Destiny, the Moon (Did you know that...?)

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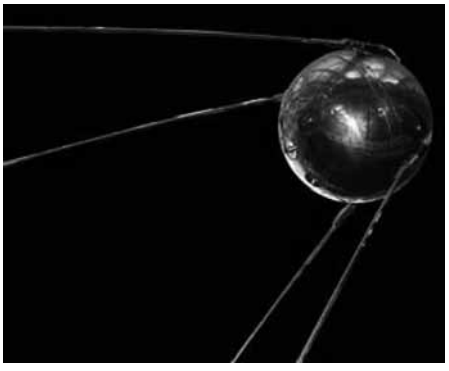
Why the Moon?

After World War II, the relationship between the Soviet Union and the USA was anything but friendly. There was not a formal declaration of war but, effectible, the antagonism had reached a peak that could only be defined as a "Cold War". They were, both, trying to be number one in the amount of ICBMs available for "retaliation" but had not thought much about conquering Space.

Then, Soviets launch Sputnik and become the first nation to place a manmade object into Earth´s orbit. This action set the beginning of the Space race although things were not yet too clear about what Space race meant.



Americans create NASA to separate defense and scientific efforts and with this creation, NASA starts the American Space Program. The first project was named Mercury and it was to use an already well known missile, the Redstone; at the same time, selection of astronauts began while a chimpanzee, HAM, was being trained to be the first American astronaut.

Before HAM was launched, Soviets launched LAIKA and, again, become first in sending a mammal into space.

Americans were training a group of astronauts to flight project Mercury. Seven had been selected and became the "Mercury 7". The first to flight was Alan Shepard but, here also, Soviets are first, by only 23 days, sending Yuri Gagarin into space aboard Vostok 1. Also, Yuri goes into orbit and does a complete Earth turn, Shepard only accomplishes a 16 minute suborbital flight.

American president, Kennedy, addresses the Senate and the House of Representatives on the 25th of May 1961, and requests the consensus and budget to get the Americans to the Moon before the decade is over to show the world their economic and technological leadership. Project Apollo has begun.


In the mean time, project Mercury finally gets a capsule to Earth orbit with astronaut Glenn by using a bigger launcher, an Atlas. Also project Gemini begins as the predecessor to Apollo.

Soviets are not sleeping and send first woman into Earth orbit, Valentina Tereshkova (1963), and also do the first space walk, Leonov (1965), and they are also striving to build a rocket that could take them to the Moon before the Americans.

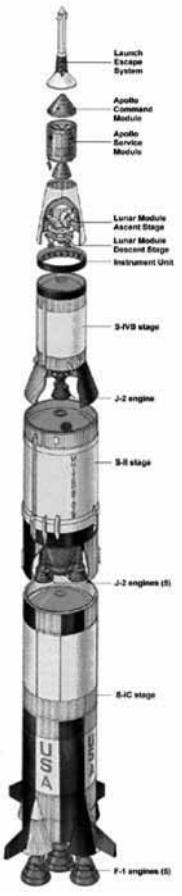

Moon project starts

The first designs for a rocket to send men to the Moon go from a missile big enough to leave Earth, land on the Moon, return to Earth and land safely at home (NOVA), to the launch of two different rockets that would meet in Earth´s orbit and match together to continue the trip. And, finally, a Moon rendezvous that would carry the astronauts in a big Command and Service Module and use a smaller module (LM) to land in the Moon and return to orbit to meet the CSM. This project was proposed by Tom Dolan and led by John C. Houbolt.

The project was underway, first they needed a launcher big enough to place in Earth's orbit the components that would go to the Moon and back so they developed a giant 3 stage launcher called SATURN V.

The first stage was called the S1-C (Boeing, New Orleans) and had 5 F-1 engines, the center one being fixed while the outer four were steerable. The propellants were a super refined kerosene and liquid oxygen and it was able to produce a thrust of 3.5 thousand of metric tons. This first stage burned for 2.5 minutes and was able to place the vehicle at an altitude of 67 km and a speed of 8600 km/h. The ignition sequence started 8.9 seconds before liftoff with the central motor starting first and the outside motors following

with 300 milliseconds of interval each. Once the five engines were at full thrust the launcher was released from the launch platform. 1 minute and 20 seconds after liftoff, the astronauts experienced a maximum dynamic pressure of 4 Gs.

