SATURN V APOLLO

LUNAR ORBIT RENDEZVOUS MISSION

GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

III. 3.

SATURN V
APOLLO

The huge rocket that will launch three Americans on an epic voyage to the moon before the end of this decade will be a Saturn V, provided by NASA's George C. Marshall Space Flight Center at Huntsville, Ala.

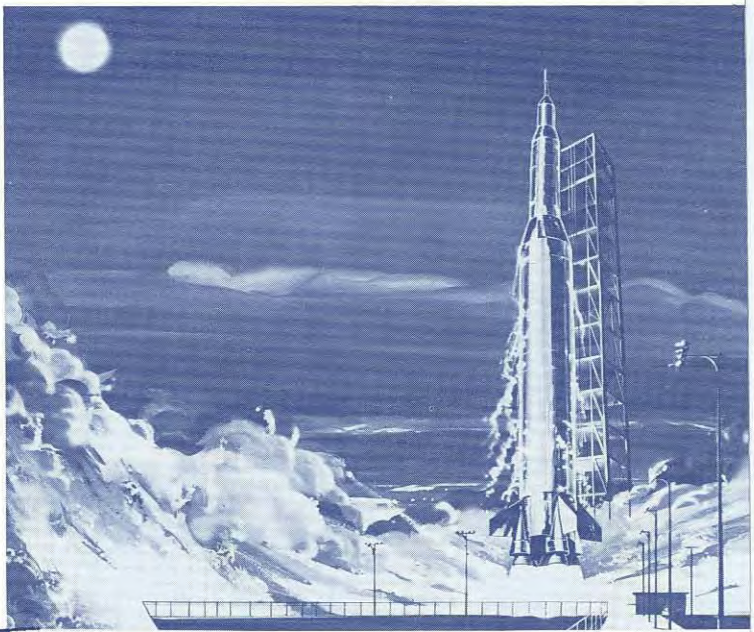
The Saturn V is being developed especially for Project Apollo, America's Manned Lunar Landing Program. Using the Lunar Orbital Rendezvous Mode, two of a three-man crew will land on the moon, explore it for at least one day, rejoin the third crew member who remained in lunar orbit, and return safely to earth. This illustrated booklet describes the Saturn V launch vehicle, the Apollo Spacecraft, and the Lunar Orbital Rendezvous Mode chosen for our first manned lunar landing attempt.

The Saturn V is now in the early stages of development. The first research and development launching is scheduled for 1966, with operational launches planned about two years later.

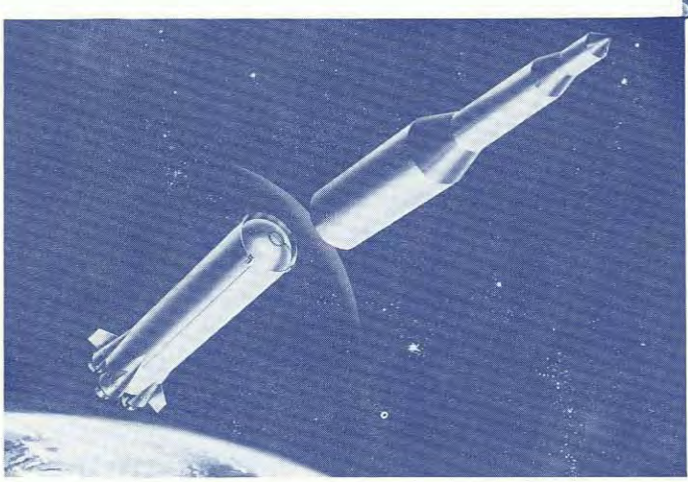
The big three-stage Saturn V will be able to place more than 120 tons into earth orbit, or send about 45 tons to the vicinity of the moon.

Sept 1963

LIFTOFF FROM LAUNCH PAD

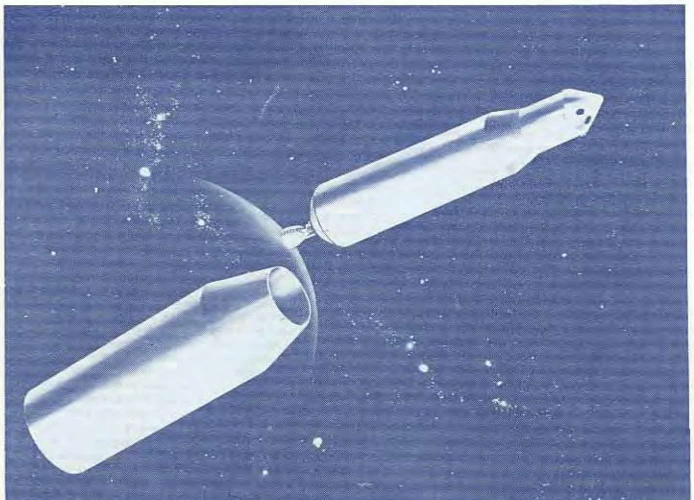


The trip to the moon will start at Cape Canaveral, Fla., when the 33-foot diameter, 350-foot tall Saturn V rises thunderously from the launch pad. The first stage develops a total of 7.5 million pounds of thrust to start the three Astronauts on man's most fantastic trip of exploration.



1st STAGE SEPARATION

The booster, or S-1C stage, is under development by Marshall and the Boeing Company. It clusters five Rocketdyne F-1 engines, burning liquid oxygen and kerosene to produce 1.5 million pounds of thrust each. The F-1 has been static fired successfully at full thrust for full flight duration, which is about 2½ minutes. The first stage drops away after cutoff. The escape tower is discarded after second stage ignition.

