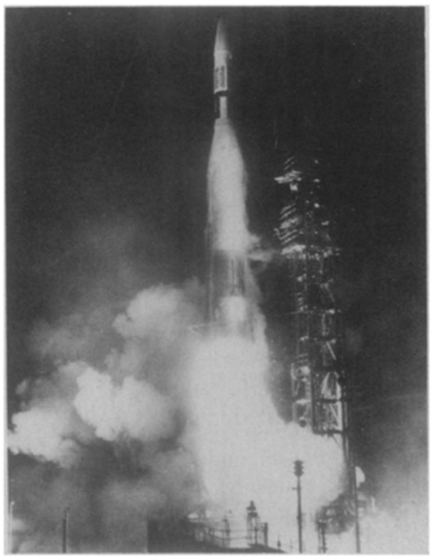
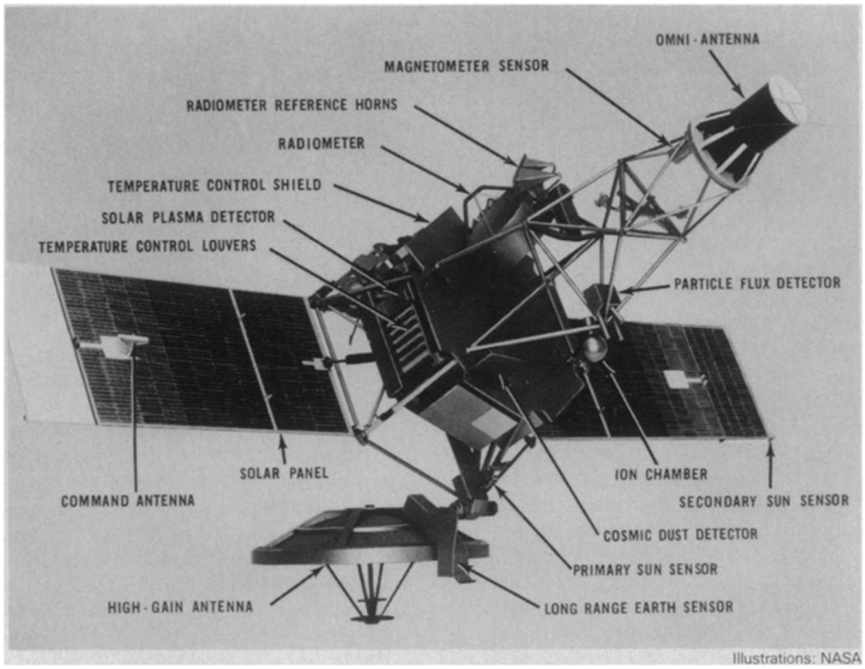
The Hard Ride of Mariner 2

Twenty years ago, a hastily adapted spacecraft opened the way to the planets





Illustrations: NASA

By JONATHAN EBERHART

Blazing a trail for the exploration of other worlds did not come easily. By Dec. 14, 1962, when a little probe named Mariner 2 took the first close look at a planet beyond the earth-moon system, the Space Age, with its extraordinary growth rate, was beginning its sixth year. Some 200 launchings had been conducted, communications and weather satellites were already in use, and four Russians and five Americans had become public heroes as traveled spacemen. Yet the road to the planets was a pile of wreckage.

After what are believed to have been three unsuccessful attempts to reach the moon, Soviet probes went on to score the first lunar flyby (though cosmonaut Yuri Gagarin has written that it was an intended impact mission that missed), the first deliberate lunar impact and the first photos of the moon's far side. But of five attempts to reach Mars (three of them unannounced by the Russians but inferred by U.S. analysts), the first two failed at launch, two more got no farther than earth-orbit and the other stopped transmitting en route to its destination. Four of five Venus-bound craft, too, were stranded in earth-orbit, and the fifth went mute on the way.

Early U.S. efforts were even more dismal. America's frustrating lunar score over those same years was 0 for 11, including a probe called Ranger 4, designed to photograph the moon all the way down to a crash landing. Ranger 4 even hit the moon; unfortunately, it was also carrying a faulty timer that failed to turn on its camera. The United States would not even try for Mars until late 1964, and its single Venus candidate — Mariner 1 — had to be destroyed during launch because of what was later found to be the omission, years before, of a single symbol in the programming of its guidance computer.

