
How to Turn a Beetle Into a Beauty Page 156
POPULAR MECHANICS
JULY 1969
50 CENTS
40 Tests to Put a Camper Thru Before You Buy It
AVION
APOLLO 11
14 Pages To Help You Understand Man's Greatest Adventure
Those Wild New Bicycles—Page 150
How to Service Outboard Ignition Systems
Owners Reports: Cadillac and Ambassador
Trailer Hitches: Tips to Keep You Out of Trouble
A Firepit for Your Patio, Plus Four Weekend Projects

Science Worldwide BY JOHN F. PEARSON

If this month's Apollo 11 mission is a success, some of the moon soil brought back by astronauts Neil Armstrong, Edwin Aldrin and Michael Collins will be used to grow such common plants as corn, potatoes, tomatoes and tobacco. The microscopic structure of the plants will be analyzed and compared to the structure of plants grown in Earth soil. But before planting takes place at NASA's Lunar Receiving Laboratory, Houston, scientists will test the moon soil to see if it contains any factors that might be dangerous to Earth life.

The possibility of predicting and preventing stroke—said to be the nation's third leading cause of death—was forecast by a research team from NASA's Ames Research Center and Stanford University School of Medicine. The researchers have developed a new method of identifying potential stroke victims. A radioactive drug is injected into the bloodstream and monitored by a detection device as it passes through the brain. Computer analysis of the data provides a pattern of blood-flow rate in the brain. A low flow rate, say the researchers, might be the result of hardening and narrowing of the arteries of the brain.

Silicone membranes may be the roofing material of the future. That prediction comes from General Electric scientists who have field-tested the rubberlike material over a period of years. An .022-inch-thick membrane provides the same protection as two to four inches of asphalt, say the researchers. Because silicone membranes are flexible, they are not cracked by small expansions and contractions in underlying roof surfaces.

If you spot an unusual bug or observe abnormally heavy insect damage to flowers, trees, lawn, vegetable garden or house, inform your county agricultural agent or state or federal authorities. That request comes from U.S. Department of Agriculture officials who explain such evidence could mean that a foreign bug has sneaked past quarantine barriers or that an established pest is building up to dangerous proportions in areas where it has not previously been seen. Plant-pest-control experts stress the important part played by private citizens in discovering new insect enemies. It was a Florida homeowner's curiosity about the larvae he found in a grapefruit that triggered the successful campaign in 1956 against the destructive Mediterranean fruit fly.

A dirigible for use on big construction projects is being built in the Soviet Union, according to the newspaper *Sovietskaya Rossiya*. The airship reportedly will be able to lift five-ton loads as high as 1500 feet and will initially be used in putting up a big oil refinery. Tethered at the site, the dirigible will be maneuvered by means of a system of cables. Russian engineers plan to use the ship on the upper stages of construction projects, at levels too high for efficient crane operation.

Hormones that make a man masculine also trim years off his potential life span. That conclusion was arrived at by researchers at New York City's Downstate Medical Center after a study of 1032 male inmates—297 of them eunuchs—at an institution for the mentally retarded. Inmates who had been castrated had a median length of life of 69.3 years as against 55.7 for intact males. And those castrated before sexual maturity were longer lived than those castrated after, report the researchers, who note that the same thing holds true for cats. How the hormones shorten life span has yet to be determined.

Improving the breed. That's the goal of a program underway at the Lexington, Ky., office of the Jockey Club, the organization responsible for the registration of racehorses in the United States. Pedigree and performance data on 357,000 thoroughbreds are being taped for use in a computer system. "We are working on a system for rating horses based on their genetic makeup and racing performance," explains a club official. "Using this computer-compiled information for selective breeding should ultimately result in a better strain of racehorses—stronger, faster and more competitive." ★ ★ ★

WHEN ANSWERING ADS
GIVE YOUR ZIP CODE

The Dream Comes True

Seventeen years ago experts told how a lunar expedition could be made. How accurate their plan turned out to be is described here, the first of five features in this issue devoted to man's next giant step in space—a moon landing.

By JOHN F. PEARSON

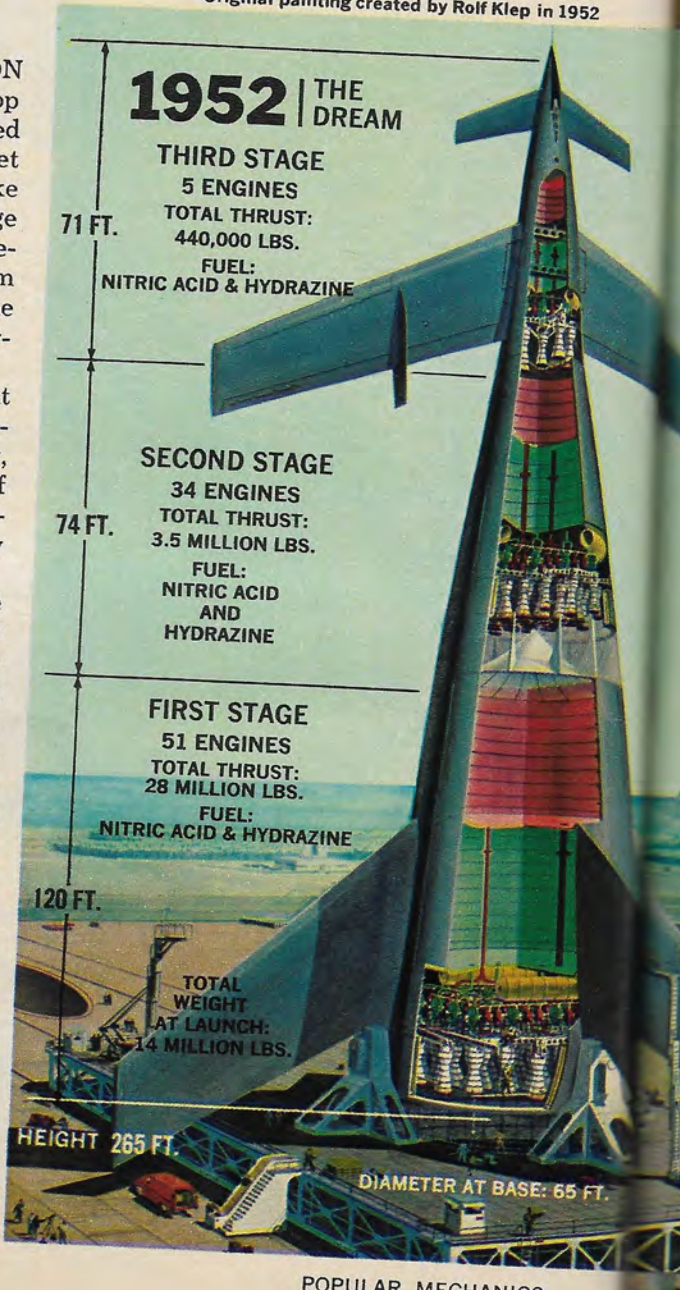
"OUR TRIP TO THE MOON will not be a simple nonstop flight from the Earth. We'd need too large and expensive a rocket ship for that. Instead, we'll make a stopover in space. We'll change vehicles, shifting from one especially designed to break away from the Earth's atmosphere into one specifically designed for moon voyage . . ."