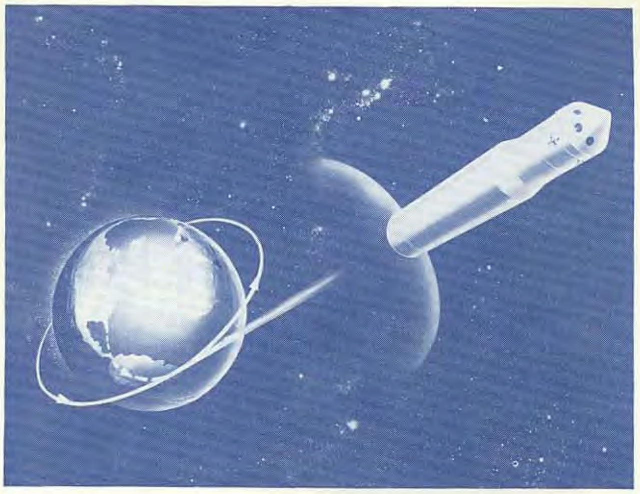


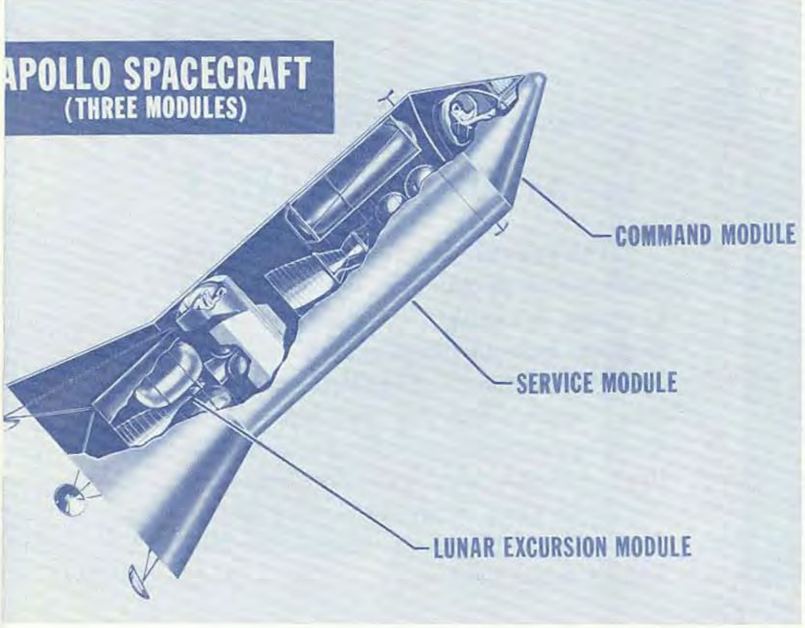
2nd STAGE SEPARATION

The second, or S-II stage, is under development by North American Aviation, Inc. It uses five Rocketdyne J-2 engines, burning liquid oxygen and liquid hydrogen. The J-2 engine, now in the static firing phase, will provide 200,000 pounds of thrust. The second stage is separated after burnout. A partial burn of the single J-2 engine in the third, or S-IVB, stage is necessary to place this stage and the Apollo Spacecraft into a "parking" earth orbit. The third stage is under development by Douglas Aircraft Company.

INJECTION INTO LUNAR TRAJECTORY

At least 1½ half revolutions around the earth will be required to reach the proper launch "window" (most direct line of flight toward the moon), to check out the spacecraft, and to determine that everything is ready to commit the spacecraft to the mission. When the decision is made to go ahead, the third stage engine will be ignited again to reach the escape velocity of about 25,000 miles an hour.



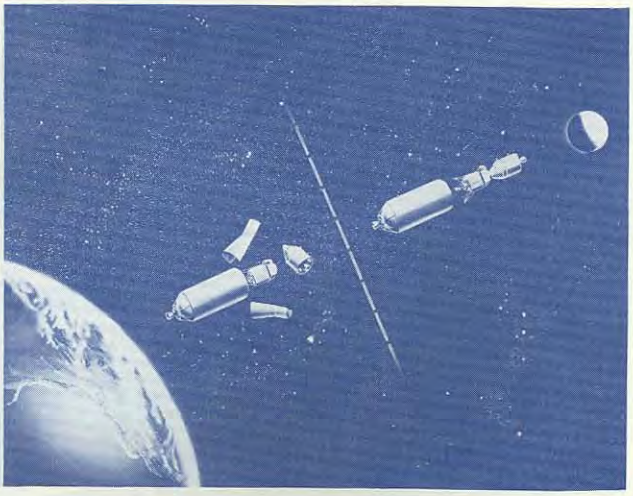


APOLLO SPACECRAFT

The Apollo Spacecraft, which is the responsibility of NASA's Manned Spacecraft Center at Houston, Texas, has three major parts. The Command Module carries the crew, plus guidance and control .instrumentation. The Command Module will weigh about five tons and measure 12 feet high. The Service Module, containing the primary spacecraft propulsion elements, will weigh about 23 tons and measure 23 feet high. The third element is the Lunar Excursion Module, or "Bug." It will weigh about 15 tons and stand about 20 feet tall. In addition to its scientific instruments, communications, and guidance systems, the Bug will carry two astronauts to and from the lunar surface and the orbiting Command-Service modules.

