Moon mobile debut on Apollo 15

The Lunar Roving Vehicle will allow the astronauts to explore 28 square miles

by Everly Driscoll

Years from now when men are living on the moon and using it as a base to travel to other planets, the first moon buggy will seem as archaic as the Model-T does to jet-setters. But to present-day earth dwellers, who often find their car a clumsy liability, the moon jeep affords a refreshing ride.

It is built creatively to meet the scientific needs of the men who explore the moon, but it has zero nonfunctional frills or aesthetic appeal. Equipped with television camera, movie camera, antenna and a sophisticated navigation system, it also has a rumble seat that unfolds to house lunar tools and scientific experiments. It can be folded up to fit a space too small for a Volkswagen, can carry twice its own weight and has no pollution exhaust. It turns with a slight hand touch and crawls over craters like a centipede (albeit somewhat faster).

It does, however, have a few drawbacks. Its top speed is a little more than 10 miles per hour (although to drive faster on the bumpy lunar surface would mean being off the ground a good deal of the time), and its operational lifetime is only 78 hours. And the total cost for seven test units (including the one-g trainer) and three flight units has soared to $38 million—twice the original contract.

The moon mobile, which the National Aeronautics and Space Administration calls the Lunar Roving Vehicle (LRV or Rover), will make its debut July 31 during the Apollo 15 mission. But the idea is not new. Similar manned and unmanned vehicles have been on the drawing boards for years. "Moon mobiles" and an unmanned "moon crawler" that looked very much like the current Russian Lunakhod were being considered until the manned Apollo outran the unmanned Surveyor. In 1963 the "moon scooter" emerged from fiction. Similar in theory to Buck Rogers' flying belt it had a three-foot circular platform on which a man was supposed to stand while he was rocketed vertically and horizontally over the lunar surface.

The Rover, however, is more than just a means of transporting the astronauts. In addition to the two astronauts with their life-support systems (400 pounds for each man), it can carry all the lunar tools toted by the Apollo 14 moon cart (SN: 9/12/70, p. 215) plus 70 pounds of soil and rocks and 130 pounds of scientific experiments. It weighs 480 earth-pounds but can carry 1,064.

It looks like a jeep but that is where any similarity to earth mobiles ends.

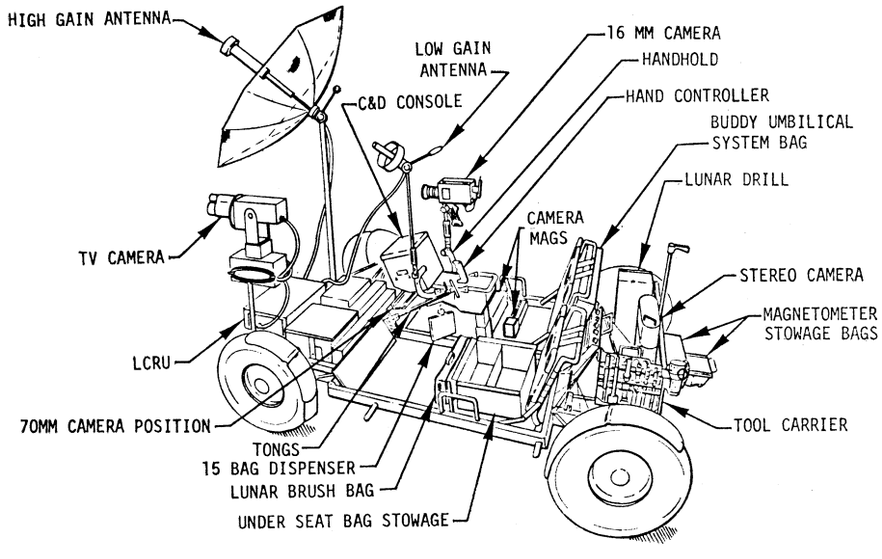
Electric motors in each of the four wheels are powered by two complete battery systems, each sufficient to power the Rover in case one fails. The television uses that power. The two nonrechargeable 36-volt silver-zinc batteries each have a capacity of 121 ampere hours. NASA officials are counting on some power being left over to power the first television pictures of a lunar lift-off. Then the residual power could be used by scientists to continue a pictorial survey of the site after the men have left. (The television camera is remotely controlled by ground although the astronauts can override the commands.)