Sound familiar? This statement might have been written as recently as a few months ago. Actually, it appeared in a 1952 issue of *Collier's* as part of a series of articles by Wernher von Braun, Willy Ley and Fred L. Whipple.

Dr. von Braun, famous as the co-designer of the German V-2 rocket, had joined the rocket-development effort in the United States following World War II. Ley, a pioneer writer about space, was a founder of the German Rocket Society. Dr. Whipple, was chairman of the astronomy department at Harvard. They were men of sound credentials and soaring dreams, superbly qualified to lay out a blueprint for a moon voyage and exploration.

How accurate was their crystal ball? You can judge for yourself by comparing their rocket concept (right) with the Saturn 5 and their moonship (page 82) with the LM. Remember, this team did its brainstorming 17 years ago when Buck Rogers still was the biggest

Original painting created by Rolf Klep in 1952




1969 | THE REALITY
LAUNCH ESCAPE SYSTEM 33 FT.
APOLLO COMMAND AND SERVICE MODULES
53 FT.
LUNAR MODULE ADAPTER
THIRD STAGE
1 ENGINE
THRUST: 230,000 LBS.
58.5 FT.
FUEL: LIQUID OXYGEN AND LIQUID HYDROGEN
SECOND STAGE
5 ENGINES
TOTAL THRUST: 1 MILLION LBS.
81.5 FT.
FUEL: LIQUID OXYGEN AND LIQUID HYDROGEN
FIRST STAGE
5 ENGINES
TOTAL THRUST: 7.5 MILLION LBS.
FUEL: KEROSENE AND LIQUID OXYGEN
138 FT.
HEIGHT 363 FT.
TOTAL WEIGHT AT LAUNCH: 6,219,760 LBS.
DIAMETER AT BASE: 33 FT.
UNITED STATES
USA

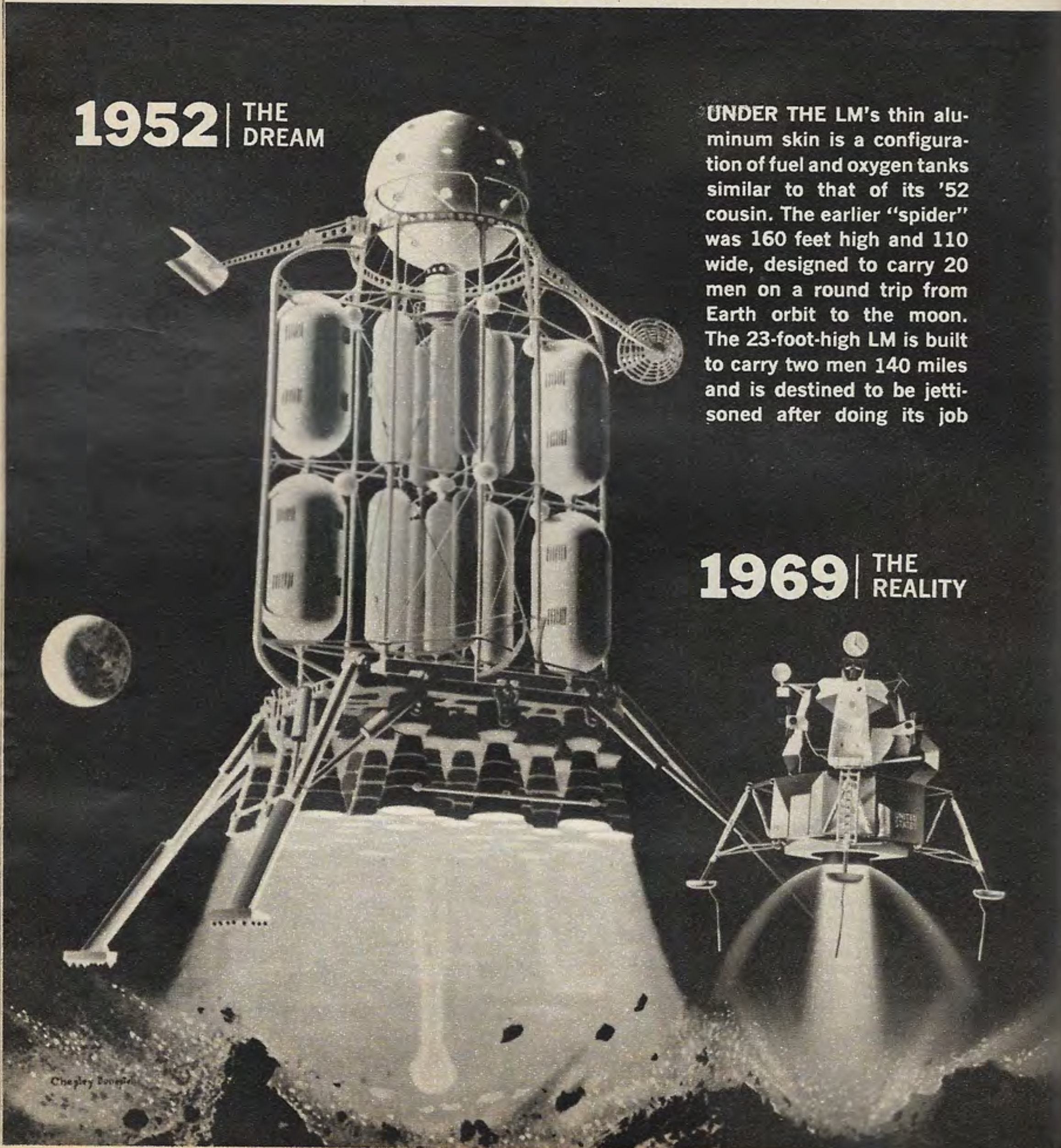
name in space. That was five years before Russia astounded the world with the launch of Sputnik 1 in 1957 and nearly 10 years before John Glenn successfully rode around the world in a Mercury capsule. Small wonder, then, that skeptics regarded the blueprint as science-fiction.

"We will go to the moon in the next 25 years," the three "dreamers" announced in revealing their carefully worked-out plan. The rocket they envisioned was a huge three-stage vehicle, though not as tall as the Saturn 5.