DOCKING IN TRANSIT

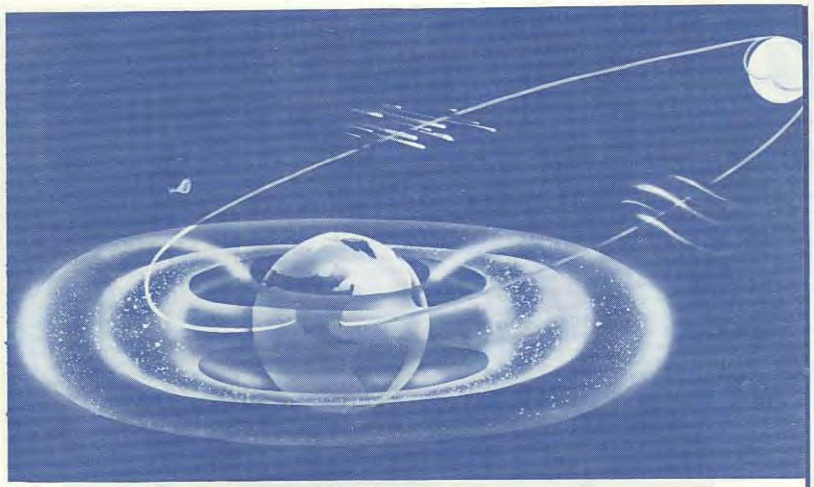
When the proper earth-to-moon trajectory has been established, fairings which have shielded the Bug are released. The Command-Service modules are separated from the Lunar Excursion Module-third stage, and turned 180 degrees, then mated nose-to-nose with the Bug. This will be done by "flying" the Command-Service Module to its re-oriented position through attitude control. After this maneuver the third stage is jettisoned.

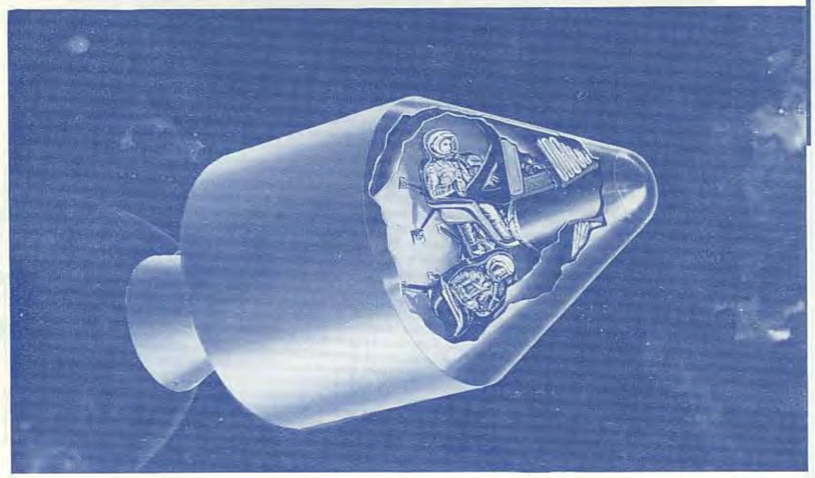


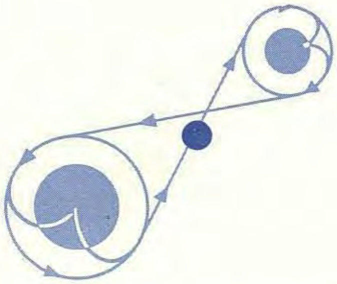
ENROUTE

During the journey to the moon, the Astronauts must keep close watch on radiation levels. The great radiation area encircling the earth, discovered by America's first satellite, Explorer I, is a severe problem to manned space flight. They pass through it quickly, avoiding prolonged exposure. Radiation from solar flares and meteorites are other hazards.

Inside the spacecraft, pressurized space suits can be discarded for light, comfortable coveralls. The crew can talk directly to earth ground crews, reporting scientific observations, and their physical and mental condition.

