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Why Mars?

Since the 16th century, learned men have recognized Mars for what it is—a relatively nearby planet not so unlike our own. The fourth planet from the sun and Earth's closest neighbor, Mars has been the subject of modern scientists' careful scrutiny with powerful telescopes, deep space probes, and orbiting spacecraft. In 1976, Earth-bound scientists were brought significantly closer to their subject of investigation when two Viking landers touched down on that red soil. The possibility of life on Mars, clues to the evolution of the solar system, fascination with the chemistry, geology, and meteorology of another planet—these were considerations that led the National Aeronautics and Space Administration to Mars. Project Viking's goal, after making a soft landing on Mars, was to execute a set of scientific investigations that would not only provide data on the physical nature of the planet but also make a first attempt at determining if detectable life forms were present.

Landing a payload of scientific instruments on the Red Planet had been a major NASA goal for more than 15 years. Two related projects—Mariner B and Voyager—preceded Viking's origin in 1968. Mariner B, aimed at placing a capsule on Mars in 1964, and Voyager, which would have landed a series of sophisticated spacecraft on the planet in the late 1960s, never got off the ground. But they did lead directly to Viking and influenced that successful project in many ways.

When the space agency was established in 1958, planetary exploration was but one of the many worthy projects called for by scientists, spacecraft designers, and politicians. Among the conflicting demands made on the NASA leadership during the early months were proposals for Earth-orbiting satellites and lunar and planetary spacecraft. But man in space, particularly under President John F. Kennedy's mandate to land an American on the moon before the end of the 1960s, took a more than generous share of NASA's money and enthusiasm. Ranger, Surveyor, and Lunar Orbiter—spacecraft headed for the moon—grew in immediate significance at NASA because they could contribute directly to the success of manned Apollo operations. Proponents of planetary investigation were forced to be content with relatively constrained budgets, limited personnel, and little

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publicity. But by 1960 examining the closer planets with rocket-propelled probes was technologically feasible, and this possibility kept enthusiasts loyal to the cause of planetary exploration.

There is more to Viking's history than technological accomplishments and scientific goals, however. Viking was an adventure of the human mind, adventure shared at least in spirit by generations of star-gazers. While a voyage to Mars had been the subject of considerable discussion in the American aerospace community since the Soviet Union launched the first Sputnik into orbit in 1957, man has long expressed his desire to journey to new worlds. Technology, science, and the urge to explore were elements of the interplanetary quest.

ATTRACTIVE TARGET FOR EXPLORATION

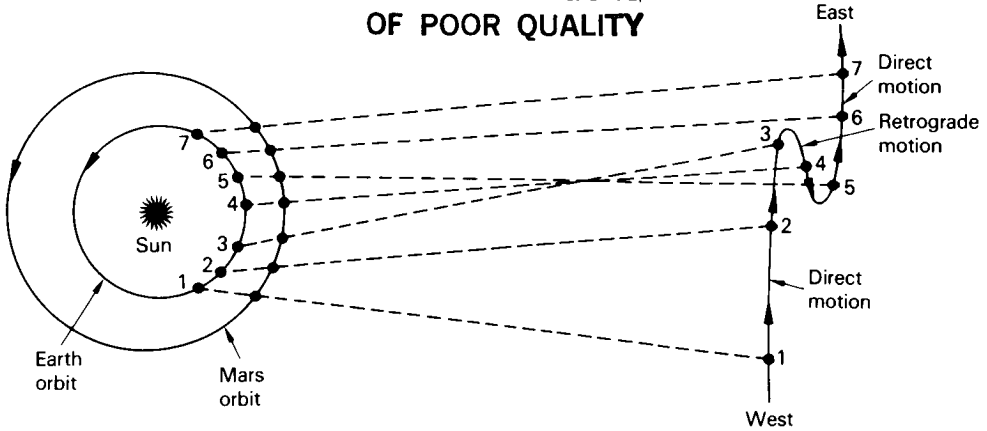
Discussion of interplanetary travel did not have a technological foundation until after World War II, when liquid-fueled rockets began to show promise as a transportation system. Once rockets reached escape velocities, scientists began proposing experiments for them to carry, and Mars was an early target for interplanetary travel.

Mars fell into that class of stars the Greeks called *planetes*, or "wanderers." Not only did it move, but upon close observation it appeared to move irregularly. The early Greek astronomer Hipparchus (160-125 B.C.) recognized that Mars did not always move from west to east when seen against the constellations of fixed stars. Occasionally, the planet moved in the opposite direction. This phenomenon perplexed all astronomers who believed Earth to be the center of the universe, and it was not until Johannes Kepler provided a mathematical explanation for the Copernican conclusion that early scientists realized that Earth, too, was a wanderer. The apparent motion of Mars was then seen to be a consequence of the relative motions of the two planets. By the time Kepler published *Astronomia nova* (New astronomy), subtitled *De motibus stellae Martis* (On the motion of Mars), in 1609, Galileo was preparing his first report on his observations with the telescope—*Sidereus nuncius* (Messenger of the stars), 1610. (See Bibliographic Essay for a bibliography of basic materials related to Mars published through 1958.)

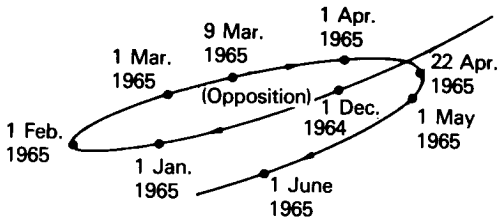
From 1659, when Christiaan Huyghens made the first telescopic drawing of Mars to show a definite surface feature, the planet has fascinated observers because its surface appears to change. The polar caps wax and wane. Under close scrutiny with powerful telescopes, astronomers watch Mars darken with a periodicity that parallels seasonal changes. In the 1870s and 1880s during Martian oppositions with Earth,* Giovanni Virginio Schiaparelli, director of the observatory at Milan, saw a network of fine lines on the planet's surface. These *canali*, Italian for channels or grooves, quickly became *canals* in the popular and scientific media. Canals would be

*Appendix A describes some of the orbital relationships between Earth and Mars.