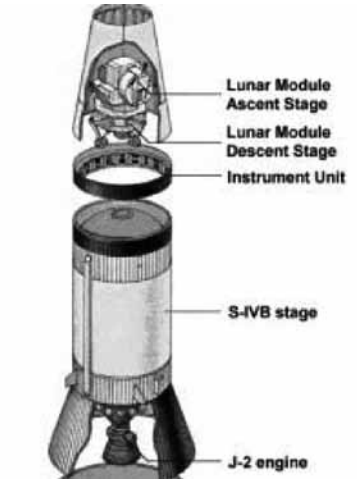


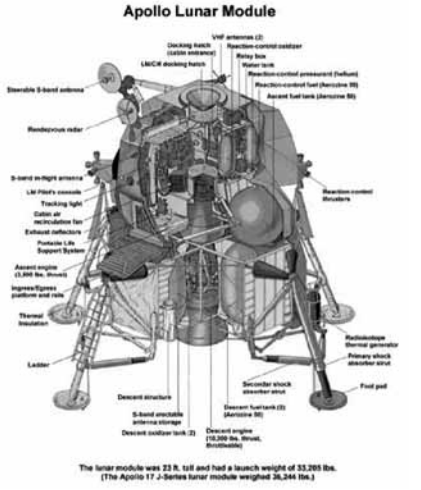
After the propellants were depleted, first stage would separate from the rest of the vehicle and second stage would ignite. At this time, the launch escape tower was jettisoned. This second stage was called S-II (North American Aviation, California) and was composed of five J-2 motors with the center one fixed while the outer were steerable as in the first stage. The propellants were Oxygen and Hydrogen and they would burn for 6 minutes placing the rest of the vehicle at 185 km high and 20600 km/h.

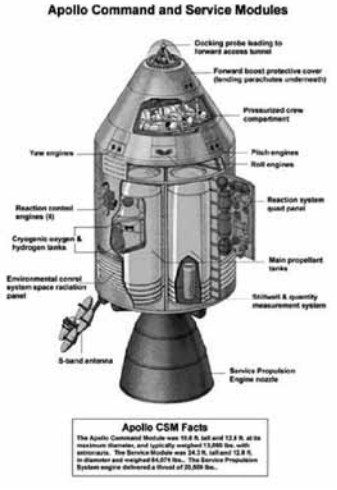
This was just a little less than needed to go into Earth´s orbit so the second stage separated and the third ignited for 2.5 minutes giving the necessary increase in speed to circle the Earth. This third stage was called SIV-B (Douglas Aircraft, California) and used the same type propellants than stage II. It had a single J-2 engine which was restartable as it would ignite again to place the vehicle in lunar trajectory. Atop the SIV-B there was a ring called the IU, Instrumentation Unit, (IBM) that received information from multiple sensors in the vehicle and sent orders to different parts of the launcher based on this information . After the IU, a hatch concealed the Lunar Module (Grumman) which had the landing legs retracted.

On top of the hatch, the Command and Service modules (North American Aviation) were attached, and on top of these, the escape tower. (This had been jettisoned after first stage separation).

The LM used Propergol (Mono-methyl hydrazine + Nitrogen tetroxide) as propellant while the SM used Aerozine 50 (hydrazine + unsymmetrical dimethylhydrazine) + Nitrogen tetroxide.







Vehicle readiness

All these formed the titanic rocket called Saturn V but how were all these stages assembled?

The assembly took place at the VAB (vehicle Assembly Building) which is located at the Kennedy Space Center in Launch Complex 39. It is the largest single-story building in the world. It was initially built to assemble the Saturn V vehicles and later used for the Shuttle. It was finished by 1966.

It is 160.3 m. tall, 218, 2 m. long and 157.9 m. wide and encloses 3.665.000 m^3 of space. For conditioning, it uses 125 ventilators on the roof to keep moisture under control. Nevertheless, its interior is so vast that it has its own weather, including rain clouds on very humid days. Inside air can be totally replaced in one hour.

There are four entries to the building which comprise the four largest doors in the world with a height of 139 m. Each door takes 45 minutes to open or close.

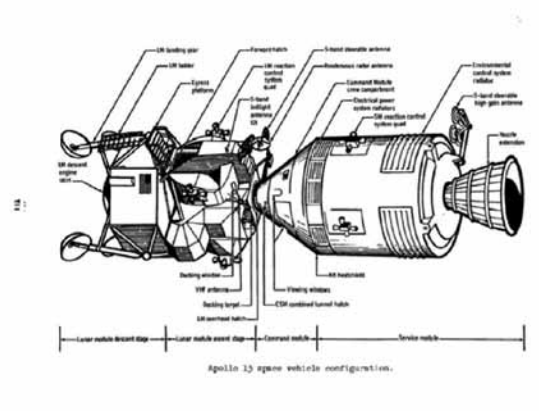
Due to its location, it was built to withstand hurricanes and tropical storms.

