The rockets can take it — but can we?

TERRORS of SPACE TRAVEL

Morton Clurman

A COUPLE OF YEARS AGO a waggish member of the British Interplanetary Society issued to a few friends and colleagues a "British Interstellar Passport," a blue-covered, gold-embossed booklet that looked very much like a standard British passport. Included on the cosmic passport were bits of useful travel information — trip schedules to the various planets, the escape velocities necessary to overcome their respective gravitational pulls, the different atmospheric compositions of the planets (methane on Jupiter, carbon dioxide on Venus), and, finally, a warning not to play cards with strangers while crossing the Milky Way. A London tabloid splashed a picture of the passport across half a page; immediately, hundreds of readers applied for one, thus plainly indicating their readiness to trade this world for another.

Contemporary Britain's regime of austerity may have something to do with this desire to abandon "the green and sceptered isle" for the moon; doubtless, too, it reflects the old adventurous spirit of Western man, ever ready to venture into unknown realms. In any event, the incident dramatized the increasing haziness, in the public mind, of the line separating fact from fiction in the matter of space travel.

Unquestionably, this haziness is due in part to the startling advances made in rocket engineering during the past decade. The Nazis, for example, had a man-made satellite on their drawing boards. In 1949, Secretary of Defense Forrestal mentioned an "earth satellite vehicle

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program" in his annual report. Two years ago, a two-stage rocket — consisting of a small rocket, the Wac Corporal, mounted in the nose of a large German V-2 — rose 250 miles above the desert sands of New Mexico. This is twice as high as the earth's atmosphere and represents the beginnings of true space flight. These and similar developments have raised hopes of imminent trips to the moon and nearer planets.

Comparatively little attention, however, has been paid to the human aspects of such flight. An enormous volume of popular, semi-popular, and scientific discussion has been devoted to the technological difficulties involved; there has been very little discussion of the physiological and psychological difficulties. Yet there are mounting indications that the human problems of space flight will be harder to overcome than any other.

Before considering some of these human problems it is necessary to understand just what is and what is not technologically possible in the near future according to the best rocket scientists.

A voyage directly from the earth to the moon and back again is not possible now or in the near future, barring some unforeseen, and totally unexpected, technological development. Neither is a voyage from the earth to any of the planets. The reasons are simple. Rockets get their power from rapidly burning fuels which leave the rocket at high speed. This causes a rocket to kick forward very much the way a bullet leaving at high speed causes a gun to kick back. The force of the rocket's forward push depends on three factors: the weight of the rocket, the weight of escaping fuel gases at any instant, and the speed or exhaust velocity of these gases. Exhaust velocity is a very critical factor. The greater it is the more efficient the rocket and unless it is very efficient, the rocket will never get anywhere. And the fact is that exhaust velocities for all known fuels today are much too low to permit excursions to the moon or nearest planets and back; also, there is no way of increasing these exhaust velocities very much by using chemical fuels. Conceivably, atomic energy could be used to achieve the necessary exhaust velocities, but most scientists are very doubtful that this can be done in the near future. The problems involved in the application of atomic energy to rockets are much too great.

Despite these handicaps, there are still some very interesting possibilities. An unmanned rocket to the moon whose explosive flash upon impact could probably be seen through a telescope is well within present-day rocket skills. A similar one-way rocket to either Mars or Venus, the two nearest planets, might also be possible, with automatic radar flashing news of the impending landing and perhaps television sending close-up pictures of the planets.

But what hope is there for those among us who are determined to leave this earth, and who will never be satisfied just to stand by and watch a rocket do it. For such as these there is a third possibility — a three-stage orbital rocket and its stepbrother, the space terminal. A three-stage rocket is simply a rocket with two enormous fuel-carrying boosters each of which falls away after its fuel is exhausted. This arrangement insures the minimum dead weight with the maximum fuel capacity, two factors essential for a rocket to reach a high velocity.

With the knowledge we now possess it is possible to build a three-stage rocket that can reach a velocity high enough to make it, like the moon, a permanent satellite of the earth. The rocket could be "hung" in an orbit as low as 160 miles above the earth and still stay put, with the centrifugal force created by its speed exactly balancing the gravitational pull of the earth. The crew could then dump building materials for a space terminal out of the ship — the parts, roped together, would continue to circle the earth like a satellite — return to earth, pick up more supplies, ferry them back, and so on until a respectable landing field in space had been constructed. From the gravity-free airport manned rocket ships could easily make the trip to the moon and back, circle the planets and return, and perhaps, if conditions were suitable, land on Mars and Venus and return.

So from a technical point of view trips to and from the moon and nearer planets do seem possible. Whether, however, human beings could survive such voyages is another question again. They are certainly in for a lot of surprises if they try it.