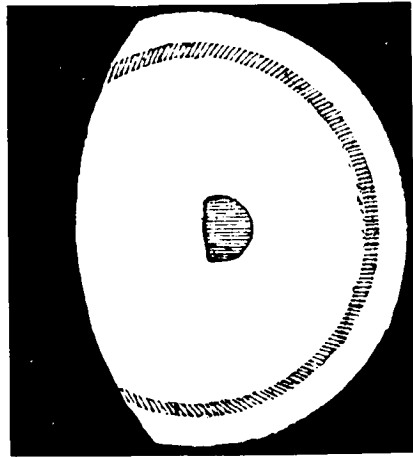
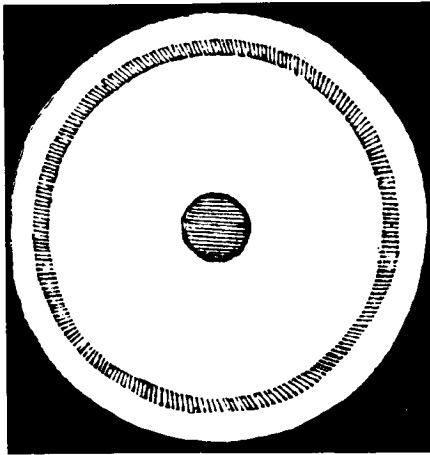
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OF POOR QUALITY



The apparent motion of Mars. When Earth and Mars are close to opposition, Mars, viewed from Earth, appears to reverse its motion relative to fixed stars. Above, the simultaneous positions of Earth and Mars are shown in their orbits around the sun at successive times. The apparent position of Mars as seen from Earth is the point where the line passing through the position of both appears to intersect the background of fixed stars. These points are represented at the right. Below are shown the locations of Mars in the sky before and after the 1965 opposition. Samuel Glasstone, *The Book of Mars*, NASA SP-179 (1968).



evidence of intelligent life on Mars. The French astronomer Camille Flammarion published in 1892 a 608-page compilation of his observations under the provocative title *La Planete Mars, et ses conditions d'habitabilité* (The planet Mars and its conditions of habitability). In America, Percival Lowell, in an 1895 volume titled simply *Mars*, took the leap and postulated that an intelligent race of Martians had unified politically to build irrigation canals to transport their dwindling water supply. Acting cooperatively, the beings on Mars were battling bravely against the progressive desiccation of an aging world. Thus created, the Martians grew and prospered, assisted by that popular genre science fiction. Percy Greg's hero in *Across the Zodiac* made probably the first interplanetary trip to Mars in 1880 in a spaceship equipped with a hydroponic system and walls nearly a meter thick. Other early travelers followed him into the solar system in *A Plunge into Space* (1890) by Robert Cromie, *A Journey to Other Worlds* (1894) by John Jacob Astor, *Auf zwei Planeten* (On two planets, 1897) by

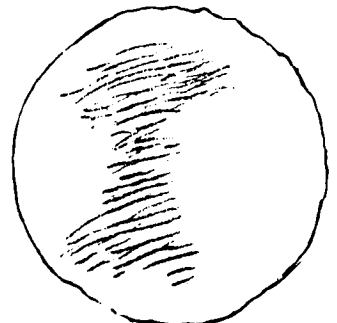
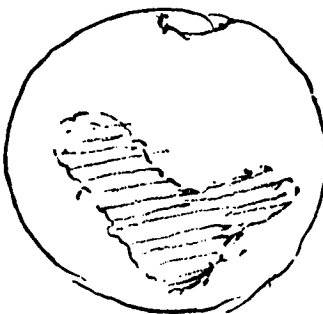
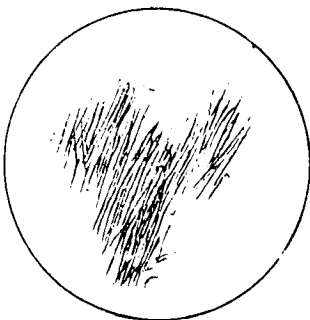


These drawings of Mars by Francesco Fontana were the first done by an astronomer using a telescope. Willy Ley commented, "Unfortunately, Fontana's telescope must have been a very poor instrument, for the Martian features which appear in his drawings—the darkish circle and the dark central spot which he called 'a very black pill'—obviously originated inside his telescope." The drawing at left was made in 1636, the one at right on 24 August 1638. Wernher von Braun and Willy Ley, *The Exploration of Mars* (New York, Viking Press, 1956); Camille Flammarion, *La Planète Mars et ses conditions d'habitabilité* (1892).

Kurd Lasswitz, H. G. Wells's well-known *War of the Worlds* (1898), and astronomer Garrett P. Serviss's *Edison's Conquest of Mars* (1898).¹ In "Intelligence on Mars" (1896), Wells discussed his theories on the origins and evolution of life there, concluding, "No phase of anthropomorphism is more naive than the supposition of men on Mars."² Scientists and novelists alike, however, continued to consider the ability of Mars to support life in some form.

Until the 1950s, investigations of Mars were limited to what scientists could observe through telescopes, but this did not stop their dreaming of a trip through space to visit the planets firsthand. Willy Ley in *The Conquest of Space* determined to awaken public interest in space adventure in the

Christiaan Huyghen's first drawing of Mars (at left below), dated 28 November 1659, shows surface features he observed through his telescope. Of two later sketches, one of the planet as observed on 13 August 1672 at 10:30 a.m. (center below) shows the polar cap. At right below is Mars as observed on 17 May 1683 at 10:30 a.m. Flammarion, *La Planète Mars*.





Nathaniel E. Green observed changes in the southern Martian polar cap during opposition. The first sketch, at top, shows the polar cap on 1 September 1877, and the second, the cap seven days later. Flammarion, La Planète Mars.

postwar era. His book was an updated primer to spaceflight that reflected Germany's wartime developments in rocketry. Ley even took his readers on a voyage to the moon. Considering the planets, he noted, "More has been written about Mars than about any other planet, more than about all the other planets together," because Mars was indeed "something to think about and something to be interested in." Alfred Russel Wallace's devastating critique (1907) of Percival Lowell's theories about life and canals did not alter Ley's belief in life on that planet. "As of 1949: the canals on Mars do exist," Ley said. "What they are will not be decided until astronomy has entered its next era" (meaning manned exploration).³

Ley's long-time friend and fellow proponent of interplanetary travel, Wernher von Braun, presented one of the earliest technical discussions describing how Earthlings might travel to Mars. During the "desert years"

of the late 1940s when he and his fellow specialists from the German rocket program worked for the U.S. Army at Fort Bliss, Texas, and White Sands Proving Ground, New Mexico, testing improved versions of the V-2 missile, von Braun wrote a lengthy essay outlining a manned Mars exploration program. Published first in 1952 as "Das Marsprojekt; Studie einer interplanetarischen Expedition" in a special issue of the journal *Weltraumfahrt*, von Braun's ideas were made available in America the following year.⁴

Believing that nearly anything was technologically possible given adequate resources and enthusiasm, von Braun noted in *The Mars Project* that the mission he proposed would be large and expensive, "but neither the scale nor the expense would seem out of proportion to the capabilities of the expedition or to the results anticipated." Von Braun thought it was feasible to consider reaching Mars using conventional chemical propellants, nitric acid and hydrazine. One of his major fears was that spaceflight would be delayed until more advanced fuels became available, and he was reluctant to wait for cryogenic propellants or nuclear propulsion systems to be developed. He believed that existing technology was sufficient to build the launch vehicles and spacecraft needed for a voyage to Mars in his lifetime.

