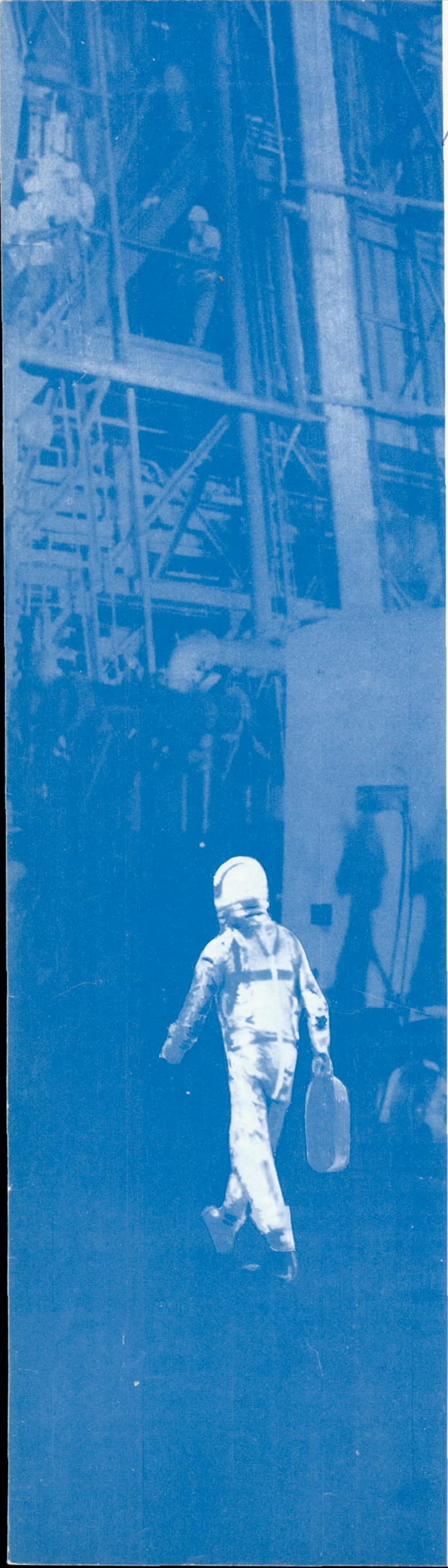

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THE MISSION OF MAN IN SPACE

by HOMER E. NEWELL, Director
Office of Space Sciences

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NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION

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HOMER E. NEWELL
Director
Office of Space Sciences

Homer E. Newell was named Director of Office of Space Sciences on November 1, 1961. He was formerly Deputy Director of Space Flight Programs.

Before joining the NASA on October 20, 1958, Dr. Newell was Acting Superintendent of the Atmosphere and Astrophysics Division of the U.S. Naval Research Laboratory. He was also Science Program Coordinator for Project Vanguard, the U.S. scientific earth satellite program for the International Geophysical Year.

A native of Holyoke, Mass., Dr. Newell earned both the bachelor and master of arts degrees from Harvard University and a Ph. D. in mathematics from the University of Wisconsin in 1940.

From 1940 to 1944 he was an instructor and later assistant professor at the University of Maryland, and a ground instructor in navigation with the Civil Aeronautics Administration from 1942 to 1943.

Dr. Newell joined the Naval Research Laboratory in 1944, and became Head of the Rocket Sonde Branch in 1947. In this position, he was in charge of the upper atmosphere research program of NRL. In 1955 he was named Acting Superintendent of the Atmosphere and Astrophysics Division.

His scientific committee memberships have included the Special Subcommittee on the Upper Atmosphere of the National Advisory Committee for Aeronautics (1947–51), and the Rocket and Satellite Research Panel (formerly Upper Atmosphere Rocket Research Panel) since 1947. He was Chairman of the Rocket and Satellite Research Panel in 1959 and 1960.

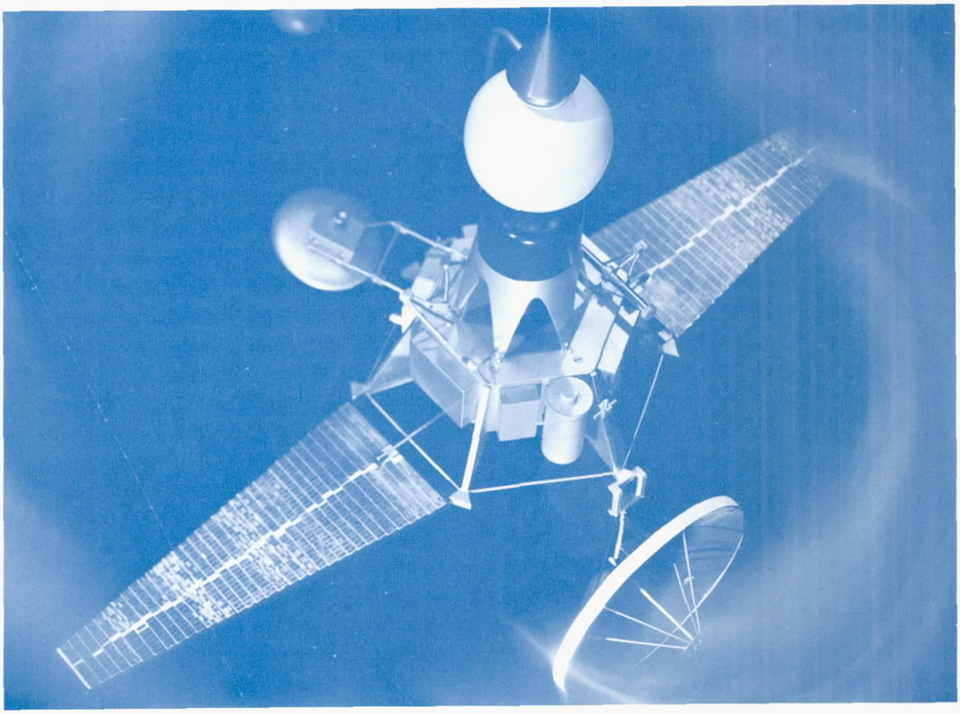
Dr. Newell is the author of several technical books and numerous articles. He is a member of Phi Beta Kappa, the Research Society of America, the American Geophysical Union, the American Rocket Society, and he is a fellow of the American Association for the Advancement of Science. Dr. Newell, his wife, and their four children live in Washington, D.C.

