SPACE

# Outer Space on Earth

Even stranger than the rockets and spacecraft in man's quest for space are the curious devices he is designing to show him what he will find there.

By JONATHAN EBERHART

➤ PRACTICING for a trip to the moon is like learning to water ski in a swimming pool. Some of the conditions and problems can be re-created, but it's just not the same. In an effort to foresee as many as possible of the problems of space travel, man is building a vast array of strange testing devices, designed to create at least part of the feeling of space.

The closest simulations are found in "space testing chambers," for the most part large vacuum bottles full of astronauts and test equipment, but little, if any, air. One of the newest of these is a two-story, 18-foot-diameter room, in which four men will live for as long as a year, with fresh supplies added every three months. The upper story contains living quarters and recreation space, while the work area occupies the lower deck.

While this chamber is bringing space to General Dynamics laboratories in San Diego, Calif., an even bigger "roomful of nothing" is a center of activity at Douglas Aircraft Company in Santa Monica, Calif.

There, a 39-foot sphere has been designed for testing everything from a tiny rocket nozzle to an astronaut to a whole spacecraft. The test subject (or "victim") is suspended from the lid of the sphere, which is then lowered and clamped into place. Douglas scientists have added an air lock, or "man lock," as they call it, so that the chamber can be used by human subjects. In addition, an escape capsule has been built in, in case something goes wrong inside the chamber.

The walls of the giant sphere are honeycombed with pipes carrying liquid nitrogen, which cools the walls down to as low as minus 320 degrees Fahrenheit, approaching the cold of outer space. A partial vacuum can be created in the chamber, lowering the air pressure to that found 475 miles above the earth.

A 17-foot-high stainless steel dome in Downey, Calif., contains a mock-up of the crew compartment of the Apollo spacecraft in which America's astronauts will travel to the moon. There, test "pilots" will spend a solid two weeks, sometime in mid-1965, at one-third normal air pressure, equivalent to an earth altitude of 23,000 feet.

Such "space isolation booths" have been in use for some time. At 6:30 on the morning of Sept. 15, 1960, Capt. William D. Habluetzel and Lt. John W. Hargraves Jr. walked out of an 8- by 12-foot steel tank, in which they had lived for an entire month, simulating conditions on a flight to the moon.

Just two years later, in Farmingdale, N. Y., 20 volunteers, in groups of five, spent two weeks breathing pure oxygen, the first time that a pure oxygen atmosphere had been used for such a long period. Two medical students were part of each group, taking blood samples and administering psychological tests.

### Other Conditions Simulated

By no means are all experiments with artificial space conditions limited to mere isolation, however. Heat, motion, cosmic rays, even the actual view of stars outside spacecraft windows, have been reproduced in the laboratory to learn the strengths of man and machine when exposed to the hot-and-cold vacuum of outer space.

The National Aeronautics and Space Administration's Manned Spacecraft Center, Houston, Texas, has two large chambers in which temperatures can be varied from a searing 240 degrees Fahrenheit down to 400 degrees below zero. In addition, a large turntable can put test subjects in the chambers through the effects of tumbling in space, to test the effects of motion on a man's ability to control his position.

The actual look of space has been brought to earth by OLAFS (Orbiting and Landing Approach Flight Simulator), another Douglas Aircraft invention. OLAFS is basically a six-foot globe, full of television cameras and lined with tiny lights. The camera takes pictures of the lights and projects them, like stars, onto the windows of a mock-up cockpit.

A second group of cameras is mounted on rails in a darkened "model room." There they photograph a model of whatever planet or satellite is the target of the test mission. An electronic computer puts the images together so that they move about, grow or diminish in size, as the "pilot" varies the speed and direction of his spacecraft.

### Mock-Up of Space Rendezvous

One of the most realistic of the space flight training devices is a life-size mock-up of the Gemini spacecraft and the Agena target vehicle, with which Gemini will rendezvous in outer space. Both are mounted on movable carriages on a 100-foot pair of rails, simulating the last 100 feet of Gemini's approach to the Agena.

The Gemini model includes control panel indicators and hand controls that are identical to those in the actual spacecraft. The view out the window is the same. The electronic computer controlling the trainer even has hydraulic drive systems that duplicate the forces of the attitude control rockets used in space.

McDonnell Aircraft Corp.