According to von Braun's early proposal, "a flotilla of ten space vessels manned by not less than 70 men" would be necessary for the expedition. Each ship would be assembled in Earth orbit from materials shuttled there by special ferry craft. This ferrying operation would last eight months and require 950 flights. The flight plan called for an elliptical orbit around the sun. At the point where that ellipse was tangent to the path of Mars, the spacecraft would be attracted to the planet by its gravitational field. Von Braun proposed to attach wings to three of the ships while they were in Mars orbit so they could make glider entries into the thin Martian atmosphere.*

The three landers would be capable of placing a payload of 149 metric tons on the planet, including "rations, vehicles, inflatable rubber housing, combustibles, motor fuels, research equipment, and the like." Since the ships would land in uncharted regions, the first ship would be equipped with skis or runners so that it could land on the smooth surfaces of the frost-covered polar regions. With tractors and trailers equipped with caterpillar tracks, "the crew of the first landing boat would proceed to the Martian equator [5000 kilometers away] and there . . . prepare a suitable strip for the wheeled landing gears of the remaining two boats." After 400 days of reconnaissance, the 50-man landing party would return to the seven vessels orbiting Mars and journey back to Earth.⁵

One item missing from von Braun's Mars voyage was a launch date. While he concluded that such a venture was possible, he did not say when he

*Earth's atmospheric pressure at sea level is 1013 millibars. From calculations made by A. Dollfus of the Paris Observatory in the 1950s, the mean Martian atmospheric pressure was determined to be about 85 millibars. The actual figure as determined by Viking measurements is 75 millibars.

expected it to take place. A launch vehicle specialist, von Braun was more concerned with the development of basic flight capability and techniques that could be adapted subsequently for flights to the moon or the planets. "For any expedition to be successful, it is essential that the first phase of space travel, the development of a reliable ferry vessel which can carry personnel into [Earth orbit], be successfully completed."⁶ Thus, von Braun's flight to Mars would begin with the building of reusable launch vehicles and orbiting space stations. He and his fellow spaceflight promoters discussed such a program at the first annual symposium on space travel held at the Hayden Planetarium in October 1951, in a series of articles in *Collier's* in March 1952, and in *Across the Space Frontier*, a book published in 1952.⁷ Two years later, however, von Braun concluded publicly that a major manned voyage to Mars was a project for the more distant future. As pointed out in an article entitled "Can We Get to Mars?":

The difficulties of a trip to Mars are formidable. The outbound journey, following a huge arc [568 million kilometers], will take eight months—even with rocket ships that travel many thousands of miles per hour. For more than a year, the explorers will have to live on the great red planet, waiting for it to swing into a favorable position for the return trip. Another eight months will pass before the 70 members of the pioneer expedition set foot on earth again.⁸

Von Braun feared that it might "be a century or more" before man was ready to explore Mars.⁹

But five years later von Braun's response to an inquiry from the House Select Committee on Astronautics and Space Exploration indicated that his thinking had changed again. Gathering ideas for possible space activities, the House committee solicited opinions from the aerospace community and published its findings in *The Next Ten Years in Space, 1959-1969*. Von Braun considered "manned flight around the Moon . . . possible within the next 8 to 10 years, and a 2-way flight to the Moon, including landing, a few years thereafter." He believed it "unlikely that either Soviet or American technology will be far enough advanced in the next 10 years to permit man's reaching the planets, although instrumented probes to the nearer planets (Mars or Venus) are a certainty."¹⁰

A number of important technological and political events were instrumental in changing the rocket expert's thinking about American goals for space. Rocket technology had advanced considerably, as evidenced in the development of both American and Soviet intercontinental ballistic missiles. Soviet progress was forcefully impressed on the American consciousness by the orbital flights of *Sputnik 1* and *Sputnik 2* in the fall of 1957. Even as the Soviet Union stole a march on the Americans, von Braun and many others were busy defining and planning appropriate space projects for the United States.

Von Braun and his colleagues at the Army Ballistic Missile Agency in Huntsville, Alabama, had lost out to the Navy in September 1955 in the competition to launch an Earth satellite and had failed in their bid against the Air Force in November 1956 to be responsible for the development of intermediate range ballistic missiles. These setbacks prompted the managers of the agency to seek new justifications for the large launch vehicles they wanted to develop. Creating boosters that could be used for space exploration was the obvious answer. This goal was consistent with von Braun's long-time wish to see spaceflight a reality. In April 1957, Army Ballistic Missile Agency planners began to review United States missile programs in the light of known Soviet spaceflight capabilities and proposed a development strategy. The first edition of their sales pitch, "A National Integrated Missile and Space Vehicle Development Program," was issued on 10 December 1957. It reflected the post-Sputnik crisis:

The need for an integrated missile and space program within the United States is accentuated by the recent Soviet satellite accomplishments and the resulting psychological intimidation of the West. . . . we are bordering on the era of space travel. . . . A review and revision of our scientific and military efforts planned for the next ten years will insure that provisions for space exploration and warfare are incorporated into the overall development program.¹¹

The National Advisory Committee for Aeronautics (NACA) was also moving quickly in the wake of Sputnik. In an effort to define its role in the dawning space age, NACA's Committee on Aerodynamics resolved in November 1957 that the agency would embark upon "an aggressive program . . . for increased NACA participation in upper atmosphere space flight research." Subsequently, a Special Committee on Space Research under the direction of H. Guyford Stever, a physicist and dean at the Massachusetts Institute of Technology, was established "to survey the whole problem of space technology from the point of view of needed research and development and advise the National Advisory Committee for Aeronautics with respect to actions which the NACA should take."¹²

On 18 July 1958, the Working Group on Vehicular Program* of the Stever committee presented to NACA a revised edition of the Huntsville report on missile and space vehicle development. That document proposed an expanded list of possible goals for the American space program based on a phased approach to the development of successively more powerful launch vehicles. Those vehicles were divided into five generations:

First Generation—Based on SRBM boosters [short range]

Second Generation—Based on IRBM boosters [intermediate range]

*Members of the Working Group on Vehicular Program were W. von Braun, Chairman; S. K. Hoffman; N. C. Appold; A. Hyatt; L. N. Ridenour; A. Silverstein; K. A. Ehrlicke; M. W. Hunter; C. C. Ross; H. J. Stewart; G. S. Trimble, Jr.; and W. H. Woodward, Secretary.

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Third Generation—Based on ICBM boosters [intercontinental]

Fourth Generation—Based on 1.5 million-pound-thrust [6.8-million-newton] boosters

Fifth Generation—Based on 3 to 5 million-pound-thrust [13- to 22-newton] boosters.¹³

The planets, of course, were desirable targets for space exploration, but the realities of the emerging space race with the Soviet Union made the moon a more attractive goal politically for the late 1960s. In 1958, Stever's group did not think it would be possible to send a 2250-kilogram probe to Mars for at least a decade; it would be that long before the fourth-generation launch vehicle necessary for such a payload was ready. A manned mission to Mars or Venus was not projected to occur before 1977.