THE MISSION OF MAN IN SPACE

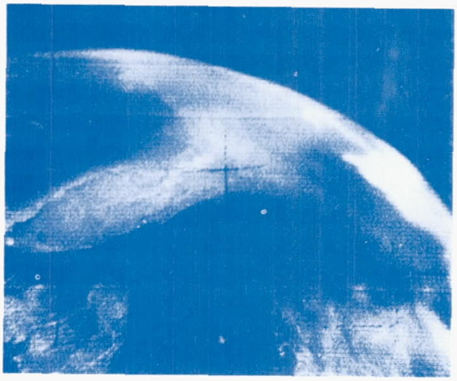
The first years of the Space Age have demonstrated clearly that unmanned spacecraft can play a significant role in man's quest for knowledge and human advancement. On the scientific side, Explorers, Pioneers, Mariner, Ranger, Sputniks, and Luniks have already yielded a wealth of knowledge, answering many important scientific questions. The future is bright for these electro-mechanical extensions of man's presence beyond the earth, especially when increased payload capacity permits us to launch Surveyors to the moon and advanced Mariners and Voyagers to the planets.

EFFECTIVENESS AND USEFULNESS OF UNMANNED SATELLITES

TIROS, Telstar, and Transit have shown how effective unmanned satellites can be in weather surveillance, for long range communications, and as navigational aids. The outstanding success of the TIROS research satellite gives full assurance that the Nimbus and Aeros operational satellites to come will advance weather surveillance, forecasting, and research far beyond their past status. Telstar, a private venture of AT&T, speaks for itself, and it, too, presages a bright future for the application of satellite technology to human advancement.



Scale model of Ranger spacecraft—the NASA project for rough lunar landing.



Florida as photographed from the Tiros I weather satellite.

All these, and other examples of the effectiveness and usefulness of unmanned satellites and deep space probes, testify to their worth. It follows as a corollary that the matter of providing these inanimate servants of mankind with protection against radiation hazards of the space in which they must operate is worthy of careful attention. Protection, through shielding, overdesign (or perhaps under the circumstances one should say "adequate design"), modified demands on components or systems, substitution of suitable components for unsuitable ones, or avoidance of hazardous regions or times, must be worked out in theory and in practice to make most effective use of the space opportunities that lie before us.

But what about protection for man, himself? If he would just stay at home on earth where some people think he belongs, the problem would be solved. You recall the old chestnut about the man with the broken leg. His pal, rushing into the doctor's office, in his excitement could hardly tell the doctor what the trouble was. Finally, breathlessly, he managed to get out with, "Doctor, what

Earth station for contact with Telstar, communication satellite, developed by the Bell System.

do you do about a man who has broken his leg in two places?" To which the doctor replies, "Tell him to stay out of those places!"

NECESSITY OF MAN IN SPACE

Well, the easiest way to protect a man from the radiations in space is to keep him out of space. And, indeed, there are many who insist that that would be the best all-around course of action. They say that we don't need man in space; that everything we wish to accomplish out there can be done with unmanned vehicles and equipments; and that in fact it would be cheaper to do it without man.

I don't agree. No matter how you design and build, you won't be able to put man's discernment, judgment, versatility, and adaptability in space except by putting the man himself there. The more complex the mission, and the farther from the earth it must be carried out, the greater will be the need for that human versatility and insight and adaptability. At some point in complexity and distance from the earth, it will actually become cheaper to use the man than to build the mechanical substitute. Some, who have studied the matter, assert that the switchover occurs between the moon and the nearest planet.

At any rate, this is no longer an open question. Man has already gone out into space. He is going to go out again, and then again. This Nation is committed in dead seriousness to placing a man on the moon in the present decade, and thousands of people are tackling this most difficult of all mankind's ventures with a determination to bring it about.

It is quite to the point, therefore, to ask what will he do out there? What is there for him to do in space anyway? I should like to explore this very question, and to review the lengthy list of reasons why man should go out into space.

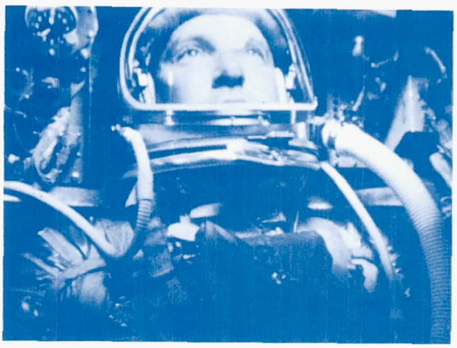
SCIENTIFIC EXPLORATION

It is clear that the very first thing that man will do in space, on the moon, and on the planets, will be to explore. Whether systematized or not, whether planned or incidental, every look he takes, every glance will be exploration. And if he is an accurate observer, all of it will be science. Each bit of information, each observation, each new phenomenon or object noted, will be listened to and seized upon avidly by the scientific community. Following this initial scientific exploration, based on the first-look results, specific investigations will be designed and carried out. Later, although right now many, indeed most, of them cannot be foreseen, there will be many practical applications, both civilian and military, of the new space knowledge and technology, and of the human ability to move about in space.

MAN IN ORBIT

Man in orbit acquires a perspective in which to view the earth that cannot be achieved on the ground or from the lower atmosphere. Already small beginnings have been made by the Mercury pilots in the area of scientific observations from orbit. In these early days when the principal concern is with the struggle to fly at all in space and return safely, the scientific exploration necessarily receives little attention. But as confidence and ability develop, the man in an earth-orbiting satellite will be able to devote more and more attention to such matters as observations of weather patterns, the airglow, the aurora, the zodiacal light, the Gegenschein, the sun's corona, and other astronomical objects.

At some time in the development of the space program, it will be important to send aloft scientists to do their own observing. It is important, therefore, that the scientific community begin to give careful thought not only to the scientific tasks to be done in orbit, but also to how they are to be done, and by whom. If scientists themselves are to go into orbit to do science there in person, these scientists must receive appropriate training for survival, for performance of their duties as members of the spacecraft crew, as well as in how to carry out their scientific investigations under the unusual conditions of space and space flight. At some appropriate time such scientists must be introduced into the NASA astronaut training program.



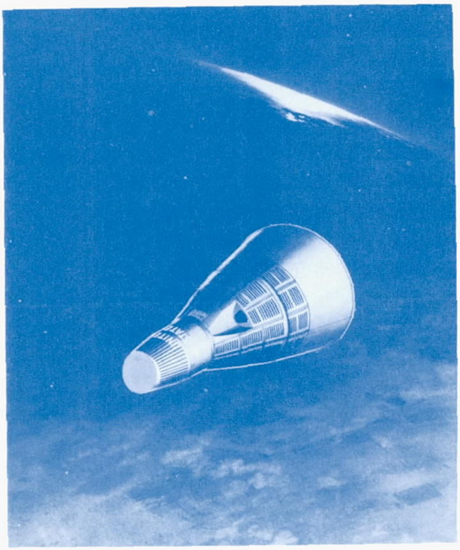
Astronaut Walter M. Schirra during his six-orbit flight in Sigma 7.