Some of the more obvious human difficulties of flight into space are rather easily met. Since space is a vacuum, the rocket cabin must be sealed, or "pressurized," in much the same way as high-altitude airplanes or submarines are pressurized today, so that livable internal atmospheric pressures can be maintained regardless of external conditions. As in submarines, oxygen for the crew must be carried in tanks, possibly in liquid form to save space.

IN MOST OTHER RESPECTS, the problems of space travel will be unique.

The orbital rocket trip, for example, will be without parallel in human experience. Assuming you are a crew member, at the take-off you will probably be lying in a nylon hammock in the nose of a three-stage rocket ship when somebody presses the button that sends you off with a roar.

The first thing you notice is the

sensation of pressure, a pressure that grows steadily worse until it is almost unbearable. It is the same kind of feeling, only increased a thousand times, that you get when you step hard on the gas of your car — the force of acceleration pressing on your body. Experiment has shown that the human body can safely stand about six gs of acceleration, that is, a force equal to six times the earth's gravity. Taking this into account, the engineers have designed the rocket so that acceleration during each stage reaches a peak of six gs and then levels off. Velocity itself has no effect on the human body (the earth is speeding around the sun at eighteen miles per second and we don't even feel it), only a change in velocity or acceleration. When the peak of six gs is reached, your heart is pounding, you are gasping vainly for breath, and beginning to black out. But two minutes after the flight has started, the pressure lets up. You are just beginning to congratulate yourself when it begins all over again. The second rocket has taken over. For two more minutes you suffer, and again, when you think you are on the point of suffocating, the pressure eases off. Rocket number two has fallen away. Now your home rocket takes over and the ordeal of acceleration recommences. Another two minutes and it is over. But now an even stranger sensation begins — the feeling of weightlessness.

Whenever a rocket motor is off — which is most of the time, since fuel for even the largest rockets will last for less than twenty minutes of powered flight — and there is no atmospheric resistance to slow up the machine, the rocket and everything in it are in a state of weightlessness. Whether it is moving toward or away from a planet, or simply in an orbit around it, as long as there is no motor thrust the rocket and its contents are in a gravity-less, free-fall condition. And there is nothing on earth to prepare its human occupants for that experience.

On earth it is possible for a man to experience weightlessness for only a second or two. When you go off a diving board you are actually weightless for about a second — with the force of gravity being exactly balanced by the force of your acceleration downward. After that first second, air resistance begins to slow up your natural acceleration, gravity once more pulls your internal organs against your body, and you lose the true falling feeling, even though you may retain the fear. Similarly, men have jumped from planes and left their parachutes unopened for five to six miles, yet only in the first few seconds of their fall were they truly weightless. After that, air resistance intervened.

We can duplicate almost every condition of space flight in the laboratory. We can imitate the pressure of the rocket's acceleration by whirling a man in a centrifuge until he blacks out. We can put him in a space suit in a high vacuum chamber which approaches, but never equals, the emptiness of space. We can test the effects of heat and cold, and even cosmic and x-rays, on him, but all we really know or can find out about weightlessness on earth is the common everyday experience which everyone has had momentarily — the feeling of falling.

A few months ago a monkey and some mice were shot forty miles into the air in an experimental rocket over White Sands, New Mexico. For almost three minutes of that flight the monkey and mice were in a weightless condition while automatic machines recorded their pulses, blood pressures, and breathing rates. To add insult to injury, a movie camera took pictures of the mice during their ordeal in the fast-moving rocket.

The records show that all the animals survived without apparent mishap — the mice held their breaths for an instant when the weightlessness began, but after that they breathed fine. The monkey died of heat prostration on the desert after he had been parachuted down, but the records show him in good shape up to that time. The movies show the mice floating around in the rocket chamber during the weightless period.

Unfortunately, however, the mice were unable to tell how they felt during their gravity-free ride. And that is a crucial question so far as human beings are concerned. Because men in rocket ships not only have to keep their physical health but their sanity as well. There is more than a little doubt of their being able to do so under prolonged gravity-free conditions.

An infant is born with two instinctive fears — falling and loud noises. He gradually becomes accustomed to noise — although sharp, loud noises can always frighten humans. But the falling fear remains intact, and controlling it even for short periods is extremely difficult. Consider, then, the situation of the man who suddenly finds himself floating around the cabin of the rocket ship.

The picture seems pleasant enough: floating around in the air, absolutely weightless. To move, you just swim through the pressurized cabin, possibly with fan-like flippers on your hands to make locomotion easier. But although you may be moving around like a bird, your sensations are bound to be entirely different, because, while air supports the bird's body from the outside, and gravity gives his internal organs weight, creating the normal feeling of "pressure" on the inside, there are absolutely no forces acting on your body inside or out. So you have a perpetual falling feeling, and what that does to your sense of security may take several clinics of psychiatrists to correct.