The amount of electrical power used is displayed on a panel directly above the steering stick between the two seated astronauts. Also on the display panel are dials showing speed, heading (the relationship of the Rover with respect to lunar north), bearing (a directional angle showing the Rover's relationship to the LM and to lunar north), range (the straight-line distance back to the LM) and distance traveled. The panel also displays power and temperature readings and the operational switches.

The Apollo 15 astronauts, commander David Scott and lunar module pilot James Irwin, will unstow the Rover from quad 1 of the LM. The deployment system is semi-automated. Inside the quad, the Rover is folded; the forward and rear sections fold over the center and the four wheels fold over the chassis. As the astronauts pull various cables and unreel tapes, the Rover slowly unfolds, first out of the stowage bay, then out of its collapsed position.

After packing the Rover with lunar tools and scientific gear (ALSEP), the astronauts will drive on their first trip to the base of the Apennines, one of the highest mountain ranges on the moon, where they will see, according to Dr. Lee Silver of the California Institute of Technology, "what no man on earth has ever seen"—a 12,000- to 15,000-foot relief going straight up. They will then drive along the side of a geological feature of puzzling origin, Hadley Rille.

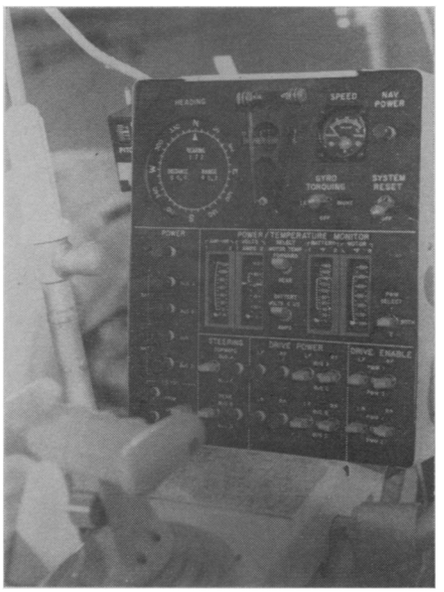
Although moonmarks at the Hadley/Apennine site are considerably more distinctive than those at Fra Mauro, the Ocean of Storms or the Sea of Tran-



LRV STOWED PAYLOAD INSTALLATION

Photos: NASA

The Rover will carry astronauts, tools, scientific instruments and rocks.



Control and instrument panel display.

quility, the men will still have to use the guidance and navigation systems. After they check out the power systems, they will "align" or set the navigation system by maneuvering the Rover so that the sun dial coincides with the down-range shadow and is set on zero. The men will read to Houston the Rover's pitch and roll, then Houston will calculate what the gyroscope heading should be. The lack of magnetic poles on the moon for a compass means that the sun shadow dial and gyroscope system will have to be updated as the sun angle changes and the gyro drifts.

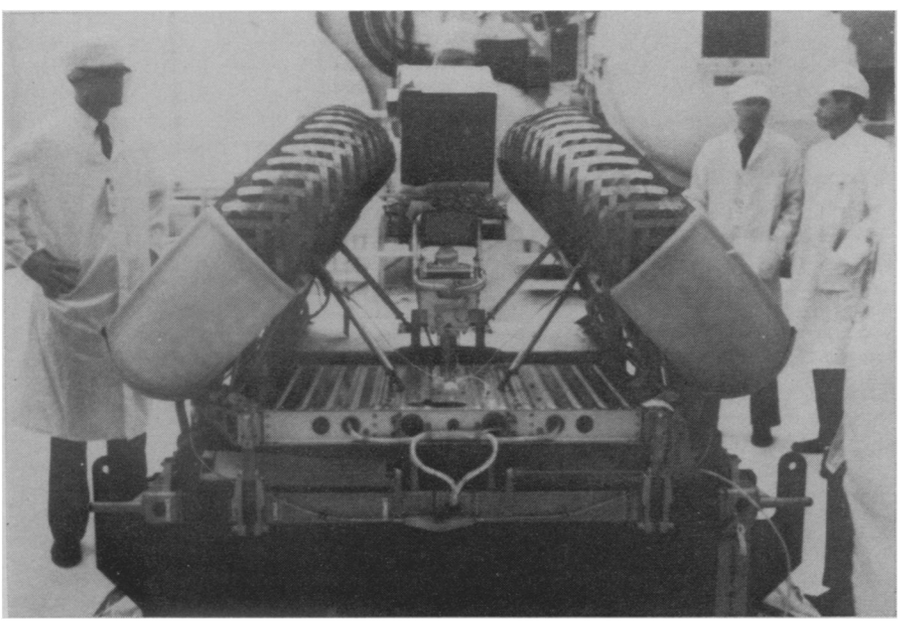
A signal processing unit (a small solid-state computer) and odometers on each wheel complete the navigation system. (The odometers, which measure the distance traveled, respond to pulses from magnets mounted on the wheels.) The entire network is a simple "dead-reckoning" system to tell the men their location in relation to the LM at any point on their trips.