Actually more thought seems to have gone into the research that a man might do in person on the moon, than in a satellite orbiting about the earth. This is due in part to President Kennedy's commitment of the Nation to the landing of a man on the moon within the present decade. It is due also in part to the fact that the moon is clearly an explorable body in the same sense as the earth is. One can easily see in the mind's eye men walking around, looking, poking here and there in search of interesting and important finds, picking up specimens for later study in the laboratory, taking pictures, making field tests, drilling holes, implanting instruments and automatic observing stations, and in general doing the many things that an exploration geophysicist might do on earth. It is also due in part to the fact that many of the questions of current scientific interest concerning the earth, its atmosphere, the sun, and astronomical problems are already being attacked with vigor and promise by means of unmanned satellites and probes.

But there are enough valuable scientific observations for a scientist in orbit to make, that are already apparent, that it behooves the scientific community to pursue the subject further with vigor. We have mentioned a little earlier some of the geophysical and astronomical observations that a man in a satellite might make. In addition, man himself, in orbit, is an important subject of scientific study. Indeed, when large orbiting laboratories can be put into operation there will be opportunity to conduct, under the same conditions of careful control and with the same close personal attention that one gives in the laboratory on the ground, biological experiments on the effects of weightlessness, radiation, new periodicities and other conditions strange to terrestrial life. In such a laboratory, fundamental and applied research, and perhaps even some of the development, of closed ecological systems can be carried out under the very conditions under which they will be required to operate. For example, those systems to be used on manned planetary missions will have to operate for years without failure. In an orbiting laboratory such a system could be given a life test that would be fully meaningful and in which one could place some confidence.

When man has learned to move about freely in space, especially when he is able to move around outside of the spacecraft or space station that serves as his home base in space, there will be many activities that he can pursue. One of these will be engineering and construction in space. At the present time, space engineering is carried out on the ground. The engineered object, if it is a space vehicle or a spacecraft, is placed in orbit after the engineering has been accomplished. In this approach, man stays on the ground, and sends his engineered object out into space. Much has been accomplished by this approach, in the form of scientific satellites and space probes, weather satellites, communications satellites, navigation satellites, and military applications of space technology, and even manned satellites.

But one day man will do some of his engineering and building right out in space. A lot of this activity may perhaps be more properly referred to as construction and maintenance, but the novelty of the problems and the environment to be faced will be such that for a long time to come the constructors and the maintainers will actually have to be engineers in the true sense of the word.



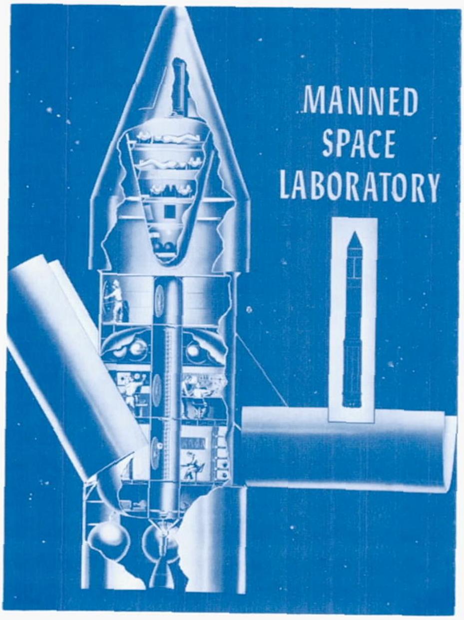
Artist's conception of the two-man Gemini spacecraft.

One can foresee the need to assemble in space large laboratories, huge antenna systems, stations to serve as staging areas for interplanetary flight, and even space vehicles for making flights to the planets and into deep space.

It may be necessary to form the reflecting surfaces for astronomical telescopes under the conditions of weightlessness under which they are to operate so as to eliminate distortions that would be introduced by forming them on the ground under 1 g and then launching them into orbit.

Considering the tremendous expense that one must anticipate for the construction of huge observatories and laboratories of the future, it may well prove to be far cheaper to provide human maintenance and repair than to rebuild and launch a new satellite every time an old one has ceased to function. In fact, in many cases it may not be just a matter of maintenance and repair. By replacement of instruments in an orbiting observatory it may be possible to update at relatively low cost a basically expensive facility.

This newly developed ability to engineer, inspect, build, maintain, renovate, and carry out complex logistics operations in space, will also have military value. In the matter of military applications of space, informed thought appears to have gone full circle. At first, years ago, although opinions varied, the general thought was that space provided an overwhelming military potential, and that he who dominated space would dominate the world. This was followed by a reaction period, during which the general thought swung to the opinion that perhaps there was very little of military value in space. At the present time, there are few who would



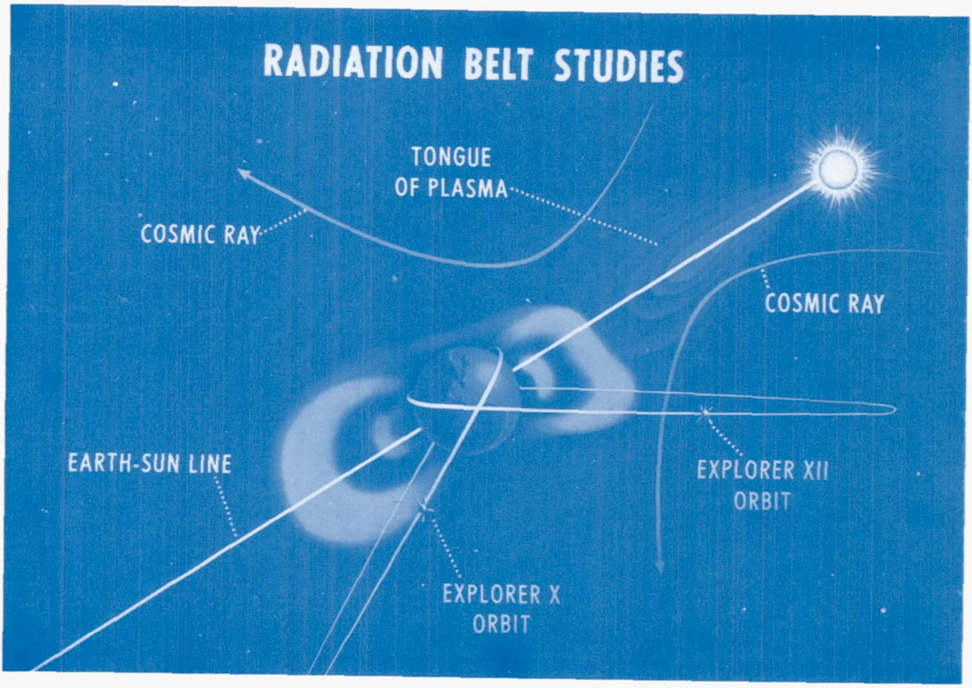
A concept of a Manned Space Laboratory for man's existence in outer space.

deny that space does offer possibilities for many important military applications. I would venture to predict that in time engineering in space will form an important segment of the sum total of manned operations in space for military purposes.