Implicit in the working group's timetable (table 1) was a gradual approach to space exploration. The proposed program was still ambitious, but it was increasingly apparent that scientific investigations in space would have to await new launch vehicles tailored to specific projects. It was technologically feasible to go to the moon and the planets, but the translation of feasibility into reality would require a national program and a new government agency to manage such activities.¹⁴

OBJECTIVES IN SPACE

When the National Aeronautics and Space Administration (NASA), the new civilian space agency that superseded the National Advisory Committee for Aeronautics, officially opened its doors for business on 1 October 1958, a considerable body of knowledge could be grouped under the rubric *space science*, and many opinions were expressed about which aspects of space science should be given precedence for government monies. Scientists had been studying outer space for centuries, but observations made above Earth's filtering, obscuring atmosphere were a new step. Among the many disciplines that would benefit from using rockets in space were atmospheric research and meteorology, solar physics, cosmic ray study, astronomy, and eventually lunar and planetary investigation.

During most of the first half of the 20th century, professors had actively discouraged students from embarking on careers that would focus on the astronomy of the solar system, because most of the important information obtainable with existing equipment had been collected, digested, and published. Astronomy was described as "moribund"; it had "grown old from a lack of new data." Observations from space promised to change all that.

Before Sputnik, there were fewer than 1000 astronomers in the United States.¹⁵ Budgets were tight, and research facilities were few. Until 1950, only 13 optical observatories with telescopes at least 914 millimeters in diameter had been built in the United States and, of these, 6 had been

Table 1
Milestones of the Recommended U.S. Spaceflight Program,
July 1958

Item	Date	Event	Vehicle Generation
1	Jan. 1958	First 20-lb [9-kg] satellite (ABMA/JPL)	I
2	Aug. 1958	First 30-lb [14-kg] lunar probe (Douglas/RW/Aerojet)	II
3	Nov. 1958	First recoverable 300-lb [140-kg] satellite (Douglas/Bell/Lockheed)	II
4	May 1959	First 1500-lb [680-kg] satellite	II
5	Jun. 1959	First powered flight with X-15	
6	Jul. 1959	First recoverable 2100-lb [950-kg] satellite	II and/or III
7	Nov. 1959	First 400-lb [180-kg] lunar probe	II and/or III
8	Dec. 1959	First 100-lb [45-kg] lunar soft landing	II and/or III
9	Jan. 1960	First 300-lb [135-kg] lunar satellite	II and/or III
10	Jul. 1960	First wingless manned orbital return flight	II and/or III
11	Dec. 1960	First 10 000-lb [4500-kg] orbital capability	III
12	Feb. 1961	First 2800/600-lb [1300/270] lunar hard or soft landing	III
13	Apr. 1961	First 2500-lb [1100-kg] planetary or solar probe	III
14	Sept. 1961	First flight with 1.5-million-lb [6.7-million-newton] thrust	IV
15	Aug. 1962	First winged orbital return flight	III
16	Nov. 1962	Four-man experimental space station	III
17	Jan. 1963	First 30 000-lb [13 800-kg] orbital capability	IV
18	Feb. 1963	First 3500-lb [1590-kg] unmanned lunar circumnavigation and return	IV
19	Apr. 1963	First 5500-lb [2500-kg] soft lunar landing	IV
20	Jul. 1964	First 3500-lb [1590-kg] manned lunar circumnavigation and return	IV
21	Sept. 1964	Establishment of a 20-man space station	IV
22	Jul. 1965	Final assembly of first 1000-ton [900-metric-ton] lunar landing vehicle (emergency manned lunar landing capability)	IV
23	Aug. 1966	Final assembly of second 1000-ton [900-metric-ton] landing vehicle and first expedition to moon	IV
24	Jan. 1967	First 5000-lb [2300-kg] Martian probe	IV
25	May 1967	First 5000-lb [2300-kg] Venus probe	IV
26	Sept. 1967	Completion of 50-man, 500-ton [450-metric-ton] permanent space station	IV
27	1972	Large scientific moon expedition	V
28	1973/1974	Establishment of permanent moon base	V
29	1977	First manned expedition to a planet	V
30	1980	Second manned expedition to a planet	V

SOURCE: NACA, Special Committee on Space Technology, Working Group on Vehicular Program, "A National Integrated Missile and Space Vehicle Development Program," 18 July 1958, p. 6.

constructed before 1920 and 3 before 1900; in the 1950s another 6 were erected. But a boom occurred in the 1960s, when 28 new optical facilities were opened. Before the mid-1950s, only a handful of astronomers had more than very limited access to the large telescopes. One observer noted, "Not long ago, the study of the universe was the prerogative of a small group of men largely isolated from the rest of science, who were supported for the most part by private funds and were comfortable with projects that spanned decades."¹⁶ Furthermore, astronomy had always been purely observational science with limited instrumentation. "Astronomers did not design experiments as physicists might; nor did they manipulate samples as chemists do." Faced with three major constraints—tight budget, lack of facilities, and the ever-present atmosphere through which they were forced to observe—astronomers saw few reasons for abandoning their 19th century ways. With World War II, change came to the field.

The war spawned radio astronomy and smaller, more sensitive instruments. Astronomers and their colleagues in other disciplines with whom they began to collaborate could detect, measure, and analyze wavelengths in the electromagnetic spectrum outside the visible range to which they had been limited. While radio astronomers probed the depths of the universe, finding among other phenomena radio galaxies more than a million times brighter than our own, a group of astronomers with highly sensitive equipment began to measure radiations and emissions from planetary atmospheres more accurately. In addition, the rocket, which could boost satellites and probes into space, promised to be another technological element that would open the way to a renaissance in astronomical research.¹⁷

In astronomical circles, the impact of the high-altitude rocket shots of the late 1940s was significant. Reacting to the first far ultraviolet spectra taken by V-2 rocket-borne instruments in October 1946, Henry Norris Russell, one of the most eminent astronomers of that generation, wrote, "My first look at one [rocket spectrum] gives me a sense that I [am] seeing something that no astronomer could expect to see unless he was good and went to heaven!"¹⁸ Before the late 1950s, less than two percent of the astronomical community had been working in planetary studies. But experiments on board rockets and discussion of travel toward the moon, Mars, and Venus revived interest in the planets. Two "almost moribund fields—celestial mechanics and geodesy (the study of the size and shape of the earth)—were among the first to benefit from space explorations."¹⁹

American scientists were able to participate in this rocket-borne renaissance during the International Geophysical Year, 1 July 1957 through 31 December 1958, first suggested in 1950 by geophysicist Lloyd V. Berkner, head of the Brookhaven National Laboratory and president of the International Council of Scientific Unions. Originally Berkner saw this as a re-creation of the International Polar Years (1882, 1932), during which scientists from many nations had studied cooperatively a common topic—

the nature of the polar regions. The study proposed by Berkner would coincide with a period of maximum solar-spot activity, during which new instruments and rockets would be put to work to investigate widely many aspects of Earth science. Berkner's idea grew rapidly.

