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New Mars rover approved for 2020 launch

NASA announced plans Dec. 4 for a multi-year Mars program including a new science rover to launch in 2020 that will be assigned to JPL.

"We are delighted to hear of NASA's commitment to continue a bold program of exploring the Martian surface into the next decade," said JPL Director Charles Elachi. "Curiosity has excited and inspired millions of people around the world, and I have no doubt that this new mission will be for all Americans a proud new chapter in NASA's robotic exploration of the solar system."

The future rover development and design will be based on the Mars Science Laboratory architecture. This will ensure mission costs and risks are as low as possible while still delivering a highly capable rover with a proven landing system. The mission is envisioned as a re-flight of much of the skycrane/Curiosity rover mission design and hardware. Flight spares, spare parts, ground support equipment and software from Curiosity could be utilized in the 2020 rover.

The mission will build on the science of prior missions, including Curiosity, and support the National Research Council's Planetary Decadal Survey recommendation that the next strategic mission should make progress towards Mars sample return.

A Science Definition Team will be established to outline the objectives for the mission and will recommend to NASA how to prioritize the science instrumentation to make substantive progress toward Decadal Survey priorities.

The mission also responds to the findings of the Mars Program Planning Group established earlier this year to assist NASA in restructuring its Mars Exploration Program.

The exploration of Mars has historically been an international effort, and NASA will be responding to inquiries already received from several international partners about potential collaboration in 2020.

NASA's Space Technology Program is investigating a series of technologies that would either enhance the capabilities of the Mars 2020 lander or use it as a demonstration platform. The potential technologies include entry, descent and landing technologies that would increase the landed mass, improve the landing location precision or provide access to higher elevations, as well as improved guidance, navigation and control technologies.

The 2020 science rover is now in pre-formulation with several key technical risk–benefit analyses to be accomplished over the next few months as its scientific payload and required capabilities are finalized for open competition.

For more information, visit *http://www.jpl.nasa.gov/news/news.php?release=2012-384.*

Five decades of roaming the planets

Several Lab veterans recall best and most astonishing mission experiences

By Mark Whalen

Dozens of JPL missions have come and gone since December 1962, when Mariner 2 became the first successful mission to another planet as it flew by Venus. As JPL observes 50 years since that defining moment in planetary space exploration, several veteran scientists and engineers shared their best memories.

Marc Rayman

In November 1999, early in its planned two-year extended mission to Comet Borrelly, Deep Space 1 suffered a serious anomaly initially deemed fatal: the spacecraft's sole star tracker, its only means of determining its full three-axis attitude, failed and appeared unrecoverable. Thrusting with the ion propulsion system had to resume by early July 2000 in time to reach the comet. But an ambitious rescue effort eventually succeeded in restoring operation in time to begin thrusting one week early.

During the spacecraft's encounter with Borrelly on Sept. 22, 2001, the first few images were distant and showed little more than a huge jet of dust—"interesting but not what we most wanted," said Mission Manager Marc Rayman. The next one, however, revealed "a truly spectacular view, far superior to any ever acquired of a comet nucleus," he said. "In that one moment, comet nuclei were transformed from indistinct blobs to objects with detailed character, complex structure and distinct geology. Because of the myriad obstacles, we had had low expectations, so the enormity of the success was that much more wonderful."

Bonnie Buratti

Bonnie Buratti's most transcendent moment at JPL was Cassini's discovery of plumes coming out of Enceladus' surface. Scientists had seen that parts of the moon were heavily cratered—signaling an old surface—but the whole moon was covered by what seemed to be bright, freshly fallen snow. Buratti, supervisor of the Asteroids, Comets and Satellites Group, thought it had to be active geology—such as a volcano—spewing out fresh ice. But early Cassini flybys in 2004 and early 2005 didn't find anything to suggest the moon was anything but dead.

But in March 2005 Cassini's magnetometer found that Saturn's magnetic field seemed to "drape" around Enceladus, as if something from the moon was pushing the field away. Later, during a daring flyby 170 kilometers above Enceladus on July 14, Cassini's infrared instrument showed a blaze of heat at the south pole, the area of the moon that should have been coldest. "Clearly there was ice being expelled at this hot spot, material that was later being accumulated back onto the moon and perhaps forming the E-ring of Saturn as well," Buratti said. In November 2005, she added, Cassini imaged "huge and glorious plumes and jets of Enceladus, which indeed came from the active south pole."