The only features of the rocket that appear unusual to us today are the big stabilizer fins on the first stage and the airplane-type wings sported by the third stage. The presence of the wings points to the major difference between the '52 blueprint and the way the Apollo missions are executed.

As late as 1962, our space scientists were debating the best way to land a man on the moon. Discussions centered on the two major objectives: how to

Original painting created by Chesley Bonestell in 1952



UNDER THE LM's thin aluminum skin is a configuration of fuel and oxygen tanks similar to that of its '52 cousin. The earlier "spider" was 160 feet high and 110 wide, designed to carry 20 men on a round trip from Earth orbit to the moon. The 23-foot-high LM is built to carry two men 140 miles and is destined to be jettisoned after doing its job

provide enough power to break away from Earth's gravity and make a lunar landing, and how to return the astronauts safely to Earth.

Four methods were considered:

- Send a rocket directly to the moon. This called for a rocket of monster proportions and the ability to land it gently, tail down, on the moon. Launching it for the return trip would be another major problem. (Buck Rogers would have felt right at home aboard this one.)
- Send several rockets, some carrying only fuel and supplies. The idea was that the astronauts could refuel their ships by using the supplies landed on the moon. But there would be no way of knowing if the supplies had landed intact or even within reach.
- Use an Earth orbit rendezvous (EOR), which called for placing sections of a moon vehicle in Earth orbit, there to be assembled for lunar flight.
- Use a lunar orbit rendezvous (LOR). A large rocket would achieve moon orbit, permitting a smaller vehicle to be detached for a lunar landing.

Because it appeared to be the fastest, LOR was the method finally adopted by NASA. This decision might not have been made if it weren't for a NASA engineer, Dr. John C. Houbolt, who waged a lonely campaign for the concept early in the 1960s. Some scientists remained unconvinced, however, pointing out that LOR required carrying out critical maneuvers—rendezvous and docking—230,000 miles from Earth, too far to send help to a crew in trouble.

Many experts still favored an Earth-orbit method. According to the original von Braun-Ley-Whipple plan, three-stage rockets would place sections of a space station in a 1075-mile Earth orbit. Assembled, the station would be the base for the moon voyage. Moon ships would be shipped in pieces for assembly.

One of the keys to the project was the use of the rockets' third stages (the only stages to achieve orbit) in a shuttle system. After delivering cargo, the third stages would be sent back to Earth. In cutting through the atmosphere they would use their wings, functioning as rocket planes with the ability to land at an airstrip.

The major advantage of this plan over the others would have been that the space station is orbiting at 15,840 mph, according to von Braun and his fellow authors, so that an added push of only 6260 mph is needed to send ships to the moon. The moon-landing craft they de-

(Please turn to page 203)

FOLKS LAUGHED, back in 1952, when *Collier's* magazine ran a series of articles showing how man would go to the moon within 25 years. They called the editors "space cadets" and ridiculed two of the authors, Wernher von Braun and Willy Ley, as a couple of nutty Germans. But space achievements since then have quieted the laughter.

On the eve of our first attempt to land men on the moon (eight years ahead of schedule, you might say), *Popular Mechanics* thought you might be interested in looking at the concepts shown in the paintings that illustrated the '52 articles. Aerospace artist Fred L. Wolff, we discovered, had the file of *Collier's* articles. But tracking down the original artwork was not that simple, for *Collier's* has been dead 11 years.

We called Roger Dakin, former *Collier's* editor and now an executive of General Foods, and Cornelius Ryan, author of *The Longest Day*, who, as a *Collier's* staffer, supervised the series. Finally, art director Tom Dauer located Rolf Klep living in Oregon. Klep made his '52 painting of a moon rocket available to us so that we could run it with a photo of the Saturn 5. Chesley Bonestell's painting of the huge moon-landing vehicle had long-since vanished, but Bonestell, still a space enthusiast at 81, agreed to recreate it for *Popular Mechanics*.

Compare the real hardware of 1969 with the dreams of 1952. Amazing, isn't it, how similar they are. What seemed so much science-fiction looks like a blueprint today.

Robert P. Crossley
Editor

Man's First Day On the Moon

After scanning the desolate moonscape, Neil Armstrong will descend the LM's ladder to become the first man ever to set foot to the moon. Serious exploration then begins

By JAMES R. BERRY

IT WILL HAPPEN ANY DAY NOW. In what history will record as the drama of the century, two men, after voyaging some 230,000 miles from their mother planet, will scout the first stepping stone to the solar system—our moon.

Barring a last-minute change, it will be Neil Armstrong and Buzz Aldrin who will view the arid lunar terrain as the spidery lunar module settles on the moon's surface. To get them there the United States will have devoted almost a decade of scientific effort and about $24-billion. And, the very first decision—one that has to be made within two minutes after touchdown—is whether the astronauts should come straight home.

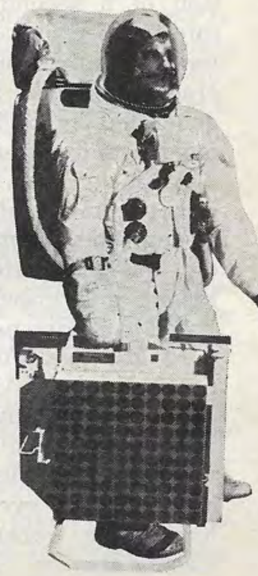
"The way the orbits work, the ascent stage of the lunar module (LM) can blast off and reunite with the command module orbiting above within the first 120 seconds," says Dick Green, NASA's manager of the Apollo Surface Exploration Program. "In that time we've got to make sure that the fuel tanks aren't leaking, that the power is fully operative, and that no other systems are beginning to fail. If something is wrong, they come right back."

Chances are everything will function. The pair will then spend the next 22 hours on the moon, with at least two hours—and possibly closer to three—exploring the satellite's surface. The exact timetable they'll follow is, at this writing, not completely decided. Any given task can be changed, eliminated, or switched in priority.

For two hours after landing, Aldrin and Armstrong will run through a complete countdown of the LM—just as though they had already completed the mission. If any problem develops, the pair will spend time solving it. Otherwise, the countdown will end 10 minutes short of blast-off.

When NASA is satisfied that the LM is in perfect operating condition, the men will prepare for the extravehicular activity (EVA), the space agency's term for a stroll on the moon.

Getting ready for EVA is no easy matter. The men will need almost an hour to don the backpack life-support system, referred to as PLISS. When combined with the space suits, the backpacks turn the astronauts into independent, man-powered satellites that are able to operate in total vacuum and in a temperature range



IF TIME PERMITS, astronauts will set up this instrument near landing site. A panel of optical reflectors, it will serve as target for Earth-based laser systems. Reflected laser beams can be used to measure precise distance from Earth to moon

WEEKS BEFORE LAUNCH DATE, astronauts Neil Armstrong and Edwin E. Aldrin go through their moon routine. Armstrong positions dish antenna (left) and Aldrin practices lowering experiment from mockup of LM

of from minus 250° F. to plus 325° F.