The National Academy of Sciences, a congressionally chartered but private advisory body to the federal government that attracted many of the nation's leading scientists, established the U.S. National Committee for the International Geophysical Year through its National Research Council. S. Fred Singer of the Applied Physics Laboratory, a member of the Council, had a strong interest in cosmic ray and magnetic field research, which led to his belief in using satellites as geophysical research platforms.²⁰ Singer proposed MOUSE—a Minimum Orbital Unmanned Satellite of the Earth—at the Fourth International Congress on Astronautics in Zurich in August 1953. A year later, at the urging of both Berkner and Singer, the International Scientific Radio Union adopted a resolution underscoring the value of instrumented satellites for observing Earth and the sun. Later that same month, September 1954, the International Union of Geodesy and Geophysics adopted an even more affirmative resolution. With momentum already established, the satellite proposal was presented to a Comité spéciale de l'année géophysique internationale (CSAGI) planning meeting in Rome. After some maneuvering, the committee on 4 October 1954 adopted the following resolution:

In view of the great importance of observations during extended periods of time of extra-terrestrial radiations and geophysical phenomena in the upper atmosphere, and in view of the advanced state of present rocket techniques, CSAGI recommends that thought be given to the launching of small satellite vehicles, to their scientific instrumentation, and to the new problems associated with satellite experiments, such as power supply, telemetering, and orientation of the vehicle.²¹

Two nations had the wealth and technology to respond to this challenge, the United States and the Soviet Union. During the next three years, the world scientific community watched the first leg of the space race, which culminated in the orbiting of *Sputnik 1* by the Soviets on 4 October 1957.²²

After *Sputnik*'s first success, it became increasingly clear that such a large-scale, cooperative scientific enterprise as the International Geophysical Year should not be allowed to die after only 18 months. Scientists from 67 nations had looked into a wide variety of problems related to Earth and the sun. To maintain the momentum behind those studies, Hugh Odishaw, executive director of the U.S. National International Geophysical Year Committee, and Detlev Bronk, president of the National Academy of Sciences, organized the Space Science Board in 1958. With many of the same members and staff that had worked on the international committee, the board was established to "stimulate and aid research, to evaluate proposed research, to recommend relative priorities for the use of space vehicles for

scientific purposes, to give scientific aid to the proposed National Aeronautics and Space Agency, the National Science Foundation and the Department of Defense, and to represent the Academy in international cooperation in space research."²³ The Space Science Board had already held two meetings when NASA opened shop in the fall of 1958.

One of NASA Administrator T. Keith Glennan's first tasks was to pull together the many space-science-related activities that were scattered throughout the government. Launch vehicle development was managed by the Advanced Research Projects Agency of the Department of Defense. The Jet Propulsion Laboratory in Pasadena, California, and the Army Ballistic Missile Agency worked on the Explorer satellite project. Vanguard, another satellite venture, was directed by the Naval Research Laboratory. Many organizations, military and private, were already absorbed in the business of space exploitation. Besides carrying out existing projects and attending to the details of organization, NASA expanded its headquarters staff, acquired new field facilities, selected contractors, and sorted out its relationships with the Department of Defense and other government agencies. One participant in organizing the new agency's space science program recalled, "If anything stood out at the time, it was that everything seemed to be happening at once."²⁴ Within this context, scientists' proposals to send probes to Venus and Mars appeared to be very ambitious and certainly premature.

In April 1958 Abe Silverstein, a NACA veteran and associate director of the Lewis Propulsion Laboratory in Cleveland, went to Washington to participate in pre-NASA planning sessions and stayed on in a key position, director of the Office of Space Flight Development. Homer E. Newell, Jr., from the Naval Research Laboratory where he had been in upper-atmosphere research as superintendent of the Atmosphere and Astrophysics Division and science program coordinator for Project Vanguard, joined NASA on 18 October 1958, becoming Silverstein's assistant director for space sciences. Robert Jastrow, a Naval Research Lab physicist, and Gerhard Schilling, a National Academy of Sciences staff member, were assigned to Newell's office. Jastrow immediately became immersed in plans for the future course of the space science program, and Schilling began studying ideas for lunar and planetary exploration.

America's space program was essentially two-sided; man-in-space was one dimension, space science the other. In the late 1950s, NACA's sounding rocket program and the Navy's Vanguard Project were the country's prime science activities, and those ventures were primarily "sky science," an examination of Earth-oriented phenomena from space. The only deep-space project in the works was the Air Force's yet-to-be-successful Pioneer probe. Since Administrator Glennan wanted to keep the growth of NASA's programs under control, Newell and his space science colleagues sought a gradual, rational expansion of existing science projects. Investigating the moon with unmanned spacecraft would obviously be more complicated

and costly than near-Earth missions, so there was hesitancy to pursue a serious commitment to lunar science. Planetary studies seemed even further out of reach. According to Newell, Glennan was reluctant even to discuss planetary missions except in the framework of future planning.²⁵

But the future came quickly. "Before Glennan left office NASA was engaged in space science projects that took in not only the earth and its environs, but also the moon and the planets, the sun, and even the distant stars," Newell remembered. Glennan, with some pride, turned over to his successor, James E. Webb, in 1961 "a well rounded program well under way."²⁶ Pressures for a broader space science program had come from several quarters—organized scientists (the Space Science Board), individual scientists (Harold C. Urey), and within the NASA fold (the Jet Propulsion Laboratory).

The Space Science Board's participation in planetary exploration discussions began in the summer of 1958 when Hugh Dryden, NACA's director, sought advice. The Air Force and the Jet Propulsion Laboratory had been promoting independently a planetary probe to Venus for 1959. Venus and Earth would be in their most favorable positions for such a mission, and it would be another 200 years before this particularly ideal opportunity came again. At the second meeting of the Space Science Board, 19 July 1958, Dryden asked the members to consider the wisdom of such an ambitious project. He feared that the mission as proposed was impractical because of limited time and a shortage of adequate tracking equipment for communications. Implicit in Dryden's hesitancy was the intent of NACA and the Eisenhower Administration to keep expansion of the space program in check.²⁷

In response to Dryden's request for advice, Board Chairman Berkner established an ad hoc Committee on Interplanetary Probes and Space Stations. This group—chaired by Donald F. Hornig, professor of chemistry at Princeton University—considered two specific proposals for space projects, the first from Space Technology Laboratories of the Ramo-Wooldridge Corporation. Engineers proposed using a variant of the Air Force Thor intermediate range ballistic missile with an Able upper stage* (this two-stage launch vehicle had flown successfully in July 1958). Space Technology Lab's representatives advanced a concept for a 23-kilogram Venus probe plus the necessary tracking and communications equipment. The second suggestion came from Krafft Ehricke of the Astronautics Division of General Dynamics†, who proposed a considerably more complex mission. He wanted to use a yet-to-be-developed high-energy second stage with the Atlas intercontinental ballistic missile, which would be capable of delivering a 450-kilogram payload to the vicinity of Mars.²⁸

*The Thor IRBM was developed by the Douglas Aircraft Company under contract (signed 27 December 1955) to the Defense Department, and the first strategic missile squadron was equipped with this IRBM on 1 January 1958. Douglas and STL collaborated to produce the Able second stage, based on components of the Vanguard launch vehicle.