MAN ON THE MOON

One of the most important reasons for placing a man on the moon is to carry out a scientific investigation of that body. The moon is of especial interest to the scientist for a number of reasons.

We know that the solar system was formed about 4.5 billion years ago, but we do not know how it was formed, and this problem has been the subject of much speculation and thought for centuries. The investigation of the origin of the solar system is a project of the greatest scientific interest, one to which

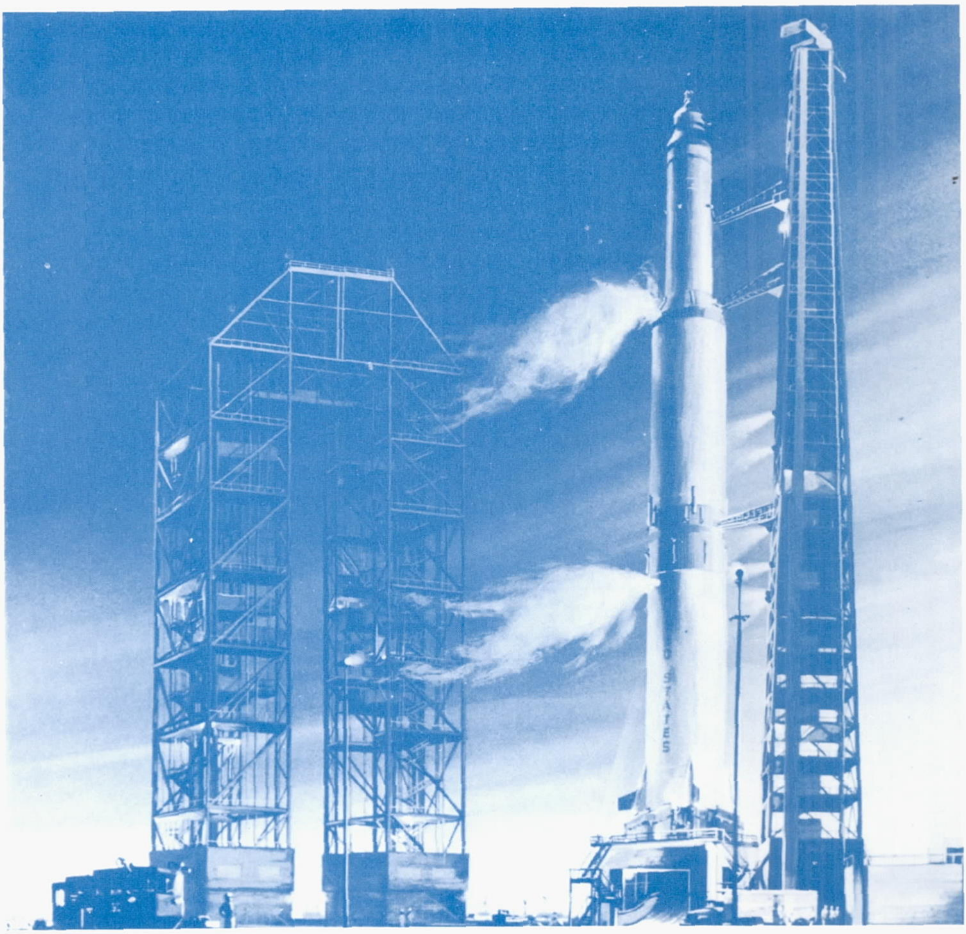


Concept of the radiation belts as studied by the Explorer satellite series.

the exploration of the moon can contribute significantly.

The moon will play a special role in this investigation because it is a body whose surface has preserved the record of its history for a much longer period than the earth, and probably much longer than Mars and Venus as well. On the earth, the atmosphere and the oceans wear away surface features in 10 to 50 million years. Mountain-building activity turns over large areas of the surface in about the same time. There is little left on the surface of the earth of the features that existed several hundred million years ago. The same is probably true of Mars and Venus. But on the moon there exist no oceans and very little atmosphere to destroy the surface. Also, inspection of the moon's surface in a telescope shows few signs of the mountain-building activity which distorts and replaces the surface of the earth so rapidly.

Thus the moon's surface will carry us back very far into the early history of the solar system, perhaps not back to the birth of the sun and planets, but cer-



Saturn C–5, destined for a moon shot, stands 325 feet tall and weighs six million pounds.

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tainly billions of years back—much longer than the 10 to 20 million years to which we are limited on the earth.

Not only the lunar surface, but also the internal structure of the moon may provide a clue to the early history of the solar system and the birth of the planets.

One of the theories for the creation of the planets, popular until recent times, held that the solar system was created during a near collision between our sun and another star, in which the gravitational forces between these two massive bodies tore huge streams of flaming gas out of each. As the intruding star receded, the masses of gas which happened to be near the sun were captured by it into orbits in which they eventually cooled and solidified to form the planets. If such a collision was the manner of formation of the solar system, then the moon and planets must have been molten at an earlier stage in their histories. In that event, the iron in their interiors

How an Apollo astronaut may appear in his "moon suit."

would melt and run to the center to form a dense core.

Another theory holds that the planets were formed out of pockets of condensation in the dust surrounding our sun during the early stages of its lifetime. We know that stars themselves are almost certainly formed in this way, by condensation of pockets of interstellar gas and dust which happened to be somewhat denser than their surroundings. It seems likely that additional subcondensations could have developed in the tenuous matter surrounding the sun before the central condensation had proceeded to its final stages; and that the moon and planets were eventually formed from these subcondensations.