The astronauts will spend another 15 minutes checking the communications, oxygen, temperature control and other systems of their suits and backpacks; the slightest problem will scratch the EVA. If everything operates normally, NASA will radio its permission to begin man's first exploration of the moon. Here is the elapsed-time schedule:

00 Minutes. Armstrong and Aldrin switch off the LM's internal oxygen supply and open the hatch. In a fraction of a second, the compartment's interior becomes a near-perfect vacuum. The only sounds they hear are the crackle of their radios and the hum generated by backpack pumps forcing oxygen and water through their suits.

At this writing, according to a NASA announcement, it will be Neil Armstrong—the command pilot—who lowers the gold-plated sunshield on his helmet and crawls through the open hatch to a ledge just outside.

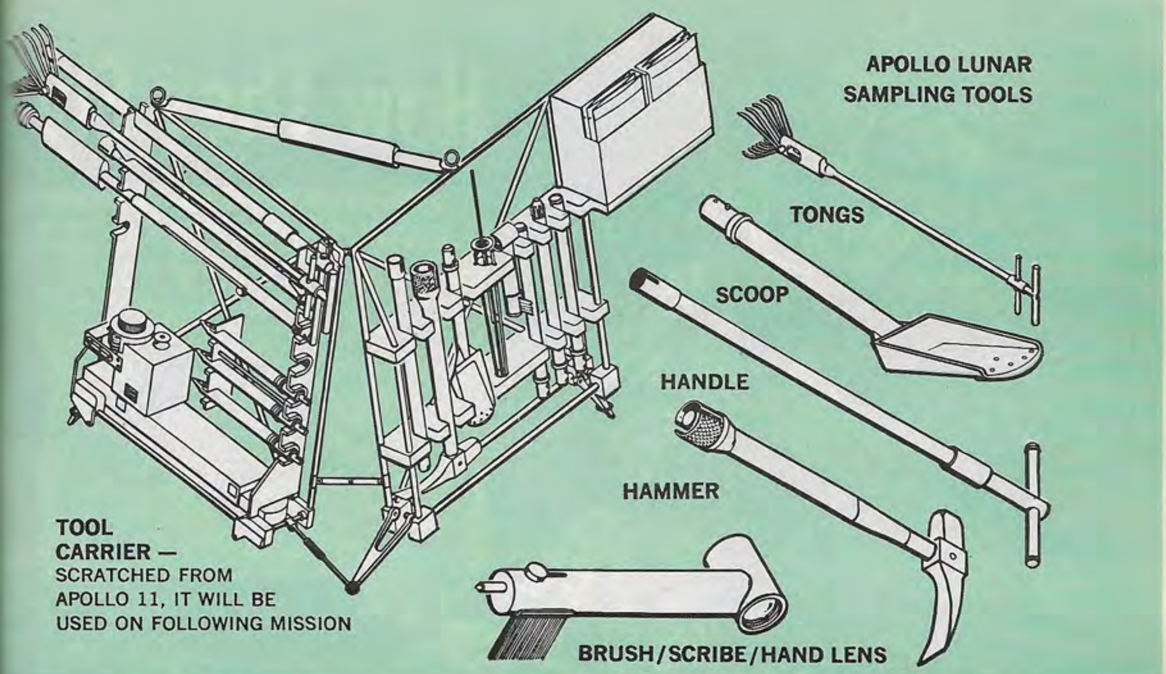
10 Minutes. For the next seven to ten minutes, Armstrong cautiously climbs down a nine-runged ladder leading from the LM's platform. Ultracautious, NASA insists that he rest almost a minute at every step, acclimating himself to working in one-sixth of Earth's gravity.

As he pauses on the third rung, Armstrong reaches to his right and pulls a D-ring handle jutting from the LM's side. A compartment called the modular equipment stowage area (MESA) slides out from the craft's lower left side at a 45° angle. In the MESA are geological tools, scientific equipment and a TV camera.

The camera points toward the ladder and automatically begins transmitting as the MESA slides out. If the LM is within range of NASA's 85-foot dish antenna in Goldstone, Calif., we'll see on our screens Armstrong groping down the remaining six rungs to reach moon soil. If the Goldstone antenna is out of range, that historic moment will be caught by a 16-mm sequence camera at the LM's window.

20 Minutes. No one knows how low gravity and a bulky space suit inflated to 3.75 p.s.i. will affect an astronaut's movements. So, like a butterfly just emerged from its chrysalis, Armstrong's first job is to gauge stability and mobility. Holding the ladder with one hand, he gently moves alternate arms and legs, and flexes his knees.

Then comes paydirt. Carrying out a top-priority assignment, Armstrong pulls what looks like a small butterfly net with an extension handle from a



roomy thigh pocket. After extending the handle, he scoops moon dust into the plastic bag at the instrument's end and stows the bag in his pocket. He throws the handle away; it is the first piece of moon litter.

"With this contingency sample of lunar soil, we'll have *something* from the moon even if the astronauts come back immediately after," explains NASA's Dick Green.

Armstrong next takes a few dozen photos with a battery-activated, 70-mm Hasselblad camera strung around his neck. Nasa wants him to get shots of the LM's feet, his own boots, and the terrain.

35 Minutes. During this time, technicians at NASA headquarters will be monitoring the oxygen supply, temperature, and other systems of the space suits and backpacks. They will also watch the heart and respiration rates of each astronaut—information relayed by transducers taped to the men. If NASA is satisfied with the readings, Armstrong will get word to walk the six or seven feet to the MESA.

These steps could prove a big effort. The moon's low gravity cuts friction between feet and ground, making stopping a problem. Consequently, Armstrong will adopt a shuffle to reduce momentum and avoid bouncing, a motion that could lead to a tumble.

Many NASA experts believe that working in low gravity will be exhausting. Others think that it will be easier than on Earth. No one knows for sure, and teams of NASA specialists will be eyeing Armstrong's oxygen consumption and other physiological details as he continues his assignments.

Once at the MESA, Armstrong lifts out the TV camera and a tripod, carries them 20 feet or so away, and points the camera toward the LM. Next, he sets up another tripod, also contained in the MESA, some 30 yards off. From the top of this tripod, he unrolls a sheet of ultrapure aluminum foil and points it toward the sun. The apparatus, called the solar wind composition experiment, looks like a home movie screen.

