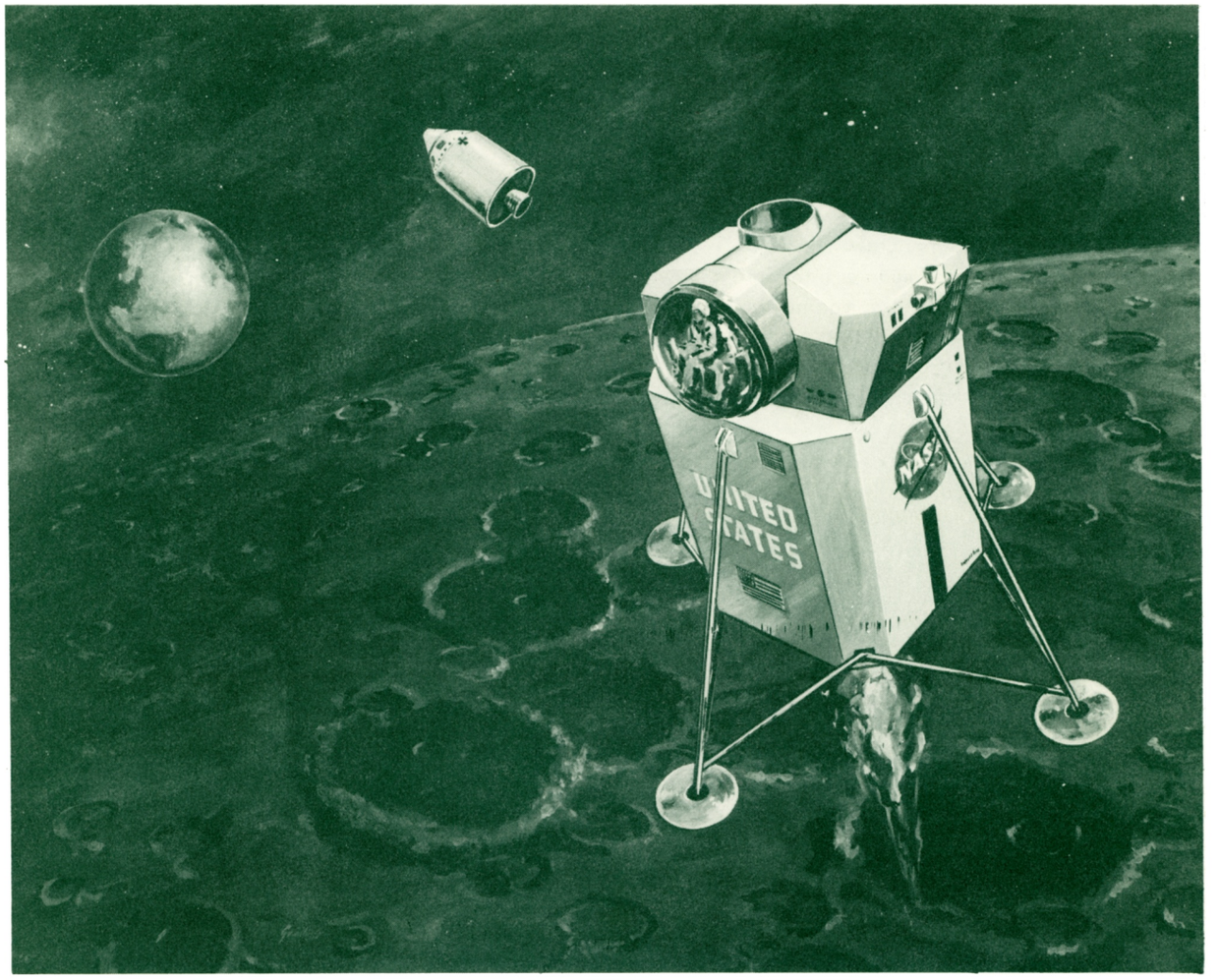
GEORGE C. MARSHALL SPACE FLIGHT CENTER

HUNTSVILLE, ALABAMA

SATURN C-5

Apollo





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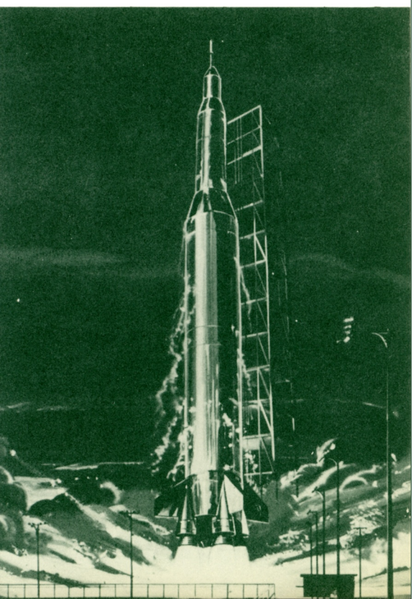
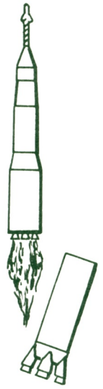
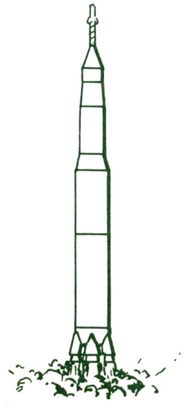






The first Americans will pull free from earth's tug and head for the moon by the thrust of a powerful Advanced Saturn rocket.

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 C-1, then under development.

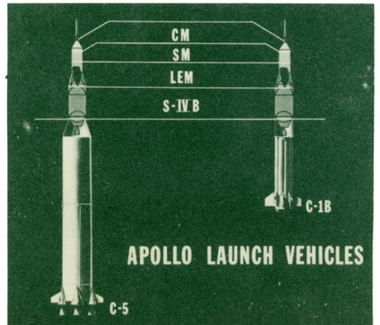
The Advanced Saturn, or Saturn C-5, is now in early development under the direction of NASA's Marshall Space Flight Center at Huntsville, Ala. The first launching is scheduled in 1965, with operational launchings about two years later.

The C-5 will be able to place more than 100 tons into earth orbit, or send more than 40 tons to the vicinity of the moon. It will consist of three stages, with the first stage having 7.5 million pounds of thrust.

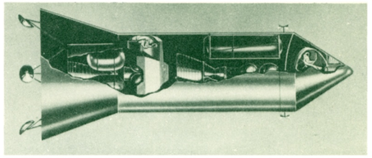
The booster, or S-1C stage, is under development by Marshall and the Boeing Company. It will use five F-1 engines, burning liquid oxygen and kerosene to produce a total thrust of 7.5 million pounds. The F-1 has been static fired at full thrust by Rocketdyne for full flight duration. It produced 1.5 million 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. It is directed at the Washington level by D. Brainerd Holmes. The Lunar Orbital Rendezvous Mode was selected by NASA in July, 1962, as the best and least expensive 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, Tex. 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.

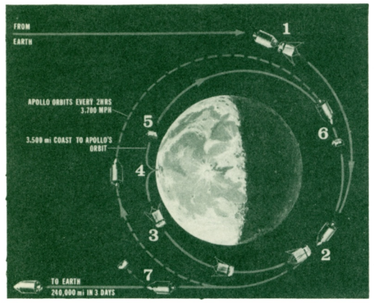
The series of outline drawings around the border of this page illustrate the steps of a moon mission.

The 3,000-ton C-5 with its precious cargo will be launched from Cape Canaveral, Fla. 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 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 of the C-5 rocket falls away.

The pull of earth's gravity will slow the spacecraft's speed to about 6,500 mph at end of one day, and to about 1,500 miles an hour 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 vehicle. 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 vehicle 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 vehicle, using the burned out landing stage as a launch pad. It remains on the moon. The orbiting command module containing the third astronaut will be above the moon's horizon when the upper portion of the excursion vehicle 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 reentry. It must return to earth at a very precise trajectory, depending upon the earth's atmosphere to slow it down for a landing. The reentry 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 up to ten times higher than those encountered during projects Mercury reentries.

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.