Scott and Irwin will go on three geological jogs of up to 10 kilometers each. The Rover can travel a total distance of 40 miles (64 kilometers), but because of the limitations of the life-support systems, they will stay within a three-mile radius of the LM. Even then, however, the total area to be explored is the size of Manhattan Island—28 square miles.

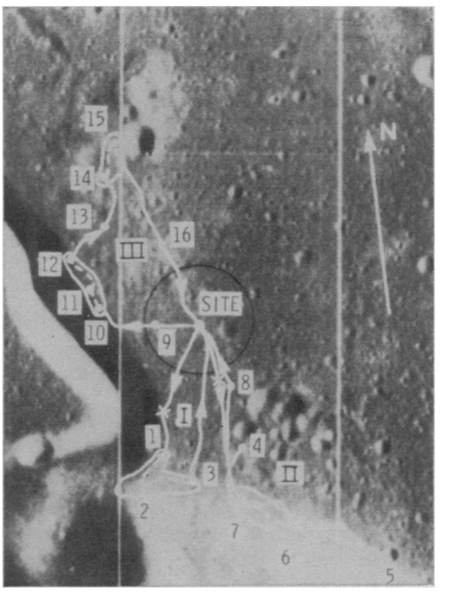
The jeep was designed to take on the lunar terrain with ease. It can start up step-like obstacles one-foot high with both wheels on the surface and cross (from a standing start) 28-inch crevasses. "In the Houston simulators, we have driven the Rover over craters five feet deep at a speed of 10 kilometers with no difficulty," says Irwin. Fully loaded the jeep can climb 20-degree slopes and park on 30-degree slopes.

To do all of this, the Rover has torsion-bar suspension and a traction and drive system that will follow the terrain up to a speed of 10 kilometers per hour. The hollow wheels are of spun aluminum with titanium bump stops mounted inside a woven wire tire (the bump stop absorbs the shock of hitting a 10-inch object while going 8 to 12 kilometers per hour). The tires, 32 inches in diameter and 9 inches wide, are woven of zinc-coated piano wire. Chevron treads of titanium riveted to the mesh give "flotation" in deep dust and added traction. The steering system operates on both rear and front tires.

During the three days the Rover will be driven on the moon, it will be exposed to temperatures ranging from minus 200 degrees F. in the shade to plus 25 to 180 degrees F. in the sun,



Folded up, the Rover fits into a space smaller than an earthbound Volkswagen.



Exploration routes for Rover crew.

depending upon sun-angle. The systems are protected by radiative surfaces and insulation. The heat generated by the sun and by the use of the systems will be dissipated after each geology trip. The heat is sent to the batteries and "bees wax" boxes (which melt and absorb heat). The astronauts will pull up the protective battery covers to expose fused silica thermal mirrors mounted on the batteries, the electronic components and the heat sinks (the wax boxes). These mirrors act as protectors as well as radiators. The fused silica will absorb only six percent of the solar heat. Heat from the batteries (by then from 95 to 105 degrees F.) can then be dissipated into space where the temperature is about minus 460 degrees F. When the batteries cool to 45 degrees, the covers automatically lower.

Obviously this is no earth jeep. The deadline and cost overruns have been a strain for NASA. The Boeing Co. and its prime subcontractor, GM's Delco Electronics, attribute much of the cost overruns to unforeseeable complications such as devising the semi-automated deployment system and the control electronics. But the Rover was delivered ahead of schedule.

Without it, the scientific goodies of the Hadley/Apennine site could barely be tapped. Compared with the first moon landing, when Astronauts Neil A. Armstrong and Buzz Aldrin had less than a day on the moon and only about one hour on the surface (their total walk was about six-tenths of a mile), Scott and Irwin will spend three days on the moon and 20 hours outside the LM. They will travel to three or four different geological features—volcanic hills (possibly), mountains, a rille and some maria.

That, say the scientists, makes it all worth it. □