Against this less-than-inspiring background, Mariner 2 was launched toward Venus on Aug. 27, 1962. Almost primitive by today's spacecraft standards, it did not even carry a camera. Yet its successful encounter with the planet three and a half months later was greeted as anything but a minor event. "One of the most exciting voyages of exploration in the history of mankind," trumpeted a typical newspaper editorial. TIME MAGAZINE, in a five-page cover story, declared that "no achievement by Russian cosmonaut or U.S. astronaut, no experiment made by any of the myriad other satellites that have been shot aloft has taught man nearly so much as he has learned already from the improbable voyage of Mariner 2."

As the first spacecraft to visit a planet beyond earth's moon, Mariner could have had its choice of the solar system. But for such a technological fledgling, the natural choice was Venus. A trip to Mars, the next-nearest world, would have required the vehicle to survive about twice as long a flight-time. The nearness of Venus to the sun would provide far more power for solar cells, and its nearness to earth would allow it to get by with a smaller, less powerful radio transmitter, both factors contributing to the chance of a smaller, lighter and less expensive spacecraft.

The mission formally began in July of 1960, when the National Aeronautics and Space Administration approved a proposal from Jet Propulsion Laboratory in Pasadena to build the craft and send it to Venus in the summer of 1962. Venus and earth line up on the same side of the sun at about 19-month intervals, and a launching timed to take advantage of such a conjunction could have been scheduled for the first two months of 1961, except that it would have left only half a year to design, build, test, deliver and launch the spacecraft. JPL's plan allowed two years — still a tight schedule, but the engineers were confident.

Little did they know how tight their schedule would really be.

Under development at the time of the mission's approval was a powerful, upper-stage rocket called the Centaur, designed to burn liquid hydrogen and achieve nearly twice the efficiency of any other booster in NASA's armada. Banking on the Centaur's availability, the JPL team by autumn had established the design for an instrument-laden Venus probe that

Above: Atlas-Agena rocket launches Mariner 2 (left). Spacecraft details at right.

would weigh in at about 1,100 pounds. Several months later, signs began to appear that the Centaur effort was lagging, but the engineers pressed on. "Then," says Jack James, the project's manager and now JPL assistant director for defense programs, "the schedule collapsed."

It was August of 1961. A phone call from NASA headquarters in Washington informed James that the eagerly awaited Centaur simply would not be ready on time. The only alternative upper stage was the well-proven — but far less powerful — Agena B, which would necessitate a much smaller payload with reduced scientific capacity. (The first Centaur to carry an operational spacecraft, in fact, did not do so until 1966, when Surveyor 1 was sent to the moon, though it has since lived up to its billing and is now being considered as an upper stage for shuttle payloads.) Would such a reduced mission be worthwhile? With so little time remaining, in fact, could it be done at all?

In three frantic weeks, from Aug. 8 to Sept. 1, the engineers chopped down their envisioned craft from something over half a ton to one that weighed only 447 pounds, with assurance from the builders of the Agena that another 110 pounds could be saved there. The hurriedly devised plan was to adapt the design of the little Ranger probe that was just about to begin a series of flights to the moon. Ranger, too, was a JPL project, which would help with the need for tight, hands-on management, and NASA, fully aware of the looming deadline, approved the radical change in a matter of days. But only nine months now remained in which to design, build and deliver the spacecraft and its rocket to Kennedy Space Center in Florida in time for final checkout procedures and a launch by July or August of 1962.

On the doorstep of the Interplanetary Era, nothing was routine. The spacecraft, for example, would be going closer to the sun than any other object ever devised by man, yet the United States did not have a test chamber that could adequately simulate the effects of such intense solar radiation. An advance test flight was an unavailable luxury, and the engineers could only make their most educated guesstimates in the use of insulation, reflective paint, movable louvers and other thermal-control techniques. Indeed, in the last few days before Mariner 2 reached Venus, the engineers back on earth could never be sure whether their spacecraft would survive or fry.

Three complete Mariners were actually built, one of them for testing and to be available for spares if needed. The other two resulted from NASA's experience with the many launch failures in the early days of space flight, and the hope that launching a pair would improve the chance that at least one would get through. Their foresight proved justified. Mariner 1 was launched less than five weeks before its successor's scheduled liftoff, and the flight team at KSC could only look on in dismay as the Range Safety Officer had to send the signal that blew it up. The guidance-programming error that sent the "bird" off course had gone undetected through several previous launches, says James, and would not have made a difference even to Mariner 1 if a particular kind of electronic noise had not showed up in the system.