*GEMINI DOCKING TRAINER—Engineers monitor the control panel as two astronauts in a model Gemini spacecraft guide their vehicle down 100-foot rails to a waiting mock-up of the Agena-D target vehicle. McDonnell Aircraft Corporation built the trainer for the National Aeronautics and Space Administration.*

The docking trainer was built by McDonnell Aircraft Corporation for the Manned Spacecraft Center. Actual docking in space will not take place until the sixth Gemini shot late this year. Only two have been launched so far, both successful but both unmanned.

Of course, the high point in the drama of man's first lunar voyage will be the actual landing on the moon. There is a great deal to be learned about the surface of the moon that directly affects the landing, such as the amount of weight that the surface will support. It is not even certain that there will be a large enough spot of level ground for a landing.

Nevertheless, experiments are underway to seek techniques for the lunar landing itself. Bell Aerosystems in Buffalo, N. Y., has developed two spidery-looking research vehicles, to be held aloft by large fans. Test pilots, or "astronauts," will practice landing them on four extendable legs similar to those that will be on the Lunar Excursion Module, the actual moon vehicle.

### Weight Remains a Problem

Finally, although much of the lunar flight will be made under reduced gravity, weight will still be a problem. A part of the trip will be made while escaping the full force of earth's gravitational pull. Manned orbiting satellites will need to create their own gravity. To reproduce these conditions, the scientists trying to anticipate problems in space have turned to the centrifuge.

One large centrifuge will whirl a 40-foot room with four passengers around a 150-foot circle for periods up to a month. North American Aviation is building it to examine the effects of long periods in artificial gravity.

NASA is also building itself a huge centrifuge, at its Manned Spaceflight Center. In a 170-foot-diameter circular building, three stories high, payloads up to 3,000 pounds will be subjected to as much as 30 times the force of gravity. In a 12-foot chamber, representing controls and accommodations in the Apollo spacecraft, three astronauts will perform their expected space duties under artificial acceleration, while being monitored by NASA doctors for respiration, body temperature, heart activity and blood pressure.

These centrifuges, isolation booths, and other strange and elaborate devices are just a few of the many pieces of special equipment that man hopes will tell him more about a place to which he has never been. Experiments have been undertaken in places ranging from the bottom of the ocean (which simulates low gravity) to a rocket-powered vibration machine. Testing will go on in many forms. The toughest test for man in space, however, will still be—when he gets there.

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# Launch Pad Poison

➤ WARNING TO ROCKET scientists of the future: do not stand downwind from the launching pad.

Poisonous exhaust gases from some of the super-fuels now being developed for both civilian and military rockets could be a major safety hazard during launches, cautions Dr. Kenneth D. Johnson of the Atlantic Research Corporation, Alexandria, Va.

Two of the most powerful but most dangerous of such fuels, elementary fluorine and metallic beryllium, are so far being used only in upper-stage rockets, which are not fired until they are safely away from the launch area. However, future military plans might require "convertible" systems in which upper and lower stages could be interchanged.

In such systems, said Dr. Johnson, the advantage of increased thrust would have to be weighed against the problem of toxic exhaust fumes.

The Atlas is one first-stage rocket that could benefit greatly from fluorine as a fuel. Scientists at General Dynamics Corporation, San Diego, Calif., estimate that they could increase the booster's payload 88% by using a fuel mixture containing 30% liquid fluorine.

Dr. Johnson said that the U.S. Air Force's Blue Scout rocket, which comes in four different versions made from five different rocket stages, is a convertible system similar to the one he envisioned, although it does not use toxic-exhaust fuels.

In order to make it easier to compare the advantages and disadvantages of fluorine, beryllium and similar fuels, Dr. Johnson developed a mathematical way to predict the area that the exhaust gases would cover, as well as the concentration of the gases and the length of time before they would disperse.

This knowledge would help to determine such factors as the cost of protecting personnel stationed at various points. It might turn out that the extra thrust in the first-stage rocket just was not worth it.

Dr. Johnson reported his study at a meeting of the American Institute of Aeronautics in Washington, D. C.

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## Space Mirrors Help Astronauts Fix Straps

➤ ASTRONAUTS in the two-man Gemini space capsules will spend part of their time in space looking at themselves in mirrors—but not for vanity's sake.

In a fully pressurized spacesuit, an astronaut cannot see to adjust the array of straps and clamps securing him in his seat. Special mirrors mounted inside his space capsule, similar to the rear-view mirror on a car, will enable him to see what he's doing, even under full pressurization.

Liberty Mirror Co., Brackenridge, Pa., is making the shatter-proof mirrors from an evaporated-aluminum coating sandwiched between two pieces of glass.

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