†The Astronautics Division grew out of the Consolidated Vultee Aircraft Corporation (Convair).

Hornig's committee concluded that both proposals were technically feasible and furthermore believed that the time had come for action. The committee recommended unanimously to the Space Science Board that it was "urgently necessary to begin the exploration of space within the solar system with any means at our disposal if a continuing USA program of space science and exploration is to proceed at an optimum rate." Essential areas for study included:

- 1) The accurate determination of the astronomical unit [the distance between Earth and the sun].
- 2) Studies of the radiation environment
 - a) High energy particles
 - b) Low energy particles
 - c) Gamma-rays
 - d) X-rays
 - e) Ultraviolet radiation
 - f) Low frequency radiation
- 3) Measurements of electric and magnetic fields.
- 4) Study of radio propagation characteristics of outer space.
- 5) Study of the meteorite environment.
- 6) Study of the density, composition and physical properties of matter in space.

Some of these studies could be conducted with telescopes and spectrographs carried aloft by balloons, but most required close approaches or orbiting probes. The committee speculated that probes could possibly provide evidence of the existence of extraterrestrial life. Once an Atlas missile and a high-performance second stage were available, photographic or other viewing devices should be focused on the planets. The Hornig panel believed that "the most exciting experiments on both Venus and Mars seem to involve viewing devices, at least until it becomes possible to descend into their atmospheres." Since communications and tracking systems for such flights would require considerable development, the committee urged an early start on a planetary program.²⁹

Hugh Odishaw—speaking for the Space Science Board in a special report to Glennan, Director Alan T. Waterman of the National Science Foundation, and Director Roy W. Johnson of the Advanced Research Projects Agency—underscored the committee's message. Since Thor-Able would be capable of transporting probes to the near planets, the board recommended "that a program aimed at launching a Mars probe during the 1961 conjunction [the time in the orbits of Earth and Mars when Mars disappears from Earth's view behind the sun] be immediately initiated." Odishaw also urged an early start on a high-performance second stage for Atlas "in order to provide a payload sufficient to carry out a more scientifically satisfying set of experiments on the planets Venus and Mars."³⁰ Instead of "resisting pressures" for early planetary exploration as requested

by Hugh Dryden six months earlier, the Space Science Board strongly espoused such exploration in December 1958.

Individual scientists were also urging a broader space science program, and one of the most influential spokesmen for lunar and planetary studies was Harold Urey. Winner of the 1934 Nobel Prize in chemistry, Urey had a long, distinguished career behind him when in the early 1950s he turned his attentions to the origin of the solar system. In 1952, Yale University published his seminal book, *The Planets: Their Origin and Development*. In November 1958, Robert Jastrow traveled to the University of California in La Jolla to talk with this elder statesman of the space science community about the directions that NASA's space science program might take. Jastrow was converted to Urey's belief that the moon was a key element in unlocking the secrets of the universe, particularly for providing clues to the origin of the planets. Fascinated, Jastrow invited him to NASA Headquarters, where the scientist also convinced Homer Newell that a series of lunar projects should be undertaken. Newell noted years later that "the Ranger Project [a series of lunar probes] was in effect born on [that] day." As Jastrow set to work organizing an ad hoc Working Group on Lunar Exploration,* lunar enthusiasts had their foot in the door, and planetary advocates were not far behind.³¹

Within NASA, a major impetus for a larger space science program came from the staff of the Jet Propulsion Laboratory (JPL). Established in the summer of 1940 by the California Institute of Technology with contract funds provided by the U.S. Army Air Corps, JPL had over the years developed expertise in the fields of rocketry, instrumentation, telemetry, and tracking. After Sputnik, JPL joined the Army Ballistic Missile Agency in a successful partnership that launched *Explorer 1*, the first American satellite, on 31 January 1958 as part of the U.S. contribution to the International Geophysical Year. William H. Pickering, JPL director from 1954 to 1976 and a strong supporter of the American space program, wanted the United States, in the wake of Sputnik, to sponsor a space project that would outdistance the Soviet Union. His first proposal, "Red Socks," was for a seven-kilogram lunar payload. A major space first, according to Pickering, would be better for U.S. prestige than being the second nation to launch a satellite. While Red Socks never came about, the proposal was indicative of JPL's interest in projects other than Earth satellites.

Pickering had other aspirations as well. In a July 1958 letter to James R. Killian, presidential adviser for science and technology, the JPL director called for a significant role for his laboratory in the new space agency. Pickering urged that NASA "accept the concept of JPL as the national space laboratory. If this is not done, then NASA will flounder around for so long that there is a good chance that the entire program will be carried by the military." Instead of the space agency's being relegated to a position of

*Chaired by Jastrow, the working group included H. C. Urey, J. Arnold, F. Press, and H. Brown.

supporting research and developing scientific payloads, Pickering believed it could with JPL's guidance establish a realistic space program and maintain the civilian character that Eisenhower desired. "As you well know, one of the problems in the present space program is the multiplicity of committees and groups which are planning programs," Pickering reminded Kilian. He believed that it was "essential for some competent group to be given a clear cut responsibility and told to draw up a realistic long term program which they can successfully complete on schedule." Only "if JPL does become the national space laboratory . . . does a complete experienced laboratory knowledgeable in all phases of the problem become the key asset of NASA."³²

There was, however, a division of opinion at the Jet Propulsion Laboratory. Many of Pickering's colleagues believed that planetary investigation deserved more immediate attention than lunar goals. Whereas there were monthly opportunities for launching rockets to the moon, there were fewer such windows for trips to the planets. In 1958, the next launch opportunity for Mars would be October 1960 and the next practical chance for a Venus shot, December 1960–January 1961. Given these considerations, the JPL team after *Explorer 1*'s success began to look into possible planetary probe missions. One early example, undertaken at Pickering's request, was a design study for a 158-kilogram spacecraft that could be sent to Mars by a variant of the Army Ballistic Missile Agency's Jupiter intermediate range ballistic missile with two liquid-fueled upper stages. It quickly became apparent to the entire space science community that a more comprehensive study of possible planetary missions was needed.³³

The space agency did want JPL to become a NASA field facility and began negotiations with the California Institute of Technology. But even before the contract between Cal Tech and NASA was signed, JPL staff members were discussing a long-range space program for the agency. A Silverstein memo suggesting that it begin thinking about future space projects had prompted the lab's actions. In Pasadena, the suggestion had been interpreted as a mandate—"a commission for JPL to plan a long range space program for NASA."³⁴