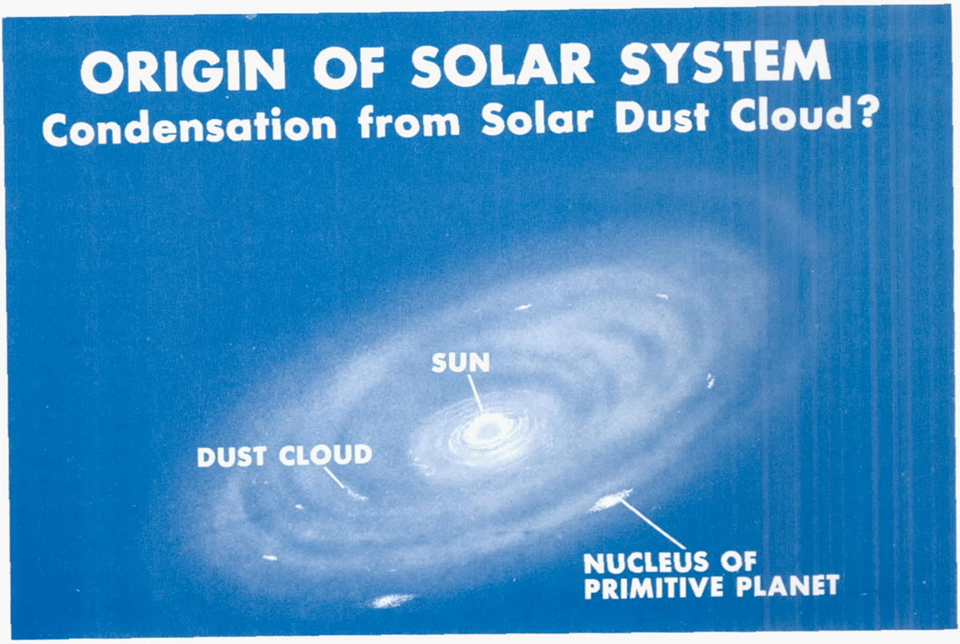
Large bodies like the earth have enough radioactive uranium inside them to produce melting of iron simply through the heat generated in nuclear decays. Therefore, the existence of a dense core of iron in the interior of the earth does not prove the validity of the collision theory, or disprove the theory of condensation. However, the moon is smaller and colder, and will provide a much better indication than the earth, as to which of the two theories on the origin of the solar system is correct.

The necessary observations and measurements obviously cannot all be made just by man's standing on the moon and looking around. But a giant step will have been taken when the first scientist on the moon does look around and begins to zero in on the most likely answers, and more importantly, can determine the most promising courses to follow for obtaining the answers. Before that time some data will have been obtained by means of unmanned spacecraft, Rangers and Surveyors, but the full power of the lunar science effort will not be brought to bear until man and instrument together tackle the problems to be solved.

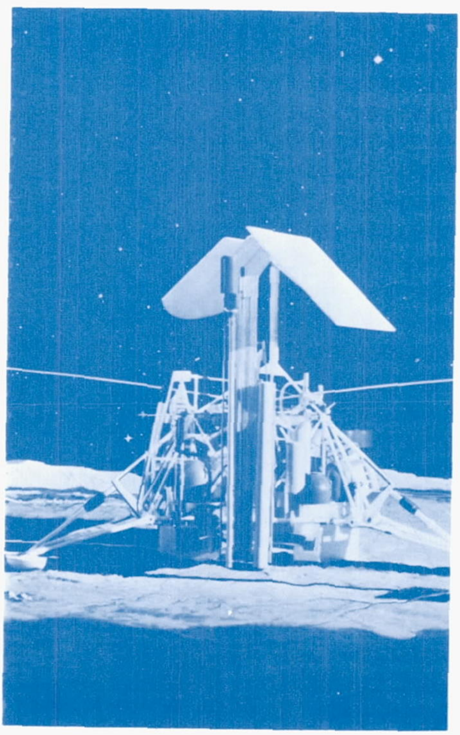
This subject was discussed at length at the Space Science Summer Study conducted at the State University of Iowa, under NASA sponsorship, this past summer. Most of the participants felt that the first scientist-astronaut to be landed on the moon should be a geologist. His first job should be to look—and think. There was considerable discussion about the qualifications of this first scientist on the moon. The thought was brought out that this man should be a top notch, first rate scientist. As an illustration, it was pointed out that it took a Darwin to make the voyage of the Beagle the historic success that it was. If one wants to be quantitative about it, one might say that the difference between sending a run-of-the-mill scientist, or a nonscientist given special supplementary training in science, to the moon to look around, and sending a Darwin there, is a matter of many many orders of magnitude in what returns are realized from the venture. Of course, the problem is to find a Darwin who can also become an astronaut, and is willing to.

The question of how man will do science on the moon is one that is worthy of much thought. One approach is that already mentioned, namely, to send scientists to the moon. Another is to train the astronauts to look for anticipated objects and phenomena and to try to be alert to the unanticipated ones and report them accurately. Still a third might be to have an astronaut-scientist team in which the astronaut on the moon is linked with the scientist on the earth by means of radio and television. In two-way conversation, the astronaut receives guidance from the scientist who sees through the television what the astronaut sees. By questioning the astronaut, the scientist can get additional details from the man on the moon about objects that appear to be of special significance.

At any rate, the scientific observer on the moon will have plenty to keep him busy. As mentioned, the first thing he



Artist's drawing of one theory of the origin of our solar system should do is look and think. He should examine the surface, note the various geologic formations, select appropriate samples to bring back to earth, and take pictures. Eventually, although very likely not on the first trip, he should conduct measurements of surface properties, radioactivity, temperature and heat flow, seismic activity, etc., bringing with him the necessary instruments to accomplish these tasks. At some time, he will begin to use the moon as a base for a variety of observations, some of them not necessarily of the moon itself. Studies of the librations of the moon can give a great deal of information about the internal construction of the moon, but other astronomical investigations may well concern the sun and stars. For example, the other side of the moon has been pointed to as ideal for setting up a radio astronomy observatory. Also there may be great value in observations of the earth, particularly atmospheric phenomena, from the moon.



Soft moon landing will be achieved by the Surveyor spacecraft.

At first this observing from the moon as a base may well be done with automatic or semiautomatic equipment emplaced on the moon by the men who go there, supplementing other such observatories that were landed on the moon by unmanned spacecraft. Eventually, however, manned bases, including scientific observatories, will probably be established.

We have already said that the first scientist to land on the moon should probably be a geologist. Because of the construction work that will in time take place on the moon, it is also desirable that among the early lunar explorers there be a civil engineer. His job also will be to look and think, and collect data for the day when construction of supply depots, radiation shelters, roads, landing areas, large bases, and observatories will take place.

Already it is certain that when man does do engineering and building on the moon, he will do it under conditions far different from those encountered on the earth. The gravity will be only one-sixth of that met with on earth, while the lack of an atmosphere, bombardment by meteoritic particles, the constant presence of the interplanetary radiations, the tremendous range of temperatures, the possible presence of dust that may be more than just a nuisance, unusual conditions of electrostatic charging, etc., will confront him with problems that will tax his ingenuity and skill to the utmost.

When manned lunar bases or observatories go into operation, it will be necessary to have worked out a plan for maintaining the supply lines to them. The required logistics and operational support to the endeavor will make an

Full phase of the moon, age 14 days.