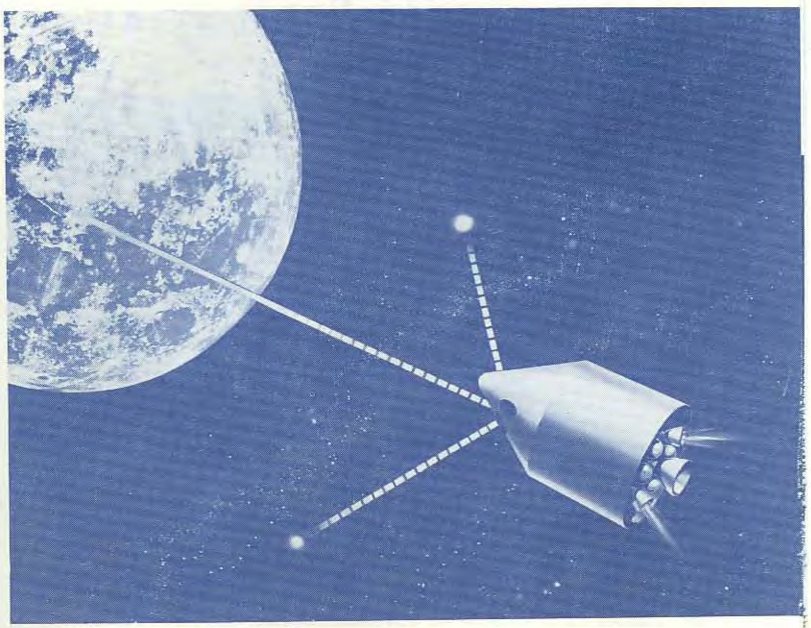


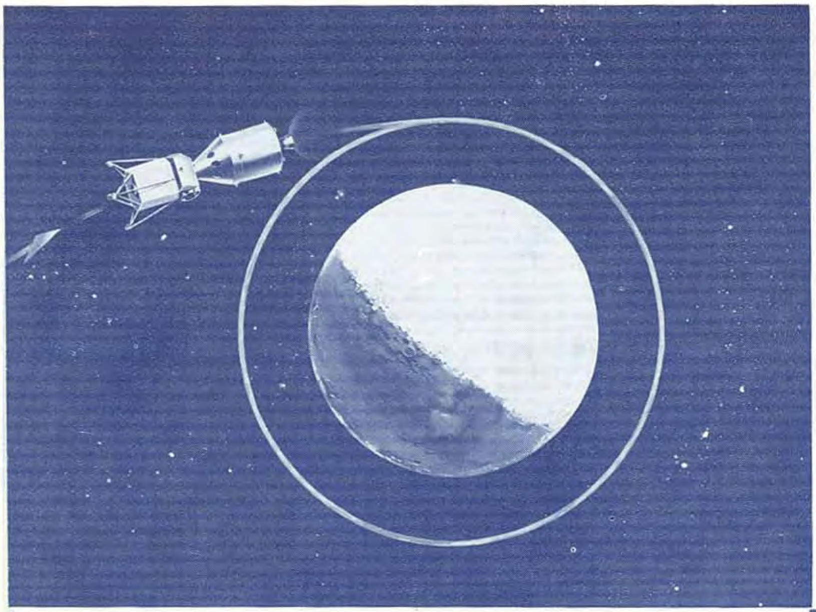




MID COURSE CORRECTION

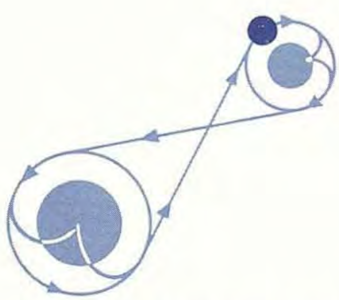
The crew makes navigation checks by taking bearings on the earth, moon, and stars, and corrects the spacecraft's course, if necessary. The pull of earth's gravity will slow the vehicle's speed to about 6,500 miles an hour after one day, and 1,500 miles an hour after two days. As the moon looms nearer, its gravitational pull becomes stronger than that of the earth, and the craft begins to fall toward the moon, gaining velocity.



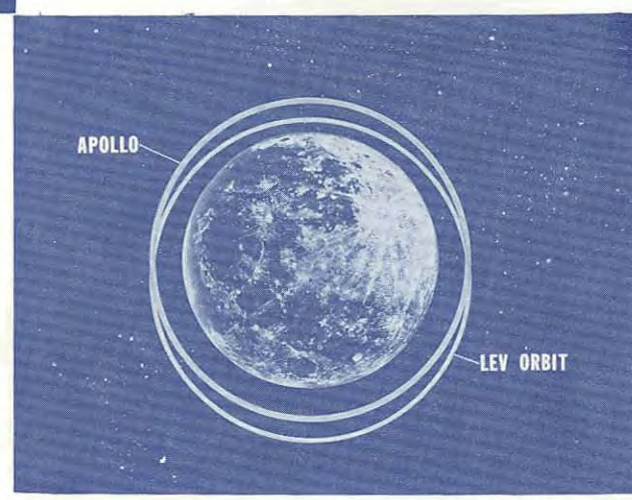


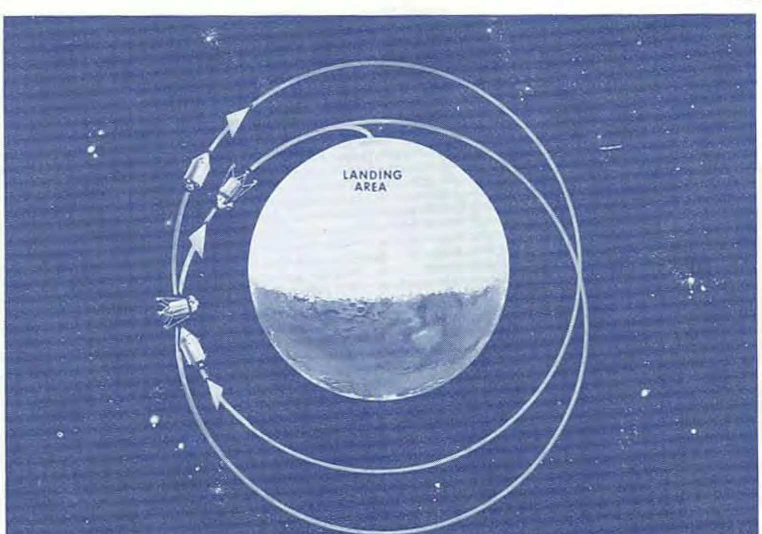
ENTERING LUNAR ORBIT

A number of mid-course maneuvers may be required to place the spacecraft into position for braking into a precise, circular lunar orbit. Approximately 72 hours after liftoff, the Service Module propulsion unit will ignite, slowing the entire spacecraft into a precise circular orbit about 60 miles above the moon's surface.