Next, the whole assembly mounted on top of a big caterpillar and with the ULT (Umbilical Launch Tower) attached, left the VAB and started the trip to LC 39A at a top speed of 2.5 km/h. When at the launch site, it would attach to the Mobile Service Structure (MSS) and the launch readiness tests would start.

These tests verified the status of the vehicle for launch and, after completed, the MSS would retreat and leave the Saturn V with its ULT continuing with the launch count. At the end of the launch count sequence the Apollo spacecraft would start its voyage to the Moon.

On the way

After 2 1⁄2 Earth orbits, and after all instruments had been checked out, it was time for the SIV-B to perform the Trans-Lunar Injection Burn (TLI). This time it was near to 6 minutes to obtain escape velocity and after the burn the craft was on its way to the Moon.

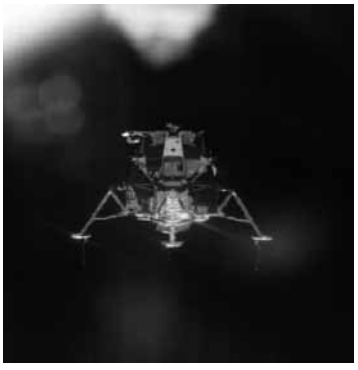


Apollo 13 space vehicle configuration.

About 40 minutes after TLI the CSM separated from the SIV-B, turned around and docked with the LM and, 50 minutes after that, the integrated CSM/LM separated from the SIV-B.

To prevent the SIV-B hitting the CSM/LM, a small evasion maneuver was performed.

During the next three days things were calm at the CSM. The astronauts performed scheduled experiments and took pictures. The CSM/LM was in a Passive Thermal Control (PTC) mode that prevented excessive heat from the Sun by rotating the craft along the longitudinal axis.

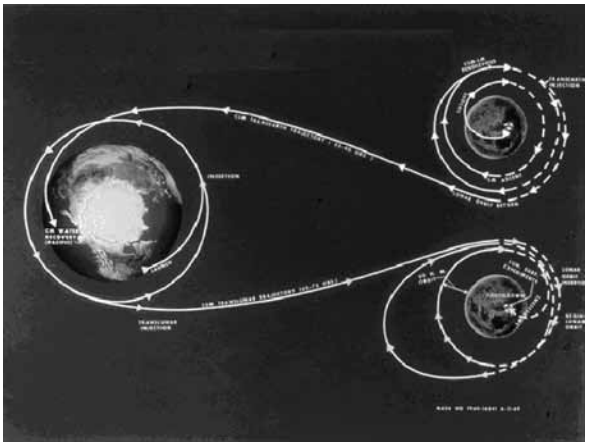


The trip to the Moon would normally place the CSM/LM in a free-return trajectory that would permit the astronauts the return to Earth with no maneuvers in case of a failure, but after the course had been verified to be correct and all equipment working normally, a correction was performed that would let the Moon´s gravity catch the vehicle with the aid of a small burn of the CSM motor while in the backside. Normally, two firing are needed as the first one places the craft in an elliptical orbit and a second will place it in a circular orbit.

The CMDR and LM Pilot then opened the hatch and go inside the LM and turn on all the equipment. A thorough checklist is then performed and LM is ready to unlatch from the CSM and start the landing sequence.

LM is on the Moon, there are many tasks to do like: ensure the entire post-landing checklist is completed, prepare for Moon EVA, collect samples and inspect surroundings, etc.

Ready to return to the CSM, fire the ascent stage and there they went. The CSM was there waiting in Moon´s orbit so both crafts latched again and Commander and Lunar Module Pilot transferred to the CSM all samples collected in the Moon, transferred themselves and unlatched the Lunar Module which was sent into a direct encounter with our satellite.



At the proper time, while behind the Moon, the CSM motor was fired giving the necessary velocity to escape Moon´s gravity and get routed back to the Earth.

Return home

The next three days were normally uneventful and astronauts did housekeeping, lots of pictures and prepared for reentry.

After verifying that the trajectory was adequate to place the CM in the proper window for reentry, the astronauts would don their spacesuits and the SM was jettisoned.

And now, they needed to reduce the speed at which they were coming from the Moon (approximately 40.000 km/h) to a mere 35 km/h to splashdown into the ocean. The capsule enters Earth´s atmosphere and the friction generates a ball of fire that engulfs the CM, the astronauts are now faced with 7 to 7½ Gs of deceleration and all communications are lost during 4 minutes due to this ball of fire. This period is known as the COMM BLACKOUT

At about 7 km altitude, the speed has been drastically reduced and the ball of fire has disappeared. A couple of conical parachutes are deployed to stabilize the craft and, later, three small parachutes are deployed to extract the main chutes. This happens at an altitude of about 3 km.

The astronauts and capsule are then recovered and mission is completed.