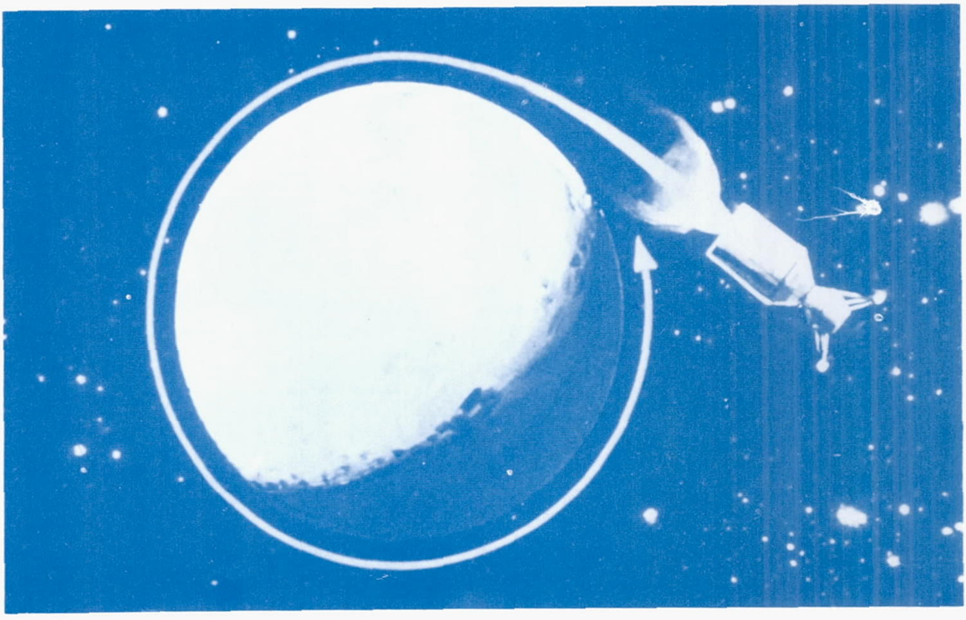
Antarctic expedition look like a grade school exercise in comparison.

All of this will require, of course, that an adequate scheme for protecting the men involved from the radiations of space will have been worked out, and put into use.

MAN AROUND THE MOON

Doubtless man will circumnavigate the moon, even go into orbit around it, before making a landing. At any rate, this is the present United States plan. During such maneuvers, prior to landing, man can make preliminary observations. Such observations will be needed to support the ultimate landing on the lunar surface, particularly those that reveal the character of the surface and permit one to select suitable landing sites. They will also be of scientific value. Of especial importance will be pictures that can be taken from the circumnavigating or orbiting spacecraft.

After man has landed and established a base on the moon, a lunar orbiting space station carrying one or more human observers can be used in conjunction with the observatory on the ground for further scientific exploration of the moon. For some time to come, the lunar satellite approach may be easier than



Artist's concept of Apollo spacecraft firing rockets to slow down and go into lunar orbit (curved arrow).

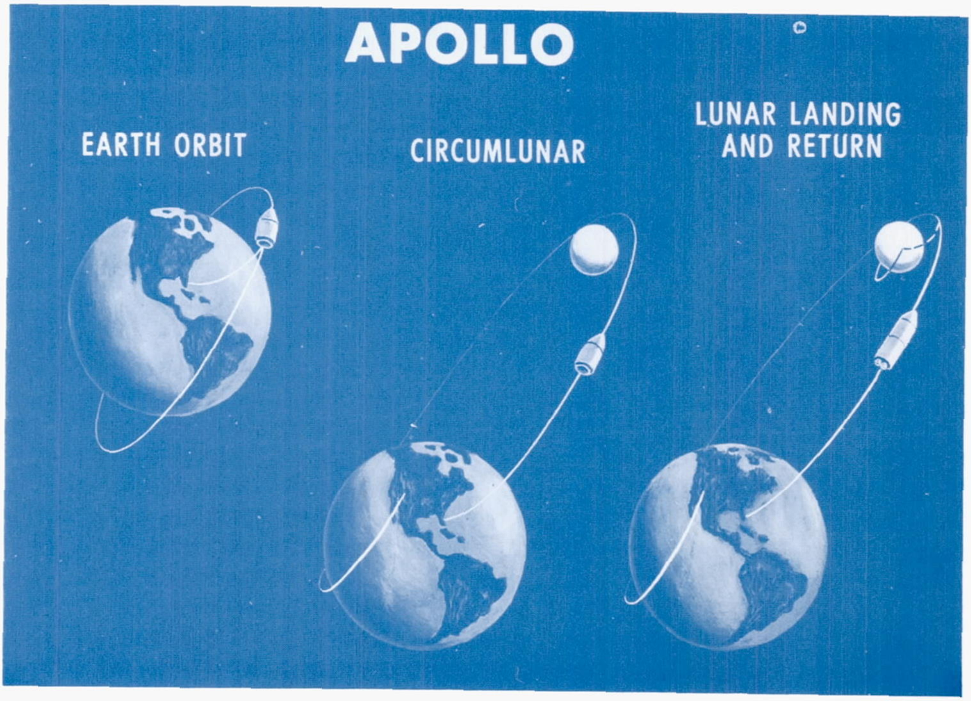
lunar surface transportation for a global survey of the moon.

MAN IN INTERPLANETARY SPACE

On the way to the moon or the planets, man must traverse the space between earth and them. Although much of the investigation of these regions will doubtless best be done by instrumented space probes, nevertheless man will again have the opportunity to look about and search for the unexpected. Most of his observational opportunities will be astronomical in character. The zodiacal light, the Gegenschein, the sun's corona, the atmospheres of the planets, new views of the bodies of the solar system, can come under new scrutiny. In addition, man can continue observations on himself under conditions of isolation not producible in any other fashion.

MAN ON THE PLANETS

The investigation of the moon and planets by satellites, deep space probes, and manned exploration, serves to broaden the horizons of the geophysicist tremendously. A little thought will show that the techniques and experience that must be called upon in investigating these bodies must be those of the geophysicist. Moreover, as one goes forward with these lunar and planetary investigations, the student of the earth should find the broadened perspective provided by increased knowledge about the moon and planets a powerful lever to use in prying loose some of the secrets of the earth itself. Indeed, it is in recognition of these facts that the American Geophysical Union just recently voted to establish a new Section on Planetary Science.