LUNAR ORBIT RELATION



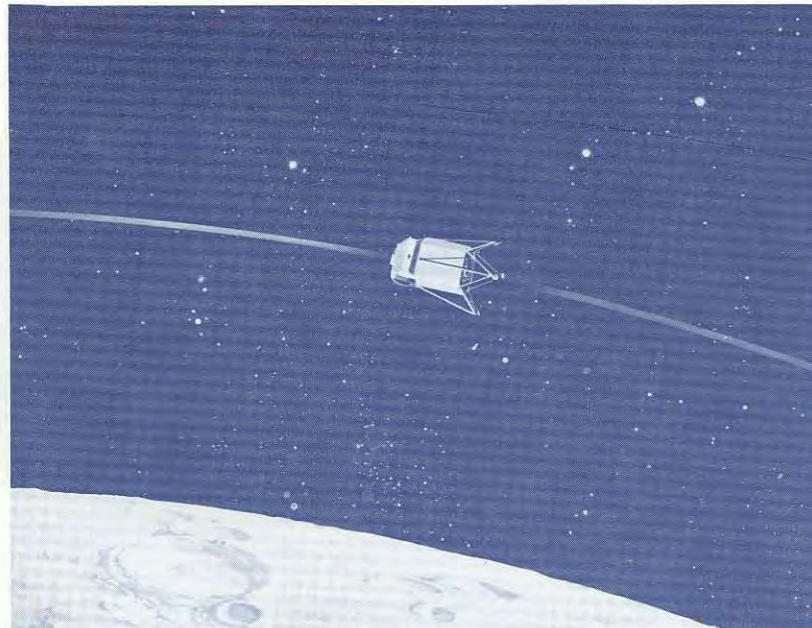


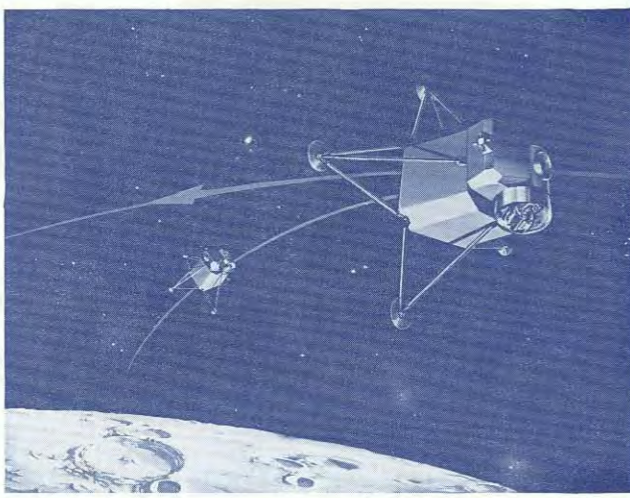
ENTERING LANDING ELLIPSE

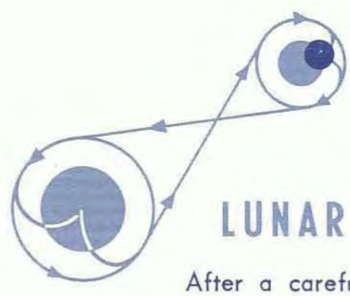
After preparing the Bug for descent to the lunar surface, the two lunar explorers will transfer to the Bug through the hatch at the connecting point of the two vehicles. Once they are transferred, the Bug will separate from the Command-Service modules, which will remain in lunar orbit, with the third astronaut.

SURVEYING LANDING AREA

The Bug's propulsion system will place the two-man ship into a trajectory having the same period as the Command-Service Modules but with a lower perigee of approximately 60,000 feet. This low perigee permits a close examination of the intended landing site. It also enables the Bug and the mother ship to come closely together twice during each orbit. This would be a natural position for rendezvous if for any reason the situation calls for an aborted mission.





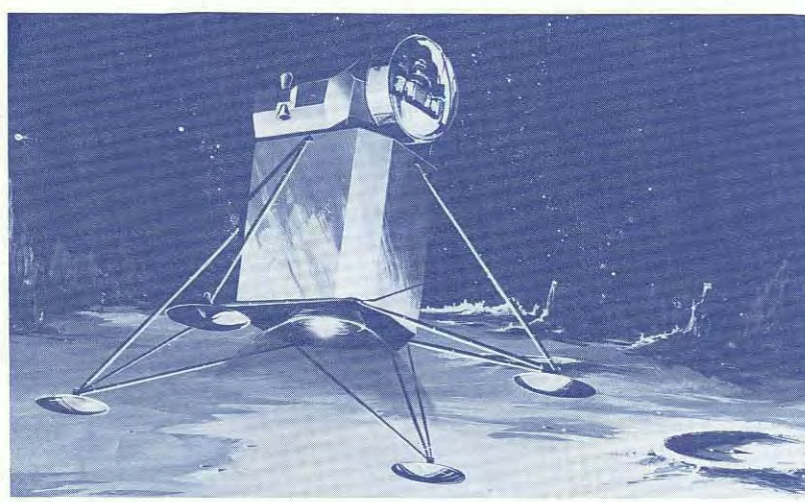


LUNAR DESCENT

After a carefully blended combination of manual control and automatic system operation, retro-maneuver will be executed, bringing the Bug out of lunar orbit. It drops to within 100 feet of the moon's surface.

LANDING MANEUVER

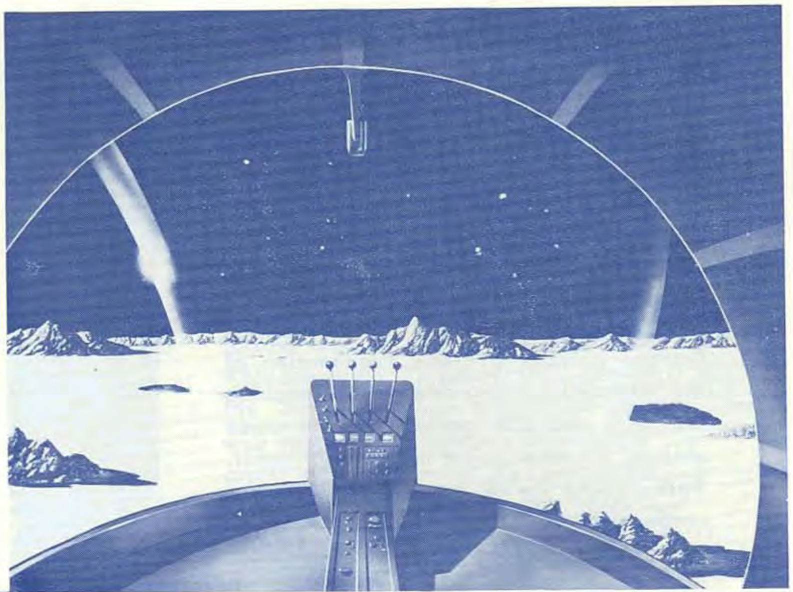
The explorers will be aided by maps, reconnaissance data and, possibly, a previously landed beacon. The Bug can maneuver laterally 1,000 feet to get in the best possible position of lunar touchdown. Descent to the surface is probably the most critical phase of the entire operation. Fortunately, the Bug will be small and will be designed specifically for landing, rather than for both landing and re-entry.

