SPACE

The Immensity of Space

Without a grasp of the vast speeds, distances and sizes in the space age, man will never be able to fully realize the magnitude of his accomplishments.

By JONATHAN EBERHART

➤ HOW FAR is 325 million miles? The number is so big that it is meaningless to most people. It is about 130,000 trips across the United States, or 13,000 trips around the world. It is also the length of the Mariner 4 space probe's flight to Mars.

The huge numbers encountered in the exploration of space become more and more vague-sounding as they become ever farther removed from the numbers in our daily lives. We suffer from nothing more than a more sophisticated version of the problem facing the African tribe whose counting system extends only as far as "1, 2, 3, many."

How far is 325 million miles? Well, if somehow it were possible to drive along Mariner's route, a man who had left earth traveling at 60 miles per hour at the same time as Columbus departed for the New World would not reach Mars until the summer of the year 2110, almost a century and a half in the future.

Distances are so great in space that unheard-of speeds are necessary to get anywhere within a reasonable length of time. Earth's gravity alone necessitates tremendous speed and power even to put a satellite in orbit, to say nothing of escaping beyond into free space. To anyone but a space scientist, however, velocities of tens of thousands of miles per hour mean nothing more than "pretty darn fast!"

For example, when Gemini 4 was injected into orbit around the earth, special "speedometers" at the control center in Houston registered 17,567 mph, or 25,766 feet per second. If you could cover the length of a football field in one second, you would be traveling at slightly more than 200 mph. Gemini could cover 85 football fields in the same length of time. In an hour, Gemini could go from New York to Los Angeles seven times.

Up, Up, and Away . . .

After the Gemini program comes Apollo, in which three astronauts will actually travel to the moon. During the Apollo practice shots preceding the actual journey, the big numbers from Gemini will get even bigger.

The Apollo spacecraft, together with its propulsion system and lunar landing vehicle, will weigh 12 times as much as Gemini. The first stage (S-1C) of the rocket used to get Apollo off the ground will have to develop 7.5 million pounds of thrust. That's enough power to lift an atomic submarine. To create that much thrust, five huge F-1 engines, each weighing more than nine tons itself, will be clustered together to produce 160 million horsepower! This is almost 70 times the generating capacity of the power company serving the whole of Washington, D.C., and the nearby Maryland suburbs.

Needless to say, the S-1C is no "economy model." During each Apollo flight the rocket will only fire for about two and a half minutes, but during that time it will consume more fuel than 1,000 average American motorists used during all of 1963! And all that kerosene-guzzling only carries Apollo for the first 200,000 feet. The S-1C must surely hold the world's record for poor mileage: on its brief trip it will consume 133,290 gallons of fuel for an average of slightly less than 0.0003 miles per gallon.

A rocket this big cannot be constructed in just any old warehouse. To hold all the stages of the Saturn V rocket, together with Apollo, the National Aeronautics and Space Administration constructed the world's biggest building, the Vertical Assembly Building, which encloses 129 million cubic feet of space. Without actually standing inside this huge, man-made cavern it is almost impossible to imagine its size. If every man, woman and child in the State of Oklahoma decided simultaneously to make a call from a phone booth, every one of them could be packed, booths and all, into the monster structure, with space left over for Coke machines. That's 2.4 million phone booths and people.

Down, Down, and Fire, Too . . .

As spacecraft and rockets become progressively larger, so do the problems of guiding them accurately. Predicting vehicle performance in advance is an important part of any space mission. Project FIRE II, a re-entry heating test for the Apollo program, is a good example.

FIRE II was launched into space on May 22, and then "launched downward" through the atmosphere with a special "velocity package" to boost the speed (and heat).

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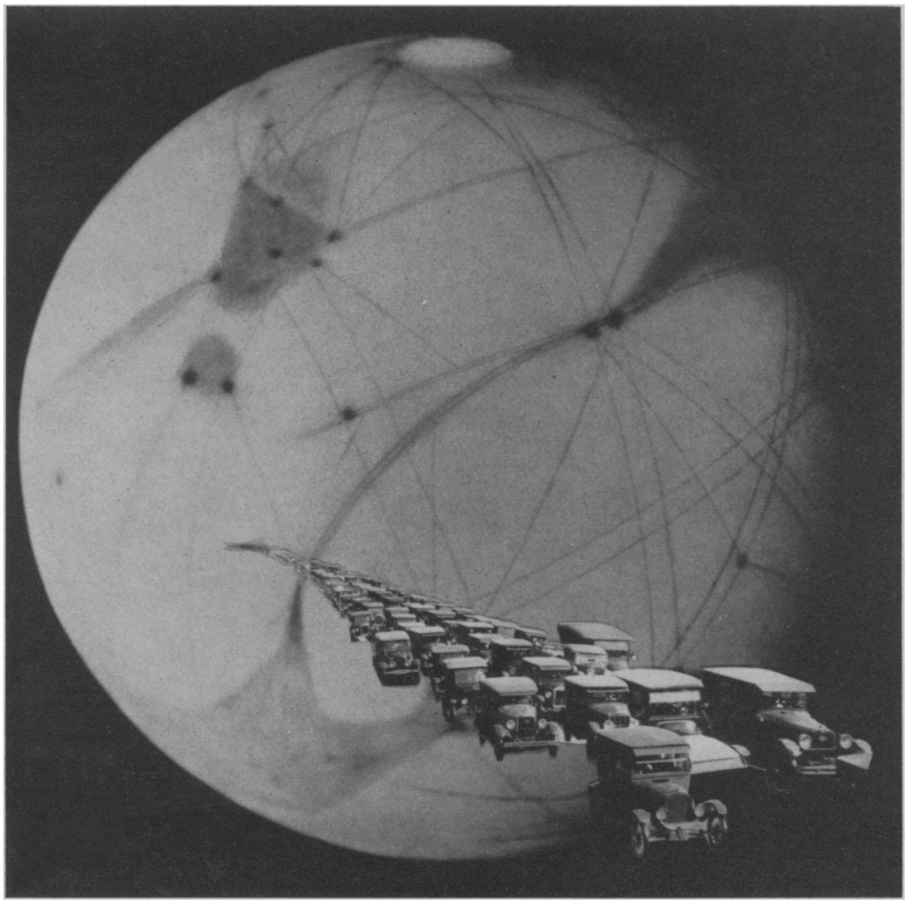