John E. Froehlich, satellite project director at the lab, noted in the minutes of a 28 October 1958 meeting at JPL that he and his colleagues expected their study to "result in NASA's *major space program* but would not incorporate the entire national program." JPL, working jointly with the Army Ballistic Missile Agency, anticipated that this would be the working plan for the next five years, not just another proposal. The California team determined that NASA should concentrate on "putting up 'large payloads' for interplanetary research," not Earth-orbiting satellites.³⁵ Froehlich also recorded that the program must be "a compromise between a very conservative approach [and] a very wild, extravagant plan."³⁶

A week later, JPL submitted to Silverstein a proposal to prepare a "Space Flight Program Study," the exact nature of which had been defined

by Froehlich, Homer J. Stewart of Cal Tech, and Silverstein at NASA Headquarters. Once Glennan and Pickering concurred on JPL's interest in lunar and planetary studies, NASA agreed to the JPL study outline. On 18 November, the NASA Program Study Committee, composed of seven working group chairmen, began their task in earnest.³⁷ By executive order, President Eisenhower had the functions and facilities of JPL transferred from the Department of the Army to NASA on 3 December 1958.

Implicit in the Program Study Committee's work was a desire to influence launch vehicle and spacecraft development. At the end of the first five years, the necessary space vehicles had to be available for further work in space. "If this is not done, we will be entering the second five-year period doing what we are doing now—trying to fit available, but not entirely adequate, equipment to our program," Froehlich predicted. As a consequence, the study group and JPL's senior staff decided that the laboratory should concentrate its major energies on planetary goals while supervising others in the operation of lunar missions. As indicated in table 2, in which JPL launches are marked with asterisks, JPL planners considered two to three launches a year to be a comfortable maximum and Froehlich considered even that ambitious.

At a meeting with Homer Newell, John F. Clark, and Raymond Zavasky from headquarters, Director Pickering raised the issue of dividing planetary and lunar studies into two distinct fields. Newell saw two possibilities: JPL could "plan on doing the lunar work first and then later moving into deep space probes or go into deep space probes now with NASA finding some other agency or agencies to take on the lunar projects." Clark argued against any separation of lunar and planetary missions, stressing the similarities in guidance and communications requirements. Proposed near-misses (or *flybys* as they came to be called) of the moon and the planets would have analogous guidance requirements and should "accordingly be logical parts of a common program, while deep space probes would not necessarily have strict guidance requirements, and could themselves be a separate collection of projects." Although Pickering agreed to discuss these points while working on the laboratory's five-year plan, differences of opinion between JPL and NASA Headquarters were obvious.³⁸

A 12 January 1959 meeting in Pasadena illustrated this growing divergence. Invited to discuss the progress of the evolving JPL-NASA study, the visitors from Washington included Abe Silverstein, Milton W. Rosen, Homer Newell, and Homer Stewart, who had been recruited from Cal Tech to Headquarters to direct the Office of Program Planning and Evaluation. After a few introductory remarks, Albert R. Hibbs of JPL described the missions portion of the study. The latest proposed lineup of flights (table 3) included a 1960 circumlunar mission and an escape toward Mars for a flyby of that planet. In 1961, JPL wanted to attempt a flight toward Venus, an escape out of the ecliptic (the plane about the sun in which all the planets

ON MARS

Table 2
Proposed Lunar and Deep Space Program, 1958

Date	Mission	Payload Weight (kg) Required	Payload Weight (kg) Available	Launch Vehicle
<i>1960</i>				
* Aug.	Circumlunar	159	230	Titan
* Oct.	Two Mars flybys	122	135	Titan
<i>1961</i>				
* Jan.	Two Venus flybys	122	135	Titan
May	Circumlunar	159	230	Titan
July	Lunar rough landing	233	230	Titan
* Sept.	Escape from Earth gravity	120	135	Titan
Nov.	Lunar satellite	233	230	Titan
<i>1962</i>				
Feb.	Lunar rough landing	233	230	Titan
Apr.	Lunar satellite	233	230	Titan
* Aug.	Two Venus entries	980	1360	Juno V
* Nov.	Two Venus flybys	161	135	Titan
<i>1963</i>				
Mar.	Lunar soft landing	1810	2300	Juno V
* June	Lunar soft landing	1810	2300	Juno V
	Circumlunar with animal			
Aug.	Lunar soft landing	1810	2300	Juno V
* Oct.	Two Jupiter and two Mercury controlled flybys	910	1360	Juno V

*JPL launches.

SOURCE: J. D. McKenney, "Minutes of the Meeting of the NASA Program Study Committee . . .," 15 Dec. 1958.

revolve), and a launch toward the moon that would produce a near-miss. Launches in 1962 would include orbiting lunar and Venus satellites, or perhaps a Venus entry probe and a Mars flyby. Lunar missions would occupy the following year with a circumlunar-return flight and a soft landing. Tentative goals for 1964 and 1965 were landings on Venus, another circumlunar-return, and a journey to Mars (1965). All these flights were by definition complete scientific exercises aimed at studying interplanetary space.

Pickering believed JPL's ambitious program was a sound one and would capture the interest and support of the scientific community. Since the recommended number of missions was limited to three to five a year, the director wanted each payload to be as advanced as possible. Toward that end, he wished to increase the laboratory's staff by 25 per cent. He also

Table 3
JPL-Proposed Lunar and Planetary Missions, 12 January 1959

Firm	Payload Number	Date	Mission	Scientific Package Weight (kg)	Gross Payload Required (kg)	Gross Payload Available Weight (kg)	Nature of Measurements
	1	1 July 1960	Circumlunar	17	159	230	Fields, atmosphere, photos of surface.
	2	10 Oct. 1960	Escape toward Mars	14	161	135	Interplanetary conditions, photos of Mars.
	3	13 Oct. 1960	Escape toward Mars	14	161	135	Interplanetary conditions, photos of Mars.
	4	22 Jan. 1961	Escape toward Venus	14	161	135	Interplanetary conditions, photos of Venus.
	5	25 Jan. 1961	Escape toward Venus	14	161	135	Interplanetary conditions, photos of Venus.
	6	Sept. 1961	Escape out of ecliptic	9	120	135	Interplanetary conditions, measure A. U.
	7	Apr. 1962	Lunar satellite	23	233	230	Gamma-rays, high-resolution mapping.
	8	30 Aug. 1962	Venus satellite	1180 ^a	1770	1360	Atmosphere, fields, surface nature.
	9	2 Sept. 1962	Venus satellite	1180 ^a	1770	1360	Atmosphere, fields, surface nature.
	10	30 Nov. 1962	Mars flyby	14	190	135	Atmosphere, photos, magnetic, and cosmic ray.
	11	3 Dec. 1962	Mars flyby	14	190	135	Atmosphere, photos, magnetic, and cosmic ray.
	12	June 1963	Circumlunar & return	1570 ^b	2300	2300	Development test for Venus landing.
	13	1963	Lunar soft landing	23	2300	2300	Surface analysis, seismography.
	14	1963	Lunar soft landing	23	2300	2300	Surface analysis, seismography.
Tentative	15	28 Mar. 1964	Venus landing	1100 ^b	2050	?	Weather, surface exploration.
	16	1 Apr. 1964	Venus landing	1100 ^b	2050	?	Weather, surface exploration.
	17	Aug. 1964	Circumlunar and return	1570 ^b	2300	2300	Manned flight.
	18	20 Jan. 1965	Circum-Mars and return	2300 ^b	4500	?	Manned flight.