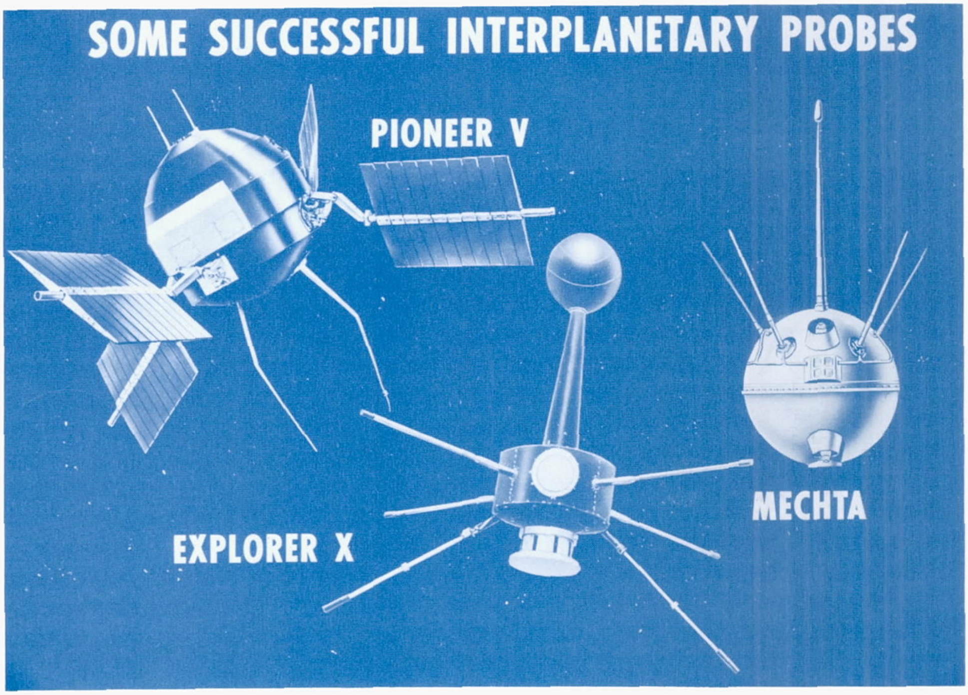
Present scientific concept of man's journey to the moon.

The experience gained in manned exploration of the moon will no doubt serve as a basis for beginning the manned exploration of the planets. There will be many similarities, and many differences. Among the latter are the considerably greater distances that must be traversed, the longer times that man must spend out in the lonely voids of space, and the existence of atmospheres on the planets.

The ability to send measuring instruments to the moon and planets, and eventually to visit them in person, permits man to study directly more than one sample of the material of which the universe is composed, and more than one sample of the bodies of the universe. It is possible that the scientist may also have the opportunity to study more than one sample of physical life in the universe.

Certainly one of the most exciting possibilities in space exploration is that indigenous life may be found there. The most likely candidate is Mars, where balloon observations in the infrared have detected emissions characteristic of the carbon-hydrogen bond. While this does not prove the existence of life on Mars, it is most certainly highly provocative. For this reason, preparations are going forward with various types of instruments to search for living forms on the Red Planet. These will be carried in fly-bys and landers as soon as we are able to provide the necessary transportation.

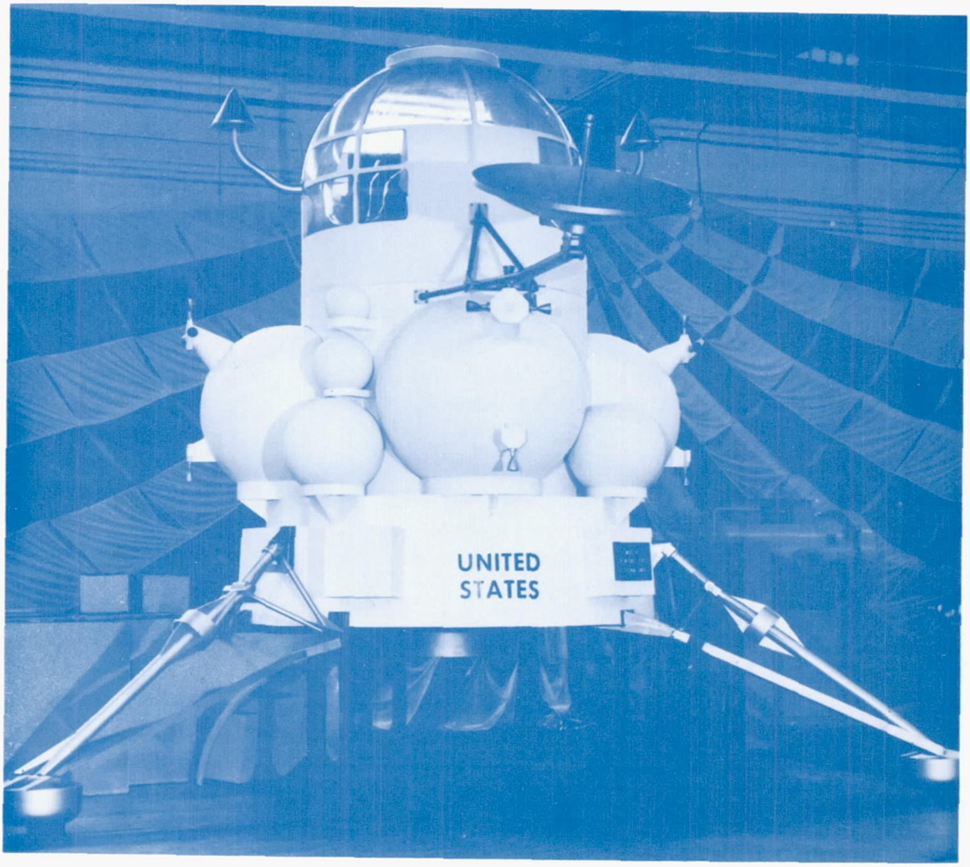
All the data available at present would indicate that there is little likelihood of life on Venus. Various radioastronomical observations for the planet indicate that the surface temperatures are in the vicinity of 600° K., well over the boiling point of water. These temperatures are in themselves discouraging enough, but when taken in conjunction with the probably very high pressures



Illustrations of successful probes into space.

existing on Venus (exceeding 20 atmospheres at the surface) it seems most likely that the entire planetary surface is bathed in a searing atmosphere, and that there is no chance of life there. The biologists insist, however, that there may yet be life on Venus, existing in the cooler upper atmosphere. Balloon samplings are being made of the earth's upper atmosphere to search for organisms that might be living there. Results from these investigations may shed additional light on how much of a point the biologists have in connection with Venus.

It does not appear likely that there are living forms on the moon, because of the lack of an atmosphere, the lack of any observable water, and the extreme temperature ranges to which the lunar surface is subjected. Some believe, however, that there might be living forms existing at some distance below the hostile lunar surface. But even if there are no living forms on the moon, other biologists point out that the moon is still of interest in that it may carry the residue of previously living forms or possibly material that is in the nature of precursors to life. Controversy rages on this issue, with some scientists categorizing this