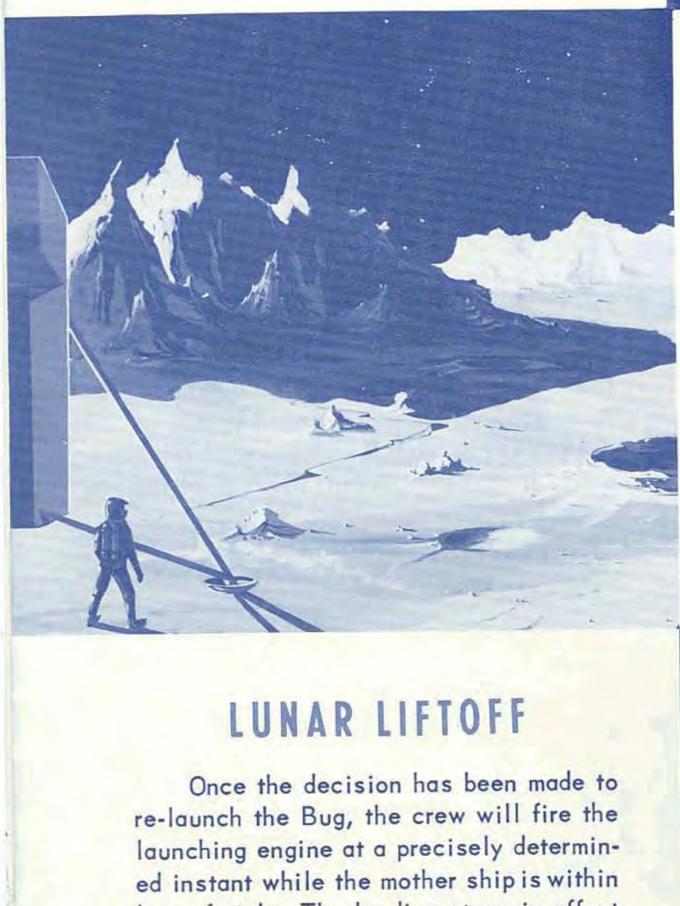


LEM FIELD OF VIEW

The Bug will have a reasonable amount of glass area so that the landing maneuver can be under visual control of the two astronauts. During the landing maneuver, the Command-Service Module with the one astronaut aboard will always be in line of sight and radio communication with the Bug.

Once lunar touchdown has been completed, and before taking any other action, the two explorers will prepare for re-launching. They will be assisted by the astronaut in the mother ship and information transmitted from earth.





LUNAR EXPLORATION

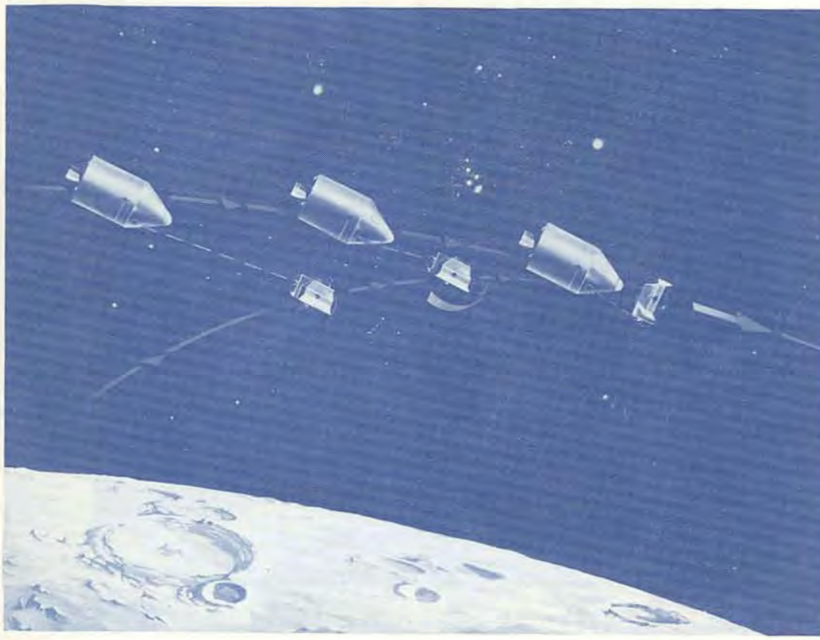
When the first Astronaut steps from the Bug and sets foot on the moon, it will transcend in significance the moment of discovery of continents or oceans here on earth. Manned exploration of the moon is a logical extension of unmanned lunar exploration. Man's judgment and ability to make unscheduled observations make him a valuable means for gathering scientific information. Much of the lunar exploration will be geologic in nature. It will include mapping, photography, observation of surface characteristics, core and surface sampling, seismic measurements, and radiation measurements. The Bug will carry about 200 pounds of equipment for this purpose.