There are other unpleasant surprises in store for you. Objects like shoes, loose oxygen tanks, monkey wrenches or plates may be floating around too, and you will have to look sharp to avoid them. Liquids will not pour; if you turn the glass upside down the glass will merely turn around the liquid. You must drink with a straw, relying on suction instead of gravity. Your soup may float out of your dish and hang suspended like a ball in the air. Any liquid will take a spherical shape unless it is held in a container because, in the absence of gravity, the natural adhesion of the molecules will pull the liquid into that shape which has the smallest possible surface for a given volume.

Generally, the body's internal organs will not suffer from weightlessness. Their functions are believed to be relatively independent of gravity. The heart does most of its work, not against gravity, but against the frictional force of the blood rubbing against the blood vessels. Swallowing is a muscular action that operates in any body position. So is peristalsis — the involuntary wavelike movement of the small intestine that forces food downward.

But a really major source of disturbance will be the complete loss of a sense of balance. Ordinarily, the body orients itself by a combination of three functions: the eyes which compare the body's position with other objects and make corrections accordingly; the nerve fibres in the skin, muscles, and internal organs which are sensitive to changes in pressure due to shifts in the body's position; and the semicircular canals of the ear which have a kind of spirit level consisting of small hard particles floating freely in a liquid and communicating the angle of the body directly. When this orientation triad, as it is called, is malfunctioning or giving conflicting information, dizziness, nausea, and general "seasickness" result.

In a space ship under gravity-free conditions only the eyes would work as a balance indicator. The other two apparatuses, both dependent on gravity, would not function at all. There are certain situations where, for a short time, the eyes alone can adequately perform this job. Thus, when a pilot makes a fast turn in a plane, his ear and nerve receptors tell him that his seat is down and head up, even though he may actually be lying on his side with reference to the earth. In other words, two-thirds of his orientation triad are furnishing him with wrong information because the centrifugal force of the plane's motion creates a false gravity that deceives them. But the pilot has been trained to use only his eyes in that situation. So he looks at his instruments and instantly understands his true position. The rocket traveler, however, has no instrument to tell him his true position *inside* the ship. His eyes must do the job alone. And they are probably not adequate. As a result, the space pilot is likely to suffer severe attacks of "seasickness" or, more correctly, "space-sickness." Add to this the extreme psychological tension (including extreme anxiety) caused by the weightless feeling and you have a mess of a human being, someone scarcely able to take care of himself much less of his space ship.

A suggested method of handling this difficulty is to spin the rocket ship like a rifle bullet. The centrifugal force would then create a false gravity which would make the circular rocket walls "down" to the rocketeers while the space above their heads would be "up."

This solution, while it might take care of the orientation difficulty, would create new problems in its stead. A rocket ship of, say, sixteen feet in diameter would have to be rotated at an uncomfortably high speed to create a force comparable to gravity. This in itself would cause dizziness. Again, since the height of a man would be a large portion of the ship's eight-foot radius, the centrifugal pull on his head would be much less than the tug on his feet if he were standing erect. This difference in pull on various portions of his body would certainly increase his confusion. Add to this the usual difficulty of moving on a rotating surface and this solution appears to raise more problems than it solves. A better idea, from the standpoint of the passengers, might be to tumble the rocket head over heels as it traveled through space. If the crew were placed in the nose of the ship, this might create an adequate gravity without dizziness since the craft is six to ten times as long as it is wide. This solution is open to the engineering objection, however, that the tumbling would have to be stopped every time the rocket motor was to be used since the direction of a rocket's flight depends entirely on the direction of the blast.

WEIGHTLESSNESS is just one of the problems that men will have to contend with on trips through space. Cosmic rays, solar x-rays, and meteorites are a few of the other space unpleasantnesses that you don't have to worry about on a train ride; the earth's 120 mile atmospheric blanket filters out the x-rays, slows up the cosmic rays, and burns up all but the largest and slowest meteorites.

Although meteorites are the most spectacular of the three they are probably the least to worry about. There aren't enough of them of any size to cause more than a long statistical chance of trouble. Most of them are very small, about the size of fine silt, and these would shatter at once against the outer skin of a double-walled rocket ship. Just in case you did run into one of the larger rocks (anything over a twentieth of an inch in diameter would probably go right through the rocket ship since meteorites move at phenomenal speeds), there are several handy solutions. Every man might be equipped with a set of blow-out patches. At the telltale "ping" a crew member would simply swim over to the hole in the rocket wall and slap a patch over it, while another crewman swam over to the opposite wall and did the same. This would keep the air inside your pressurized cabin long enough to do a real repair job. Even a wad of chewing gum might serve as an emergency patch. A better idea might be to line the walls of the rocket ship with self-sealing rubber like that used in blowout-proof tires and the fuel tanks of warplanes. Of course, if the meteor should hit *you*, that would be too bad. You would explode the way a can of tomato sauce does when hit by a high speed bullet. But the chances of that are probably less than of being struck by a falling brick while walking down Broadway.