Mariner 2 survived not only its launching, but a host of problems during its flight, some of which have not been conclusively figured out to this day. An optical tracking device kept losing its view of the earth; transmissions from the spacecraft would suddenly get almost too weak to detect, then mysteriously return to full strength. Two-thirds of the way to Venus, an apparent short-circuit suddenly cut the power from one of the two solar panels, but a week later it was back to normal — and a week after that it was gone again. With nine days to go before closest approach, the battery temperature was 120° F. and rising. (It could fail completely and not matter, but what if it caused a short, or even exploded?) Five days away, four of the telemetry channels failed, cutting off tense engineers from readings of the craft's gas and fuel pressures, and of the hinge-angles of its directional antennas. Less than 24 hours from closest approach, the onboard "sequencer" that was supposed to activate the Venus-pointing scientific instruments (others had been studying interplanetary space all the way from earth) failed to do so. Twice. Fortunately, the flight path had been planned so that the spacecraft would be in view of the big Goldstone tracking antenna in California during those critical moments, and the activating signals could be sent up by radio.

Three weeks after that, Mariner 2 died, succumbing at last to a combination of the still-rising temperatures and an assortment of other ills. But the major event of the mission, an approach to within 21,648 miles of the center of its target planet, was already behind it. The interplanetary doorway was ajar.

Cutting the spacecraft's weight from 1,100 pounds to 447 had an inevitable effect on the amount of science it could do. An ultraviolet spectrometer, useful for upper-atmosphere compositional measurements and other studies, had to be left behind, as did a polarimeter that was under consideration for such tasks as measuring cloud-particle sizes. (Cameras were not on the list even for the bigger version, due to limited data-transmission rates and other factors, including the cloud-wrapped planet's basically fuzzball appearance.) Yet until Mariner 2 arrived, the data bank of close-up measurements of the other worlds in the solar system was empty. There were no old results, no redundant experiments.

Some of Mariner 2's most important findings were made on the way, between planets. The existence of the solar wind had been inferred years before from the tendency of comet tails to point always away from the sun, rather than "behind" the comets along their orbits. But Mariner 2 provided the first substantial measurements of the solar wind over a long period of time, well away from the influence of the earth. It showed that the wind was virtually omnipresent rather than a transitory thing, and that it was a vastly complex phenomenon with fast currents and slow, significantly changing its composition even as the spacecraft traveled through it.

"We were surprised how variable the interplanetary magnetic field was, and how variable in direction," recalls magnetometer experimenter Edward J. Smith of JPL. The magnetometer would also go on to establish that Venus itself has only a weak field if any; it was just as expected from the planet's slow rotation, but no earth-based measurements could have confirmed what was merely a theory.

The whole deep-space environment was nearly unknown until Mariner 2. Its sensors showed that the craft absorbed a total radiation dose of only 3 roentgens during the flight, that the cosmic-ray flux was roughly constant (and did not change near Venus), that "space dust" was basically a non-hazard (a microphone designed to record hits by particles as small as thousandths of a microgram detected only two).

As for Venus itself, the most sought-after answer that Mariner 2 could provide was that of the planet's surface temperature. Earth-based measurements of microwave emissions from Venus had indicated a temperature of about 600° F., but researchers did not — and could not — know whether the emissions came from the surface, from cloud layers in the atmosphere or from a dense ionosphere high overhead. The question was answered by a microwave radiometer aboard Mariner 2, which revealed "limb-darkening" (weaker emissions at the edge of the planet's disk than at the center). The conclusion was not only that the surface was the hot part, but that, at about 800° F., it was even hotter than the earth-based data had implied.

An infrared radiometer, meanwhile, took temperatures high in the atmosphere, revealing, to the scientists' disappointment, no breaks in the clouds. A cold spot near the south polar region was tentatively interpreted as perhaps somehow related to a high surface feature; it has since been identified as a high-altitude, circumpolar feature of the atmosphere's circulation.

Mariner 4 would make the first successful Mars flyby on July 14, 1965 (its predecessor failed), while the next successful visits to Venus would be the flyby of Mariner 5 and the atmosphere-sampling descent of Russia's Venera 4 (after eight more failures), both in October 1967. The road to the planets was still a difficult one — but the way had been opened. □