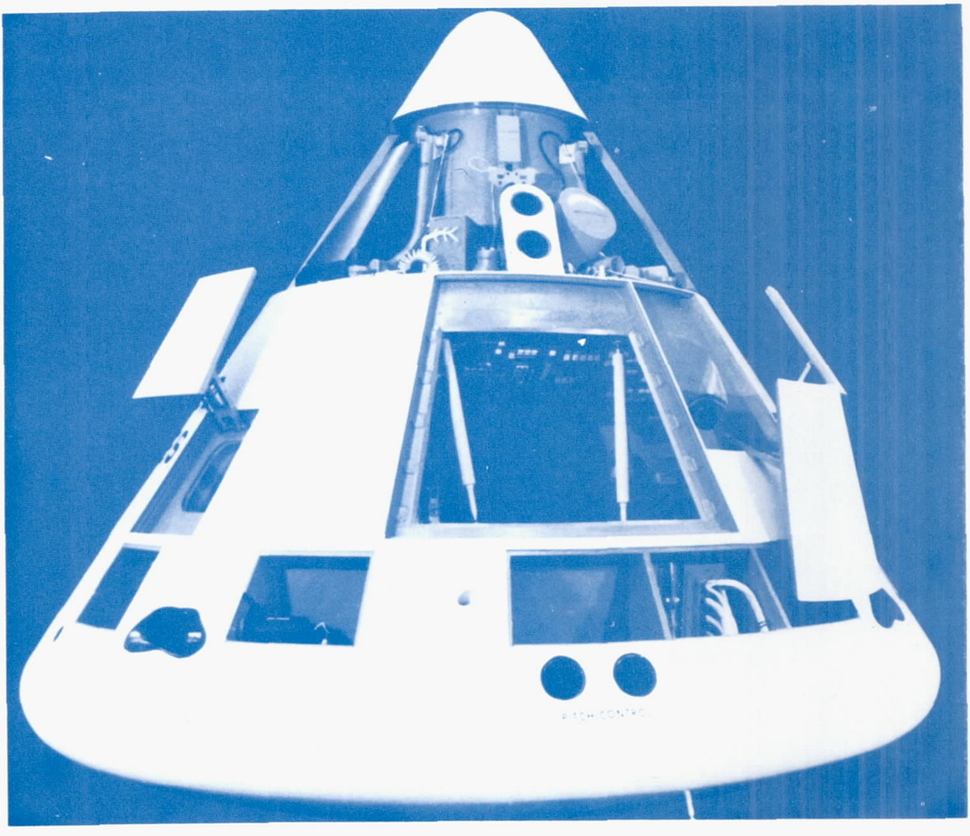


Lunar excursion module (LEM) that will land two astronauts on the moon. It is 10 feet wide and 16 feet tall, and weighs about 12 tons.

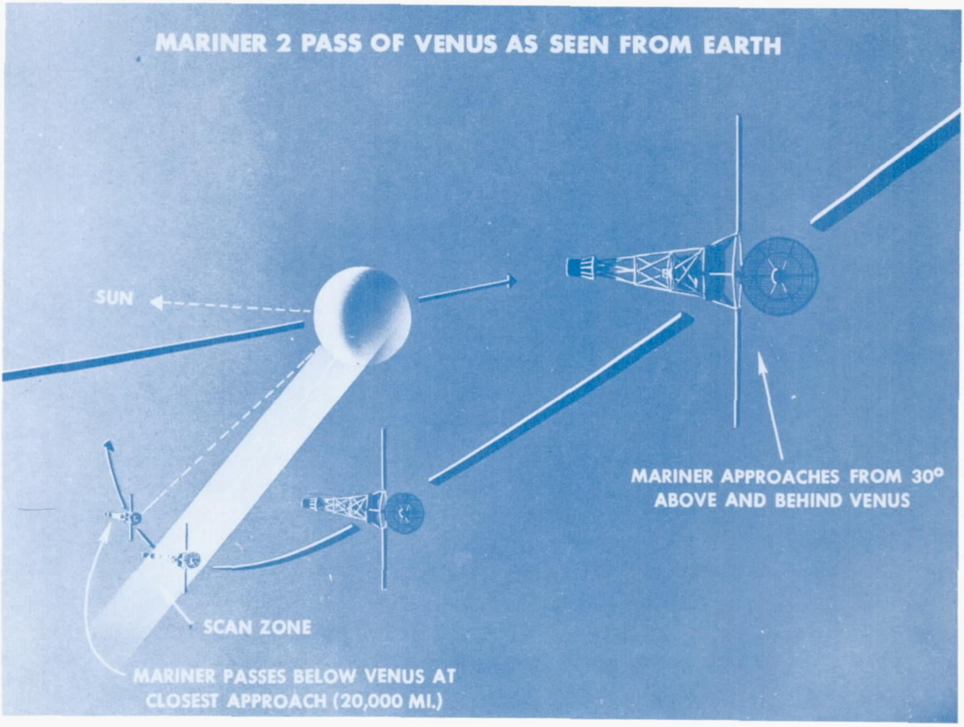
reasoning on the part of the biologists as absolute nonsense. But the biologists can counter with the observation that if they should be right, walking all over the moon with dirty feet, or plastering it with dirty material, can destroy a once-in-forever opportunity to make exobiological studies that may have great bearing on our understanding of terrestrial life.

At any rate it seems clear that we must be careful about what we do in the case of Mars. A suggestion was made at the recent Space Science Summer Study conducted at the State University of Iowa by the National Academy of Sciences under NASA sponsorship, that Mars be made an ecological preserve, where steps are taken to protect the planet from undesirable contamination. According to the suggestion, Mars would be investigated in such a manner as to protect the interests and needs of the biologists who wish to search for and study any living forms or traces of life that might exist there. This proposal also included the suggestion that, although Venus and the moon not be considered as ecological preserves, care be taken to minimize their contamination.

Of course, if Mars is to be maintained as an ecological preserve, this can be done only by international cooperation, specifically, at the present time between the United States and the U.S.S.R.



Mock-up of the command service module in which the third astronaut will remain and orbit the moon.



Thirty-six million miles from earth, Mariner recorded valuable scientific data as it passed Venus.

One might mention in passing, that those who are concerned about possible contamination of our neighbors in space through the introduction of terrestrial organisms, also point to the possible danger of back contamination of the earth by the introduction of extraterrestrial organisms. Careful thought must be given to this problem, and in due time appropriate steps taken to remove any risks that are judged unacceptable.

When man reaches out toward the planets, who can say where it will all end? Manned bases, observatories, landings on the satellites of planets, such as those of Jupiter or Saturn, artificial orbiting observatories about the different planets, and many other such things are in the realm of possibilities that the far distant future holds out to man. One even hears mentions of the possibility of modifying the atmosphere of Mars to make it less hostile or even almost habitable. This might be accomplished by the introduction of suitable biological agents to the planet, after the initial search for and investigations of indigenous life have been made.

But these speculations can serve us no real good here except to indicate that the field of space is wide open as far into the future as we can now see, and that the path to the planets leads farther than man can peer from his present position on the earth, at this point in time.

CONCLUSION

Hopefully, this little review of the things that man can look forward to doing in space will serve the good purpose of showing clearly that it is indeed desirable to find ways of protecting man against the radiation hazards of space, so that he may go out into space in pursuit of his destiny.

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