In the moon's vacuum, atoms of noble gases such as argon and krypton will be captured in the aluminum. On earth, chemical analysis of the aluminum will show how much of what gas struck the foil. This information will

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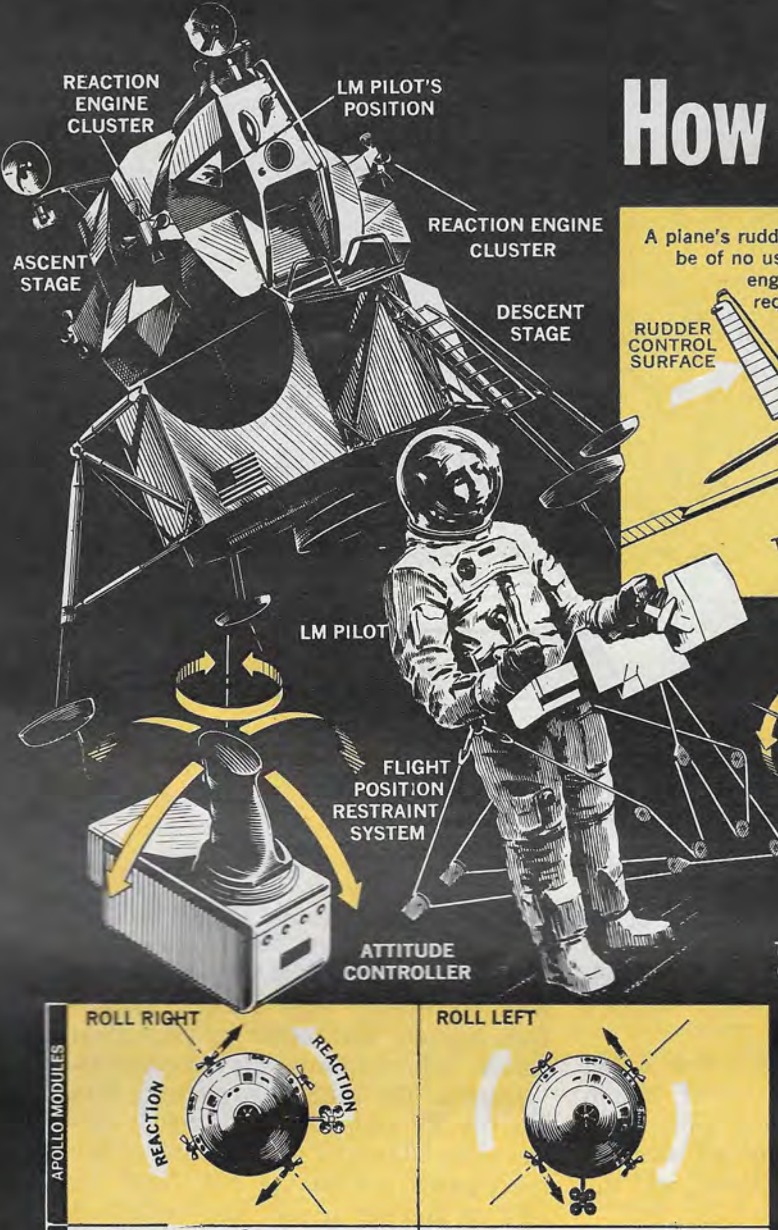
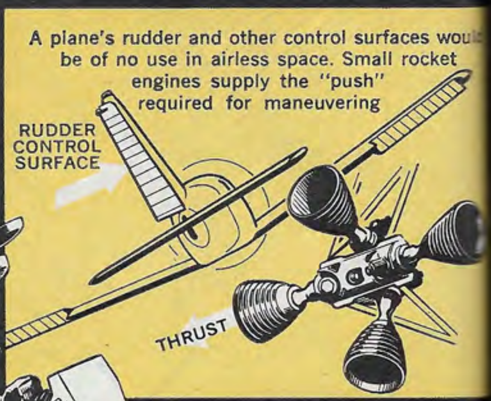
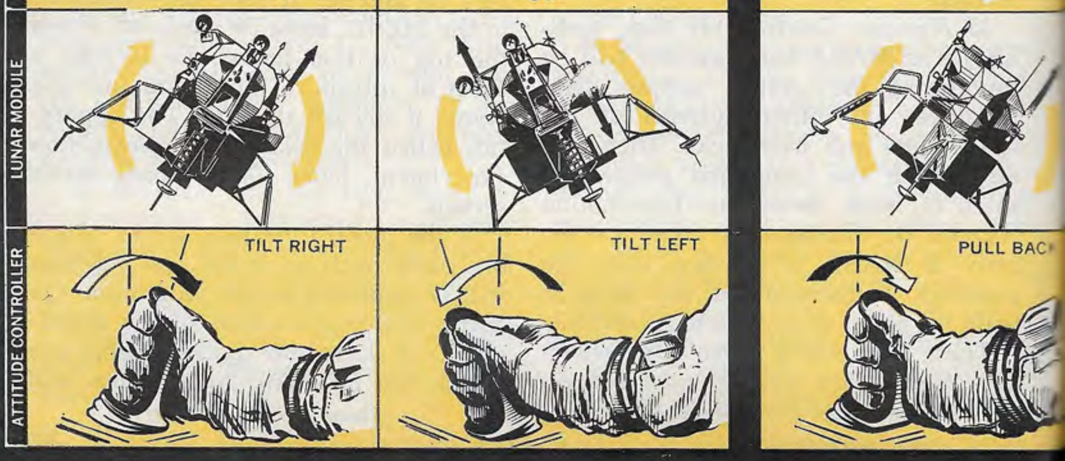
How They Fly


REACTION ENGINE CLUSTER
LM PILOT'S POSITION
REACTION ENGINE CLUSTER
ASCENT STAGE
DESCENT STAGE
LM PILOT
FLIGHT POSITION RESTRAINT SYSTEM
ATTITUDE CONTROLLER


A plane's rudder and other control surfaces would be of no use in airless space. Small rocket engines supply the "push" required for maneuvering
RUDDER CONTROL SURFACE
THRUST