HOW FAR IS 325 MILLION MILES?—The Mariner 4 spacecraft's flight to Mars covered a distance so great that it is meaningless to most people. If you could drive at 60 miles per hour along Mariner's route, the trip would take you 618 years.

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NASA estimated that the reentry velocity would be 37,256 feet per second (roughly 25,401 mph), but their guess was off—by 24 fps. Though it made no difference for FIRE II, this tiny error, less than 0.065%, could make the difference between success and failure for a long-term mission, during which the great distances between earth and the other planets could magnify a small discrepancy into a major catastrophe. If your watch loses or gains one minute a day, it is still almost as accurate as was FIRE II. (Your timepiece's error is still less than 0.07%.)

Herculean Effort

To build the ever-growing hardware of this country's ever-expanding space program is a Herculean effort. Getting three astronauts to the moon will have directly involved the services of a third of a million people—a brain-and-labor force equal to the population of Omaha, Nebr. For every company assigned by NASA to build a booster stage or a space vehicle there are hundreds of subcontractors with the task of supplying everything from magnesium panels to dehydrated food. Dr. Hugh L. Dryden, deputy administrator of NASA, has estimated that 20,000 companies are or will be connected with the program.

And when Apollo is finally launched, it will be a remarkable sight indeed, seated atop the huge Saturn V booster that will make a Gemini-Titan package seem like a child's toy. Three times as big as a Gemini-Titan, each Saturn-Apollo will tower as high as—well, just try to imagine a 30-story building blasting its way into space.

Once on their way, the Apollo astronauts will be busy with an incredible list of tasks filling some 12,000 pages of instructions. This is almost 10 times as many pages as there are in the inch-and-a-half-thick Washington classified telephone directory. In order to save weight, and to make all the information as readily accessible as possible, a souped-up variation of microfilm will be used to compress 12,000 pages into one two-foot strip of eight-millimeter film. This super-reduction could be used to reprint the entire Bible on a postage stamp. The Library of Congress, containing 270 *miles* of bookshelves, could be stored in half a dozen ordinary filing cabinets.

The biggest, the smallest, the highest, the fastest—these are the dimensions and quantities in the conquest of space. But all the spectacle, the glamor, and the plain old Buck-Rogers-ism is lacking without an understanding of just how extreme these numbers are.

How far is 325 million miles? Not just "pretty darn far," but a particular distance. Some day another spacecraft, perhaps with men aboard, will go even farther. The point is that to regard all these statistics as nothing but big numbers—collections of zeros that boggle the mind and leave no clear impression of size—is to confine man to counting on his fingers, with no mental picture to cope with any number beyond 10.

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Nature Note

SEA NETTLE

The beautiful fragile sea nettle Dactylometra is a menace in warm summer waters.

Pulsing through brackish waters of estuaries and bays, with a motion like opening and closing an umbrella, the nettle has a disk-shaped translucent body, with golden tentacles hanging down from the edges and pink mouth lobes underneath.

On the slightest contact, a painful poison is ejected from trigger hairs coiled like a spring in the stinging cells located along the jelly-like body and long thread-like tentacles.

This poison, used by the nettle to paralyze and capture small fish as food, can cause human beings to have painful red welts, muscular cramps and other serious symptoms.

The beautiful, dangerous creature, also called the stinging jellyfish, can grow up to eight inches across, some with tentacles 120 feet long.

Millions of these stinging beauties drift leisurely in the summer waters along the East Coast from New England all the way to Florida.

They also inhabit the sea along West Africa, India, the Malay Archipelago, Philippines and Japan.

Jellyfish reproduce in quite a complex manner.

Sperm cells from a male jellyfish fertilize the female's eggs, which develop into tiny hollow spherical bodies that move through the water by whipping hairs back and forth.

After a few days, the young jellyfish fastens itself to some object, develops a mouth and tentacles and becomes what is called a polyp.

Shaped like a bowling pin, the tiny polyp is about a quarter of an inch high and a sixteenth of an inch across.

This polyp produces baby jellyfish in two ways—tiny round disks peel off in layers from the top of the polyp and swim away, or else the polyp simply moves away from its base, leaving a series of circular "footprints" which grow up into mature jellyfish.

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