Solar x-rays may be much harder to handle than meteorites. Until very recently, short ultra-violet rays, which can be stopped by heavy clothing, were the strongest rays believed to come from the sun. But high altitude rockets have shown that x-rays in dangerous quantities are also given off by the sun, particularly during solar storms of sunspots and flares. Guarding against these x-rays is no great problem. Thin lead shields are probably the best protection against x-rays — except that thin lead increases the dangers of cosmic rays, and cosmic rays may be space man's biggest hazard.

WHAT ARE cosmic rays? Not so long ago little was known about them, or rather, too much was known to make any sense. Their energies vary greatly; some are moderate, while others have fantastic energies of a million billion volts — a half million times greater than the super beam produced by the so-called cosmotron at Brookhaven, Long Island. They have enormous penetrative powers, going through more than several feet of lead and thousands of feet of water. They seem to pour into the earth from all sides of the universe and consist of many different particles: protons, neutrons, a mysterious new entity called the meson, and very short, high-energy gamma rays. In recent years, high-altitude research has shown that cosmic rays above the atmosphere are actually protons traveling at enormous speeds. These particles smash into the atmosphere and pulverize the nuclei of air atoms, knocking off secondary protons, neutrons, mesons, and gamma rays. Thus, the cosmic rays reaching earth are mainly the atomic wreckage caused by these primary high-speed protons. The effect of primary cosmic rays on life is either unknown or secret information, but the effect of the secondary radiation is definitely harmful in large doses. Dense material like lead, unless it is thick enough entirely to absorb the primary protons battering it, gives off enormous quantities of secondary showers which are very dangerous to human beings. So there is a good chance that cosmic radiation will write a final veto to all forms of human space travel.

What other terrors lie beyond our gravity and atmospheric shields must await actual exploration. Some physiologists, for example, believe that the cells of the body, instead of dividing as they normally do when they reach a certain size, may, under weightless conditions, go hog wild and, like cancer cells, literally eat a man alive. Or else, one-celled plants and animals like bacteria and protozoa may, without the inhibition of gravity, grow to monstrous proportions with the same fatal effect on the human body.

THE POSSIBLE EFFECTS of space travel on the personality of a normal human being are also open to speculation. Some time ago, a story by E. B. White appeared in the *New Yorker* about two American soldiers stationed on a space terminal equipped with atomic bombs; the terminal was a kind of all-seeing military outpost. Shortly after arriving there the men made their first radio broadcast, in which they told their vast audience how it felt to be on a space terminal. It turned out that they didn't feel anything at all, including the conventional sentiments they were supposed to feel, like patriotism, conscience, honor, and so forth. All these sentiments were somehow linked to gravity, and, when that was gone, so were their normal attitudes. So the two soldiers, out of sheer boredom, dropped their bombs on the United States.

This story may be bizarre, but its point is valid: we just don't know all the factors that shape human personality, and an extra-terrestrial environment may well bring some surprising changes, not necessarily for the better.

The combination of the known and unknown terrors of space travel certainly would seem sufficient to deter men from ever making the attempt. But history assures us that to some few these dangers will serve only as a spur. A famous English mountain climber, who later perished in an attempt to scale Mount Everest, was asked: "But why do you want to climb the blamed thing?" He replied: "Because it is there." Space is also there, and for that reason alone men will try to conquer it.

In the Land of Dan'l Boone

ALEXANDER MARSHACK

YOU CAN'T SEE the River from the hill. Nor when you're down in the flat, small valley. For it rides low, trees growing right to its edge. You walk to it, and it shows as a small stream, ten or fifteen yards across, slow, algae green, gentle and soundless. A lazy start of river.

And when she floods, she floods slow. Rising, rising slow, backing up, over the banks, over the trees, over the fields, over the homes. And then goes down again, slow, leaving its thick mud. A lazy lovely river.

But it comes out of the swift limestone hills, its headwaters in Harlan County, Kentucky, "Bloody Harlan" of the mine hills, and of old mine history — though not as bloody as story would have it.

Old Jim Ford sat now on the old gray wood porch over the field by the river. He tore off a thin white cigarette paper, tapped in it some tobacco, rolled a thin, poor cigarette, licked it, and lit the wet cigarette with an old silver lighter.

"Never lived more than half mile from the river. Least not much," he said. "Seen the river change."

Seen it change, helped it change, and seen it go to ruin.

For old and gentle Ford, neither a drinker, nor a swearer, is one of the makers of the valley and the River. One of the least written of valleys and rivers in the United States and the Old South, the winding, beautiful, tortuous Cumber-

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