^aIncluding 1100-kg retrorocket.

^bIncluding aerodynamic heating protection and aerodynamic controls or brakes, or both.

SOURCE: J. D. McKenney, "Minutes of the Meeting of the NASA Program Study Committee . . ." 16 Jan. 1959.

contended that JPL should do nothing during 1959 that did not contribute directly to the development of deep space probes. In particular, it would be impossible to take on the direct technical supervision of NASA contracts in fields related to JPL projects. However, the JPL staff did expect to participate in NASA Headquarters committee activities and the like.

Abe Silverstein had in mind a different set of priorities when he looked at the rugged job NASA had ahead of it—managing an affordable but worthwhile national space program. He wanted JPL to be a part of NASA, to participate from the inside. He accepted the need for long-range planning, but NASA had to concentrate on the short run, on the creation of missions that would build congressional confidence so that legislators would support more ambitious projects for the years ahead. As a result, Silverstein was concerned with a different timetable, a launch and planning schedule for 1959. Long-range planning at this juncture could serve only as a guide. NASA did need to know where it was going, but Silverstein feared that JPL's five-year plan might take longer than five years to consummate and lock the agency on an unchangeable course.³⁹

Obviously, NASA and JPL were looking at the future of spaceflight with different perspectives. NASA was still concerned with establishing its day-to-day activities and its short-term future. Working in Washington, Silverstein and his associates felt the often conflicting pressures from the White House, Capitol Hill, and the news media for a national space program that would at once surpass the Soviet Union's and be scientifically respectable without unbalancing the budget. Those pressures did not seem as important on the West Coast.⁴⁰

JPL's plans were not only ambitious, they also reflected a difference in approach from that taken by Newell's space science office. Not unlike the von Braun team in Huntsville, Pickering's group thought of space probes in terms of their goals—the moon, Venus, Mars—while Newell's staff reflected the scientific community's concern with such topics as atmospheres; ionospheres; gravitational, magnetic, and electric fields; energetic particles; astronomy; biology; and environment. Likewise, Newell's suggestions to JPL for potential experiments for future missions reflected the disciplinary approach to space science taken during the International Geophysical Year.⁴¹ JPL's goal-oriented study represented an engineer's way of looking at things. Neither view was better, both were necessary, but each had to accommodate the other, and that learning process would take years.

NASA Long-Range Plans for Space Exploration

Not long after the meeting at JPL, NASA, spurred by pressure from Congress and the Space Science Board, was forced to do some long-range thinking of its own about the planetary exploration program. Two weeks into the new year of 1959 found Homer Stewart's Office of Program Planning and Evaluation working on a number of long-term questions. Besides looking into plans for the next year or two, Administrator Glennan wanted possible guidelines for the next 5 to 10 years.⁴²

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WHY MARS?

*Table 4
Influences on the Ten-Year Plan, 1960*

	JPL-Proposed Schedule	Goett Committee-Proposed Objectives ^b
Aug. 1960	Lunar miss (Vega)	1. Man in space soonest—Project Mercury.
Oct. 1960	Mars flyby (Vega)	2. Ballistic probes.
Jan. 1961	Venus flyby	3. Environmental satellite.
June 1961	Lunar rough landing (Vega)	4. Maneuverable manned satellite.
Sept. 1961	Lunar orbiter (Vega)	5. Manned spaceflight laboratory.
Aug. 1962	Venus orbiter (Vega)	6. Lunar reconnaissance satellite.
Aug. 1962	Venus entry (Vega)	7. Lunar landing.
Nov. 1962	Mars orbiter (Saturn 1)	8. Mars-Venus reconnaissance.
Nov. 1962	Mars entry (Vega)	9. Mars-Venus landing.
Feb. 1963	Lunar orbit and return (Saturn 1)	
June 1963	Lunar soft landing (Saturn 1)	
Mar. 1964	Venus soft landing (Saturn 1)	

Ten-Year Plan ^c
1960: First launching of meteorological satellite. First launching of passive-reflector communications satellite. First launching of Scout vehicle. First launching of Thor-Delta vehicle. First launching of Atlas-Agena B (DoD). First suborbital flight by astronaut.
1961: First launching of lunar impact vehicle. First launching of Atlas-Centaur vehicle. Attainment of orbital manned spaceflight, Project Mercury.
1962: First launching of probe to vicinity of Venus or Mars.
1963: First launching of 2-stage Saturn.
1963-1964: First launching of unmanned vehicle for controlled landing on moon. First launching of orbiting astronomical and radio astronomical laboratory.
1964: First launching of unmanned circumlunar vehicle and return to Earth. First reconnaissance of Mars or Venus, or both, by unmanned vehicle.
1965-1967: First launching in program leading to manned circumlunar flight and to permanent near-Earth space station.
Beyond 1970: Manned lunar landing and return.

^aJPL, *Exploration of the Moon, the Planets, and Interplanetary Space*, ed. Albert R. Hibbs, JPL report 30-1 (Pasadena, 1959), pp. 95-114.

^bNASA Hq., "Minutes of Meeting of Research Steering Committee on Manned Space Flight," 25-26 May 1959, p. 8.

^cNASA Hq., Off. of Program Planning and Evaluation, "The Ten Year Plan of the National Aeronautics and Space Administration," 18 Dec. 1959, p. 10.

Stewart, one of the persons responsible for getting JPL's 5-year study under way, was charged with developing a 10-year master plan (1960-1970) for the agency. His recommendations, completed in December 1959, were influenced by two groups that were doing advanced planning at the time—the JPL NASA Study Program Committee and the Research Steering Committee on Manned Space Flight, chaired by Harry J. Goett of NASA's Ames Research Center. Stewart, borrowing from both these committees, secured balance among three important components of the space program—satellites, probes, and man-in-space.⁴³ The 10-year plan formalized the agency's goals for the 1960s (table 4).

The NASA Ten-Year Plan, presented by Associate Administrator Richard E. Horner, the number three official at NASA, to the House Committee on Science and Astronautics on 28 January 1960, established planetary missions as one of the firm goals of the space agency. The 1962 date for a probe to Venus or Mars and the 1964 photo-reconnaissance mission to Mars or Venus gave the JPL team something toward which to work. Many events would conspire to delay those flights, but exploration of the planets was securely part of the American space program.