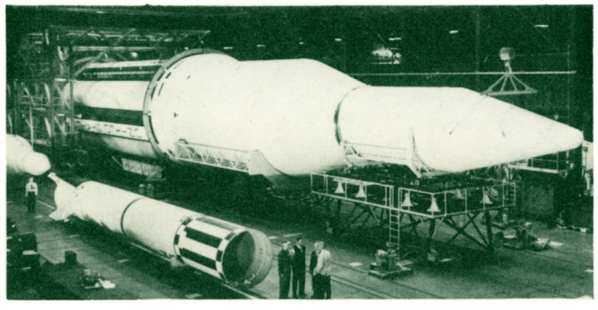
GEORGE C. MARSHALL SPACE FLIGHT CENTER

The George C. Marshall Space Flight Center provides NASA's launch vehicles for the exploration of space. Located at Huntsville, Ala., it is the largest installation of the National Aeronautics and Space Administration. The Marshall Center is directed by Dr. Wernher von Braun.

Marshall's major task for the next several years is to furnish the giant rockets that will be used in the nation's manned lunar exploration program. This is the greatest scientific and engineering project ever undertaken in peacetime by the United States. It is directed at the Washington level by D. Brainerd Holmes, head of NASA's Office of Manned Space Flight.

The Marshall Center occupies about 1,600 acres, and its facilities are valued at more than $100 million. It employs about 6,800 persons, with an annual payroll of more than $60,000,000. Most of the facilities and employees were transferred to NASA from the U. S. Army at Redstone Arsenal by direction of the President. The Center was formally opened on July 1, 1960.

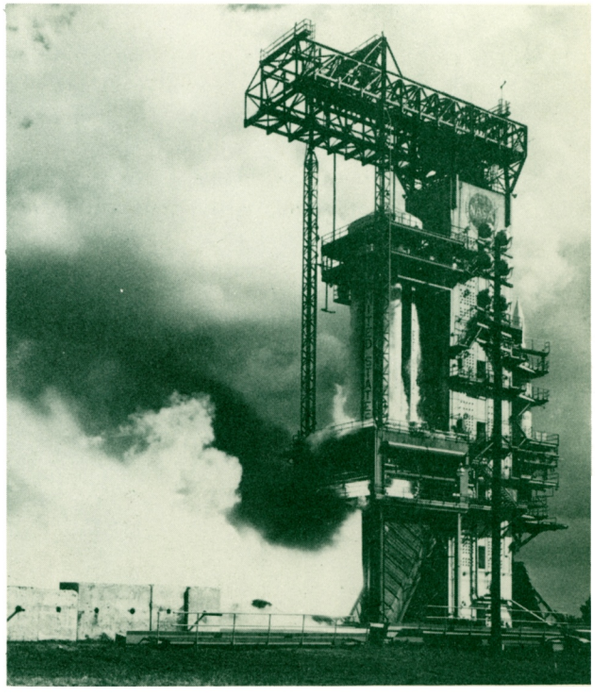
With its unique "in-house" facilities, Marshall is the nation's most complete establishment for the development of large rockets. It can carry a rocket program from conception of the idea through design, development, fabrication, and flight testing. Because of the enormity of its tasks, however, more than 85 per cent of its 1.4 billion dollar budget for this year will be spent with private industries and research organizations.



Marshall's current projects include the following space vehicles and stages: Saturn C-1, Saturn C-1B, Saturn C-5, Nova, Thor Agena-B, Atlas Agena-B, and RIFT (Reactor-in-Flight-Test). The engine development projects which Marshall is directing include the H-1 and F-1 engines, using the conventional liquid oxygen and kerosene fuel combination, and the RL-10 and J-2 engines, which use the high energy propellant combination, liquid hydrogen and liquid oxygen.

Marshall Center personnel are pioneers in rocketry and space research. The group developed the Redstone, Jupiter and Pershing missiles and conducted several outstanding space projects, including the launching of the Free World's first:

a. Satellite of the earth, Explorer I, January 31, 1958
b. Satellite of the sun, Pioneer IV, March 2, 1959
c. Successful flight into space and recovery of animal life, monkeys Able and Baker, May 28, 1959
d. Manned spacecraft, occupied by Astronaut Alan Shepard, May 5, 1961. This accomplishment was repeated July 21, 1961, with the launching of Astronaut Virgil Grissom.
e. Rocket with thrust in excess of one million pounds, the Saturn C-1, launched October 27, 1961. A second Saturn was launched successfully April 25, 1962, and a third one in November, 1962.



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