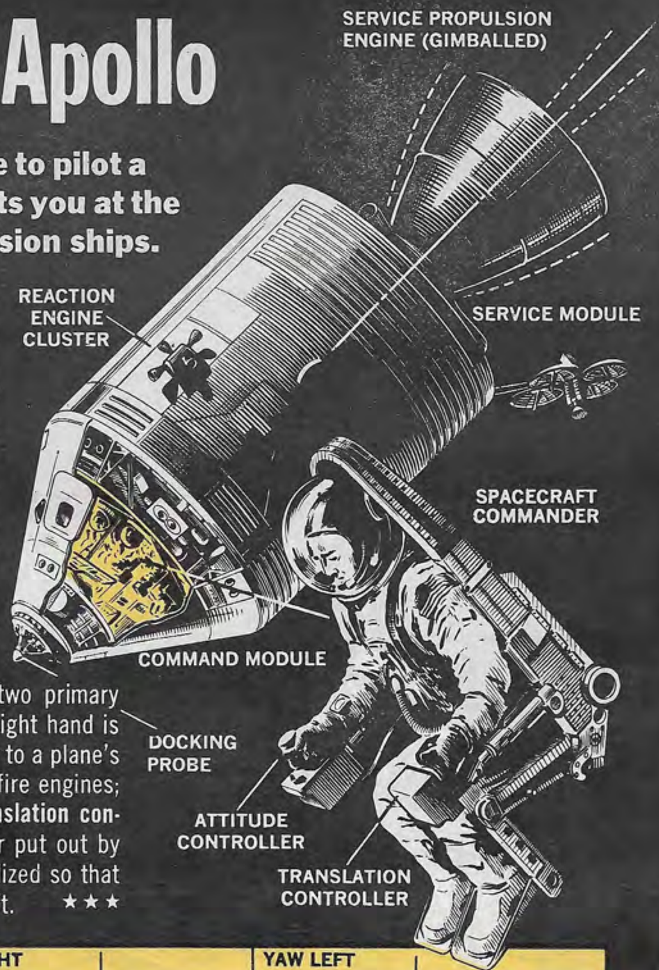

TRANSLATION CONTROLLER


APOLLO MODULES
LUNAR MODULE
ATTITUDE CONTROLLER
ROLL RIGHT
REACTION
REACTION
ROLL LEFT
PITCH UP
TILT RIGHT
TILT LEFT

the LM and Apollo

Ever wonder what it's like to pilot a spacecraft? Here, PM puts you at the controls of our moon-mission ships.

AIR SPELLS THE DIFFERENCE between flying an airplane and a spaceship. With no air to work against, the LM and the Apollo modules use rockets to alter position in orbit or to go into a different orbit. Both craft have four clusters of engines to provide control of three basic motions: roll; pitch (nose swings up or down); yaw (nose swings right or left). Attitude control is also achieved by gimballing (tilting) the main propulsion engine of the service module or of the LM's descent stage. Each craft has two primary manual flying controls: At the pilot's right hand is a pistol-grip **attitude controller,** similar to a plane's joy stick, which is used to select and fire engines; his left hand operates a T-handle **translation controller,** a throttle regulating the power put out by the engines. The controls are standardized so that the same pilot can handle either craft. ★ ★ ★



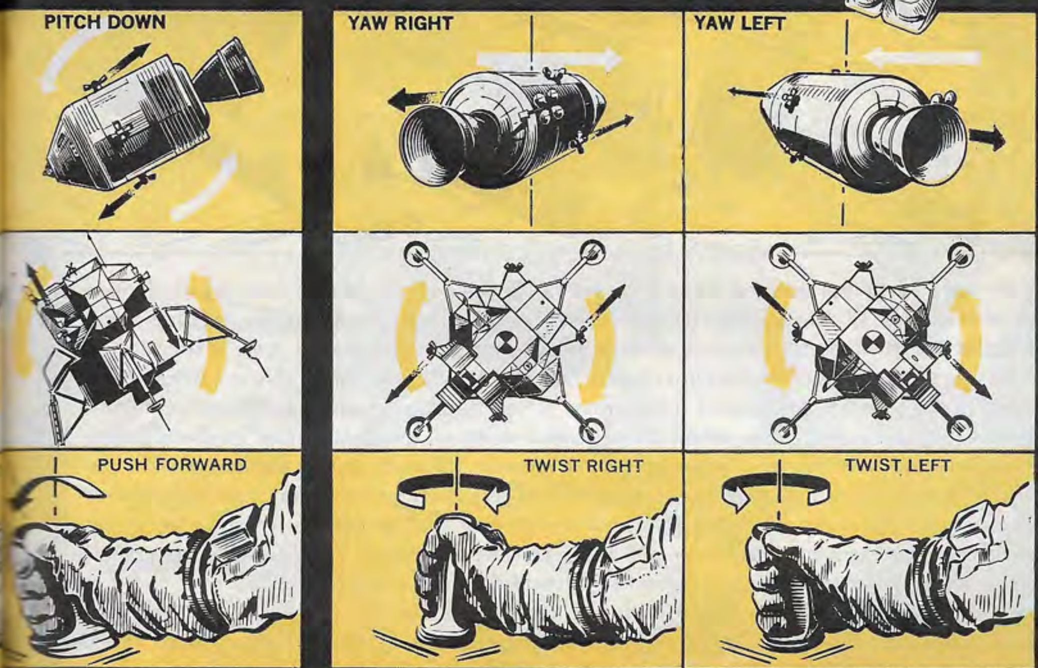


Illustration created for Popular Mechanics by aerospace artist Fred L. Wolff

...and Now,

MISSION OPERATIONS CONTROL ROOM

At the front are projection plotboards, digital clocks and a 10-foot-square TV screen for pictures and displays from any of 90 channels. All consoles contain similar equipment: keysets for calling up information; teleprinters; high resolution TV monitors; digital TV displays; pneumatic tubes for in-house communications. Areas of responsibility: 1 Booster Systems Engineer—advises flight crew and Flight Director of abnormalities; 2 Retrofire Officer—determines retrofire times; 3 Flight Dynamics Officer—gives "go" or "abort" recommendations; 4 Guidance Officer—monitors deviations in programmed events; 5 Flight Surgeon—directs all operational medical activities; 6 Spacecraft Communicator—handles voice communications with astronauts; 7 Vehicle Systems Engineers—evaluate performance of electrical, mechanical and life-support equipment; 8 Operations and Procedures Officer—responsible to Flight Director for ground support systems; 9 Assistant Flight Director; 10 Flight Director—responsible for detailed control of mission from liftoff to conclusion of flight; 11 Experiments and Flight Planning—monitors accomplishment of flight planning and scientific experiments; 12 Network Controller—responsible for operational control of worldwide data acquisition network; 13 Public Affairs Officer—channels information to the public; 14 Flight Operations Director—responsible for successful completion of flight operations; 15 Mission Director—overall mission responsibility; 16 Department of Defense Representative—control of armed forces supporting mission. ★★★