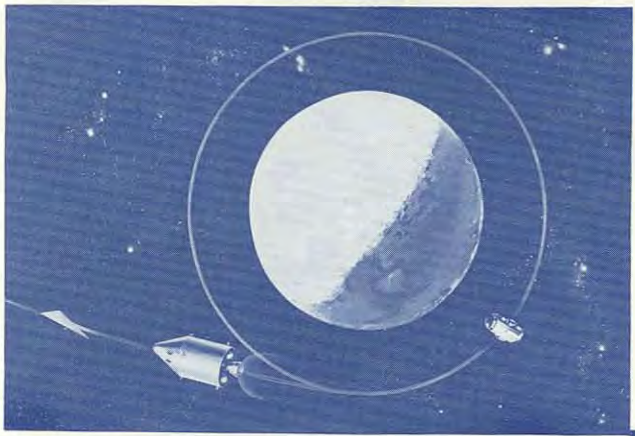
LUNAR LIFTOFF

Once the decision has been made to re-launch the Bug, the crew will fire the launching engine at a precisely determined instant while the mother ship is within line of sight. The landing stage in effect becomes a launch pad, a "Lunar Canaveral," and such items as fuel tanks for landing gear itself will be left on the lunar surface.

LUNAR ORBIT RENDEZVOUS

At liftoff the Bug's engine propels the module up a trajectory which enables it to rendezvous with the mother ship. During the ascent maneuver, there will be radar and visual contact between the Lunar Excursion Module and the Command-Service Module. A flashing light on the mother ship will aid visual acquisition. When Bug and mother craft are about three miles apart, the Bug will re-orient itself, coming into the correct position for nose-to-nose rendezvous with the mother craft. When the two are joined, the Lunar Excursion Module crew will transfer into the Command Module, and the Bug will be detached and abandoned in lunar orbit.



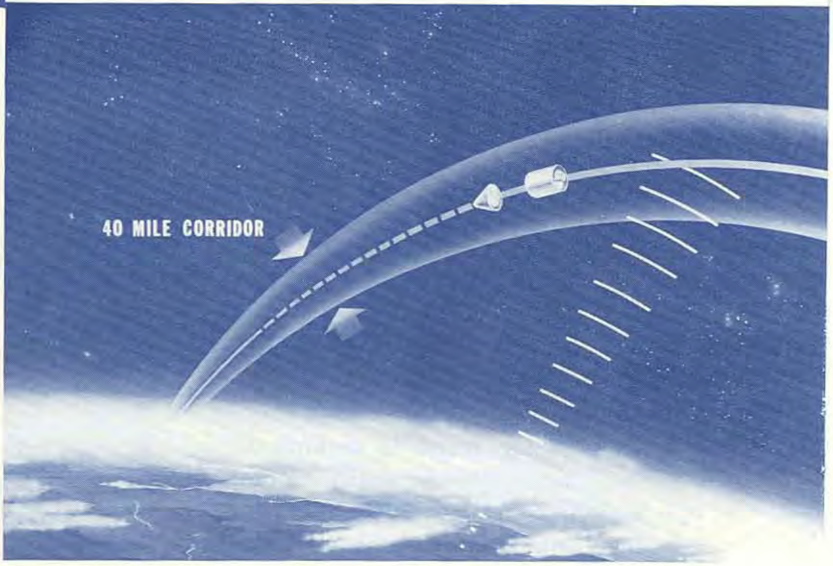


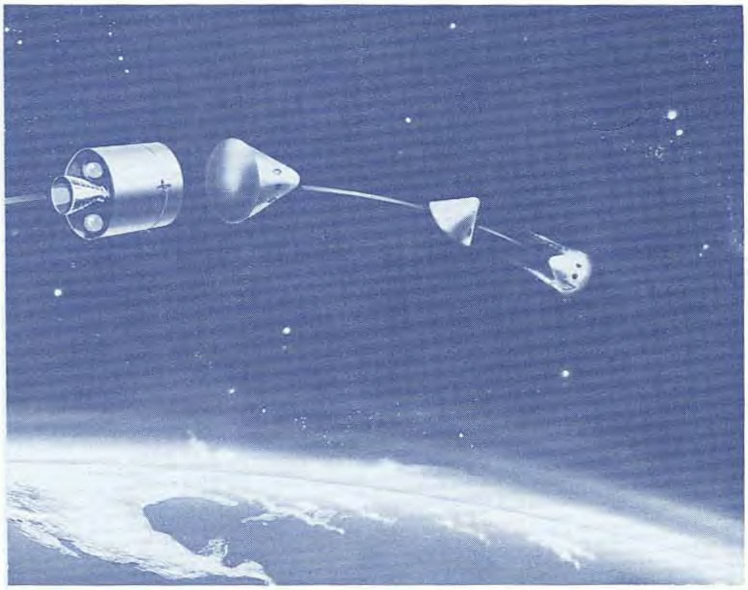
LEAVING LUNAR ORBIT

After the Command and Service Modules are thoroughly checked out, the Service Module, with a 20,000 pound thrust engine, will provide the propulsion to break out of lunar orbit and onto the proper return trajectory. Mid-course correction is made, if necessary, using the propulsion system in the Service Module.