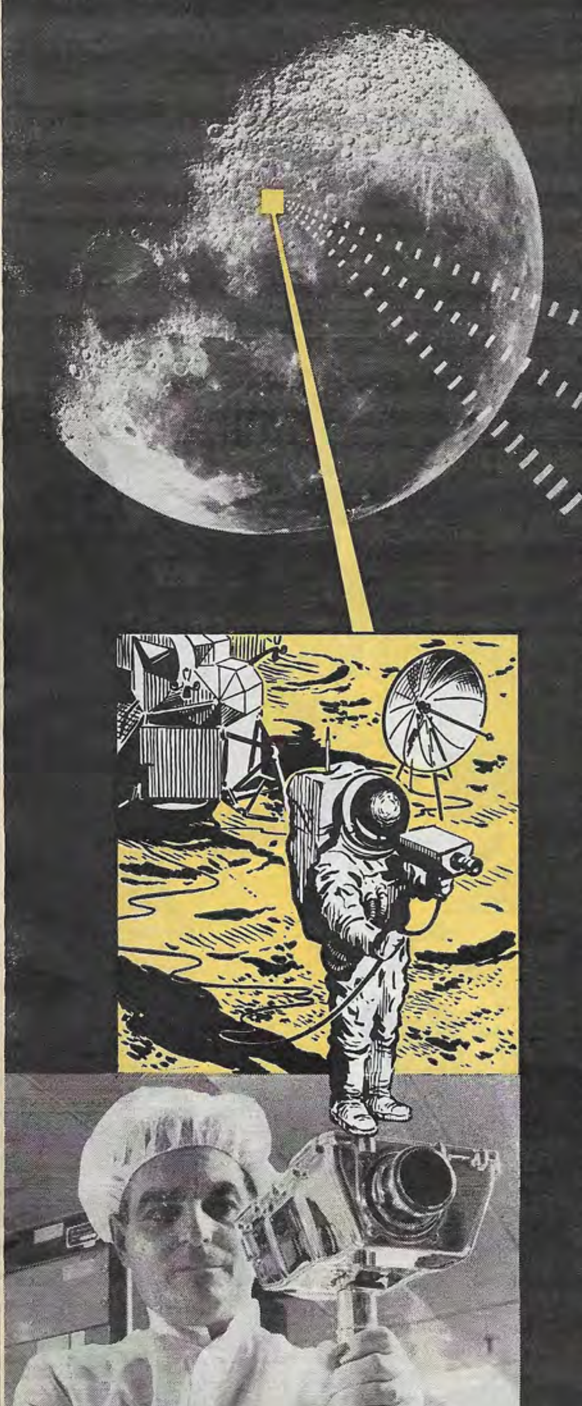
Back to Mission Control

Illustration created for Popular Mechanics by [illegible]

THE MEN WHO SIT AT THESE CONSOLES are probably the most serious-minded eavesdroppers of all time. Day after day, the attention of flight controllers, scientists and technicians in the Mission Operations Control Room of the Manned Spacecraft Center, Houston, is trained on a speck in space named Apollo. They must make the key decisions during time-critical periods that will mean success or failure of the flight. They depend on a continuous torrent of information: tracking and telemetry data from a worldwide network of land stations, and instrumented ships and planes; immediate data and reference material from a computer complex; data from voice communications with the astronauts. You've seen this team in action on your TV. Perhaps you've wondered what individual members were looking at and what they were responsible for. Here, *Popular Mechanics* shows you in an exclusive "inside" view. ★ ★ ★

How You'll See

A half-pint camera and a mere whisper of power are teamed to beam clear, strong images across 230,000 miles of space. Here's how this remarkable setup works.



NEW APOLLO TV CAMERA is so sensitive it can produce pictures in the darkness of the lunar night. Designed by Westinghouse, it is built to operate in the extremes of temperature—250°F. to minus 280°F.—found on our barren satellite.

By PHIL GERACI

MOVING WITH CAUTION, the bulky, helmeted astronaut descends the ladder one rung at a time. He reaches the last rung, about 18 inches above ground level, and pauses for a full minute. Then he lowers a heavily booted foot until it touches moon soil, the first man in history to take that giant step.

That scene will be viewed on TV in homes across America and in many other lands if our astronauts follow the Apollo 11 "script" and if no gremlins get into the act between the launch at Kennedy Space Center and arrival at the moon.

The ability to send back clear TV pictures from space was impressively demonstrated during the Apollo 8 mission. The highlight came Christmas Eve, 1968, when Frank Borman, Jim Lovell and Bill Anders sent greetings some 230,000 miles to Earth. Viewers were amazed and perhaps a bit puzzled. They may have wondered how it was that local programs, beamed with 50,000 watts, sometimes didn't come in as well as the pictures from the reaches of space. How could a tiny 20-watt transmitter push a good signal so far?

Four technological accomplishments, in addition to all those that made the flight itself possible, made a reality of what many NASA technicians had feared might be a disappointing failure. The first of these was an RCA television camera so small it weighs only 4.5 pounds. Filled with row upon row

Our Men on the Moon

of integrated circuits, each smaller than a pinhead but capable of functions which a few years ago would have required several pounds of vacuum-tube circuits, the tiny instrument became a spaceborne eye for more viewers than had ever before been served by a single TV camera.

Another factor, perhaps even more vital, was a new high-gain antenna aboard Apollo 8. Tucked into the side of the spacecraft during liftoff, the antenna popped into position on command and turned its four 30-inch steerable dishes toward earth, now just a basketball in space, and began to pour out its S-band transmissions. This

(Please turn to page 189)

TV SIGNALS FROM MOON are received by dish antennas at Goldstone and Madrid, and in Australia. Signals must be processed to make their scan compatible with that of commercial television networks in America, Europe and Asia.

Illustration created for Popular Mechanics by aerospace artist Fred L. Wolff

SEE OUR MEN ON THE MOON

(Continued from page 93)

brought a cheer from the people back at Mission Control.

In the vacuum of space, radio waves and other forms of electromagnetic energy flash straight across the voids. There are no hills to deflect them or metallic rocks to absorb them, as on Earth. The signals that left Apollo 8 as 20 watts arrived at Earth only slightly diminished.

There, the third key element came into play—85-foot, S-band receiving antennas spaced 120° apart around the globe so that at least one of them has the moon in "view" at all times. The big dishes are located at Goldstone, Calif.; Canberra, Australia, and Madrid.

Apollo 8's TV signal required processing. Here on Earth, the TV spot flashes across our screens at a rate of 30 frames per second, 60 fields per second, covering 525 lines each time. This makes for flickerfree, sharp viewing. But such an operating mode requires heavy, high-powered equipment.

The camera system RCA designed for Apollo 8 produces only 10 frames per second, made up of only 320 lines—not quite

The camera will function both in bright sunlight and nearly total darkness

as clear, nor quite as sharp as commercial TV, and prone to jerkiness when either astronauts or camera move too rapidly. It was, however, eminently viewable.

The Apollo TV system and commercial systems are not electronically compatible. That is, one can't simply be plugged into the other without fouling up the picture.

RCA solved this problem with "scan conversion" equipment—the fourth key technological accomplishment. A commercial vidicon camera was set up in front of a slow-scan monitor, its output linked to a magnetic disc recorder (the same kind used for "stop motion" football plays). The disc recorder did the trick by repeating the 10-frames-per-second Apollo pictures enough times to make up the 60 fields needed for commercial TV. For each second of broadcast there were only 10 actual changes of image; the others were repeats.

Scan conversion equipment was installed at Goldstone and Madrid. Goldstone sent the converted signal through regular coaxial cable channels to Mission Control in Houston. From there the broadcasts were distributed through conventional channels across the United States.

In Spain, a similar operation was carried out. Converted images were sent by coaxial cable to London for distribution to all of Europe and Asia.

But Apollo 8 was really just a beginning. Apollo 9 roared into Earth orbit with even more sophisticated television equipment aboard. The camera on Apollo 9, slated for later use during the actual moon landings, is designed to function both in bright sunlight and in the nearly total darkness of the lunar night.

Key to this capability is a secondary electron conduction (SEC) tube invented by scientists at the Westinghouse Research Laboratories in Pittsburgh and installed in the 7.25-pound camera.

SEC tubes convert light into electrical signals which then are amplified hundreds of times before being converted back into visible images. In scientific terms, the Westinghouse camera has a light range of from 0.007 to 12,600 foot-lamberts. On the moon, that means from bright sunshine to dim earthshine.

While the camera's main use will be to let us watch from Earth as astronauts walk about the moon's surface, it can also be used for scientific purposes. A fine-detail, slow-scan rate of ⅝ frames per second will transmit moon views to Earth with a resolution of 1280 lines. That approaches the quality associated with standard photographic camera systems.

The Apollo missions have dramatically demonstrated that the days of solitude in space are over. Thanks to TV, we're all space travelers now.

★★★

Tactile vision for the blind

Blind persons can "see" with their skin using a vision substitution system recently developed in San Francisco.

In utilizing the system—called Tactile Vision Substitution System—a blind person scans objects with a television camera. The image received by the camera is broken down into electrical impulses, then transmitted to stimulators. The stimulators recreate the picture on the observer's back by means of plastic-tipped vibrators. Thus, the user is "seeing" with his skin.

Developers of the system are Drs. Paul Bach-y-Rita, Carter C. Collins and their associates at the Smith-Kettlewell Institute of Visual Sciences, Pacific Medical Center.

The bulky, 50-pound prototype can be developed into a portable system weighing about five pounds and costing less than $1000, the developers believe.

FIRST DAY ON THE MOON

(Continued from page 87)

give physicists precious data on the composition of the solar wind that breezes through space.

Now, Armstrong makes a reconnaissance of the LM, circling the craft and taking pictures of the landing site and surrounding terrain. He ends this walking tour on the side opposite the MESA.

55 Minutes. If Goldstone and the other big antennas in NASA's network are out of optimum range, Armstrong pulls out a six-foot dish antenna folded inside a hatch of the LM's body. He unfolds it and points it toward Earth. Inside the LM, Buzz Aldrin thumbs a switch that transfers TV transmission to the highly efficient parabolic antenna just erected. One and a half seconds later, the time needed for the signal to reach Earth, home TV screens should light up with the scene of Armstrong lumbering toward the LM.

1 Hour 30 Minutes. At the MESA, Aldrin lifts what looks like a large toolbox onto a waist-high, two-foot-square table that unfolded as the MESA slid out. From the aluminum box he unloads a hammer, scoop, tongs and an extension handle that

. . . solar-cell seismometer picks up any rumbles inside the moon and radios the information to Earth.

fits all the tools. The astronauts can't bend over. At most, and only in an emergency, will they kneel. So, Aldrin attaches the extension handle to the scoop, and shovels moon "gravel" into the box. When it's filled, he closes the lid and pulls the levers on metal straps around the box. Teflon seals preserve the moon vacuum inside.

1 Hour 40 Minutes. About the time Aldrin is sealing the rock box, NASA makes a crucial decision. The backpacks are designed to hold a four-hour oxygen supply. But, depending on how much oxygen the pair actually has consumed—a measure of the efforts needed to work in low gravity—and how tired they are, NASA will opt for a three-hour EVA or call a halt after two hours.

If it's a three-hour EVA, Armstrong sets up two instruments that will stay on the moon. The first is a solar-cell-powered seismometer, which he deposits 30 feet or so from the LM. The device, which stays active for more than a year, picks up any rumbles inside the moon and radios the information to Earth. Such data could provide clues to the moon's origin.

The second instrument is a panel of optical reflectors that Armstrong points toward Earth. Laser light beamed from various Earth stations and reflected by the device can be seen through telescopes. The information gleaned from these reflections will pinpoint the distance between Earth and moon, various continents and even locations within a given country.

Meanwhile, Aldrin has three important jobs to do. After shuffling some 40 feet from the LM (probably still within range of the TV camera's wide-angle lens), he'll plunge a hollow tube into moon soil. As he does so, two metal paddles will sweep away the soil's top layers, exposing a pure sample underneath. On Earth, biologists will examine the sample, automatically sealed in a plastic bag when Aldrin withdraws the tube, for evidence of microorganisms.

Next, he fills up a jar-sized container with moon pebbles. A special seal preserves a perfect vacuum, which will allow geologists to determine how much, if at all, other moon samples became altered through exposure to even a few molecules of air. The last task is to hammer a hollow tube a few inches into moon soil. This core sample may tell geologists how the sun's rays have altered minerals on the moon's surface.

2 Hours 15 Minutes. For the next half hour, the pair load up another box with lunar rocks, ambling as far as 300 feet from the LM to get a varied selection.

2 Hours 40 Minutes. The pair wind up the EVA. Armstrong walks to the solar wind experiment, folds up the aluminum foil, and puts it into the rock box, which he carries. Aldrin climbs into the LM and hauls up both rock boxes with a small pulley. Once Armstrong enters the compartment and closes the hatch, the LM is repressurized. The pair take off their backpacks and connect their suits to the LM's internal oxygen supply.

The LM can carry only about 18 extra moon pounds (equal to 108 Earth pounds) on its return to the command module. So, the men remove the film cartridges from their cameras and throw out their Hasselblads and backpacks. They seal the hatch again and repressurize the compartment.

The astronauts finish their moon stay with a meal, eight hours of rest, and another countdown of the LM. When the command module orbits to a rendezvous position, they blast off to meet it, leaving behind the descent stage of the LM plus a good deal of expensive equipment.

Man's first day on the moon has come to an end. ★★★