RE-ENTRY CORRIDOR

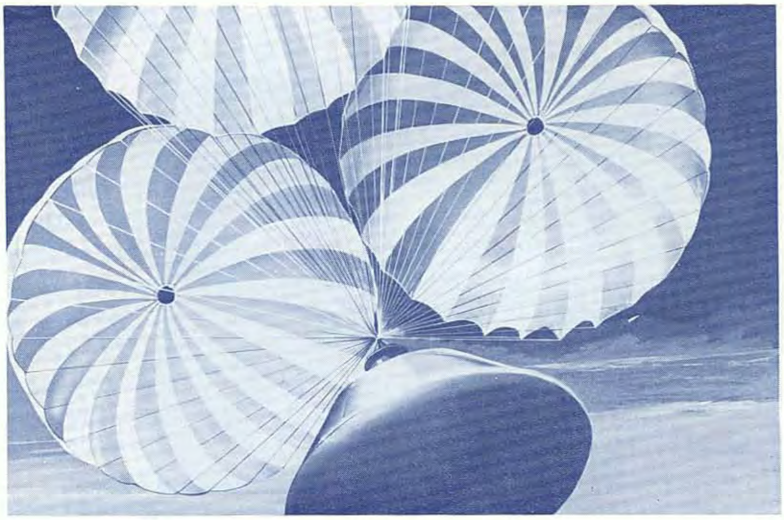
On return to the earth, a very precise trajectory must be flown to bring the spacecraft into position for a 25,000 mile-per-hour re-entry. Too shallow an approach and the earth is missed entirely; too steep an approach and the spacecraft plunges directly into the atmosphere. The re-entry corridor is only 40 miles wide, yet must not be missed from a distance of 250,000 miles away. (In comparison, this is like a rifleman with a .22 standing at one end of a football field and hitting a nickel at the other, with both rifleman and nickel moving.)





RE-ENTRY

Just before entering the earth's atmosphere the Service Module is jettisoned and the five-ton Command Module, containing the three crewmen, turns around, facing its blunt end forward. The angle of attack at re-entry will be about 30 degrees. Heating rates several times those experienced during Project Mercury may be encountered. NASA is hopeful that, by the first Apollo flight, it will be able to overcome the ionization problem and retain spacecraft communication throughout re-entry.

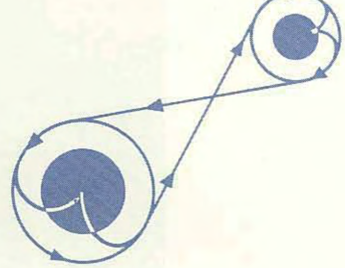


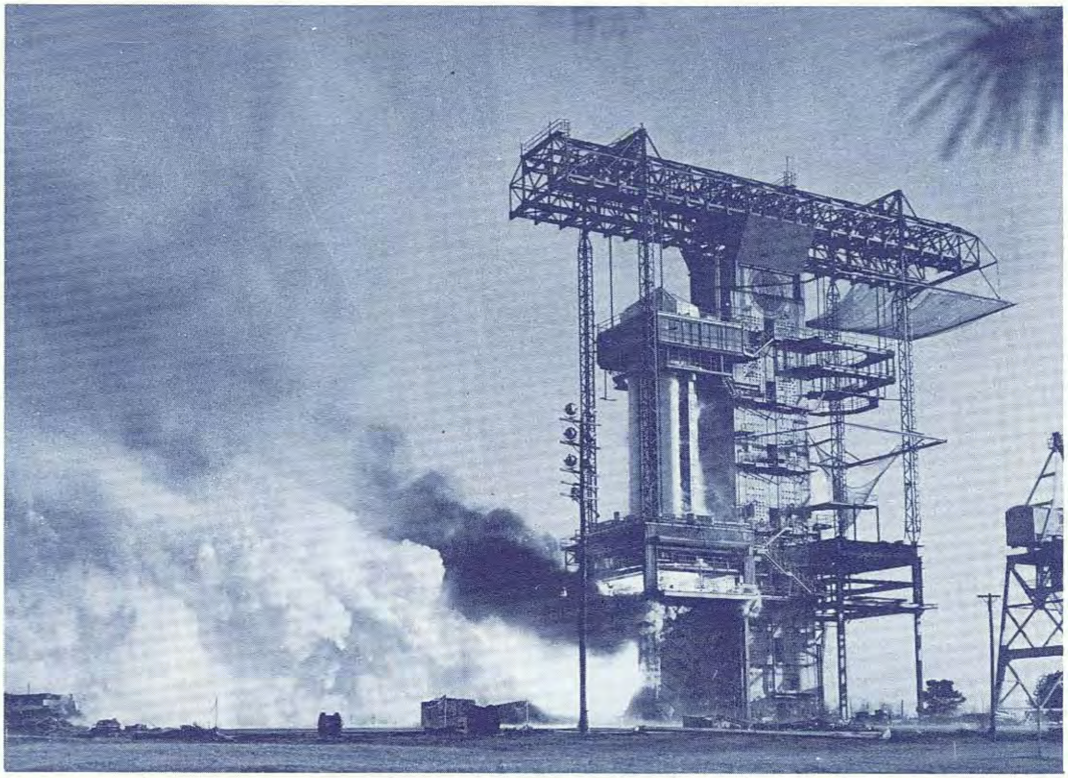
DESCENT

Drogue chutes will be deployed at 50,000 feet. Pressure and friction of the atmosphere slow the module. Final braking of capsule will be by three 85-foot-diameter parachutes, unless the Gemini program proves that a paraglider or a Rogallo wing is feasible.

RECOVERY

Radar and optical instruments track the capsule to the predesignated landing area. The astronauts will aim for an area the size of a large airport. A number of sites in the United States plains states are being considered by the Manned Spacecraft Center, which is seeking a flat area with generally good visibility and few of the restrictions posed by a dense population.





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. The RIFT (Reactor-in-Flight-Test) stage is being developed in a project for applying nuclear energy to rocket propulsion.

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.

Public Information Office
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