Continued on page 2

MARC RAYMAN

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LINDA SPILKER

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JOY CRISP

. . . in contrast to the strange experience of being a geologist asked to figure out the best way to make fake rocks.

DON YEOMANS

Most asteroids are no longer considered whirling solid rocks, but rather loose rocky collections, or rubble piles.

FIVE DECADES *Continued from page 1*

Linda Spilker

One of the biggest surprises for Cassini Project Linda Spilker came when observing images of Saturn's rings—the most detailed ever—taken by Cassini just after the completion of the Saturn orbit insertion burn in June 2004. "The images ranged from very compact, detailed ring structure to some pictures that were almost featureless," she said. "I felt like I was walking across a beautiful tapestry of Saturn's rings, seeing exquisite detail, like tiny stitches, in some parts of the A ring, and bland sections elsewhere."

Another major surprise came much earlier, in 1986, when Voyager had flown past Uranus and was looking back at the planet's rings. "The picture that came back was amazing!" she said. "The nine narrow rings were suddenly embedded in broad bands of dust that were scattering their light back to the Voyager cameras. No one had expected to see so much dust. Everyone jumped up and started pointing at the TV screen, speculating on what we saw in that memorable image."

Joy Crisp

Joy Crisp, deputy project scientist for Mars Science Laboratory, recalled her rocky start to a previous rover mission. To prepare the Mars Pathfinder airbag system for testing, Crisp had the task of obtaining rocks that would be bolted to a platform and tested in a huge vacuum chamber at NASA Glenn's Plum Brook Facility. This activity took her to landscape rock yards all over Southern California and to several makers of fake rocks who build sets for movies.

At Plum Brook the airbags were inflated under simulated martian atmosphere conditions and sent flying at the rocks at 50 mph to find out if the airbags would survive impact. One of the test rocks was even outfitted with a see-through window so a camera could be hidden inside to view what was happening from a rock's point of view as the airbag moved over it. "Talk about a wow experience to see the final results," Crisp said, "in contrast to the strange experience of being a geologist asked to figure out the best way to make fake rocks."

Don Yeomans

One of Don Yeomans' most surprising experiences concerns the June 1997 Near-Earth Asteroid Rendezvous flyby of the 66-kilometer asteroid (253) Mathilde. JPL provided navigation for the mission managed by the Johns Hopkins University's Applied Physics Laboratory, and guided the spacecraft to within 1,212 kilometers of the surface. Determining Mathilde's mass and volume found that the asteroid's density was only 1.3 grams per cubic centimeter. "Water has a density of one gram per cubic centimeter so if Mathilde were a bit less dense it would float in a bowl of water," noted Yeomans, supervisor of the Solar System Dynamics Group and manager of NASA's Near-Earth Object Program Office.

The surprising low density and an estimated porosity of greater than 60 percent also explained why Mathilde survived several impacts by asteroids large enough to create craters with diameters in excess of Mathilde's radius, he added. Together with subsequent results showing that the vast majority of large asteroids don't rotate faster than 2.2 days—the rate at which material would fly off their surfaces—this result has led to a paradigm shift, Yeomans said. "Most asteroids are no longer considered whirling solid rocks, but rather loose rocky collections, or rubble piles."

Thom Wynne / JPL Photo Lab

Curiosity takes the cake at campus holiday celebration

JPL Director Charles Elachi and wife Valerie admire a cake formed in the shape of the Mars Science Laboratory Curiosity rover, created by Caltech Athenaeum Executive Chef Kevin Isacsson (left).

The display—featuring Curiosity made of gingerbread and candies—was created for a Dec. 1 holiday party. It will remain there through the holiday season until the Athenaeum closes Dec. 21.

The Venus Mission

How Mariner 2 led the world to the planets

By Franklin O'Donnell

Friday, December 14, 1962. America is recovering from the Cuban Missile Crisis, which riveted the world's attention only a few weeks before. The Beatles have just recorded their first No. 1 hit, "Please, Please Me." Peter O'Toole graces movie screens in *Lawrence of Arabia*, which opens with a gala premier. A relatively small U.S. force is in Vietnam, where hostilities between the north and south are escalating. At home, many Americans look forward to weekend holiday parties.

At Pasadena, the mood is tense among the crewcut team as, shortly before noon, a telex machine starts clattering, spitting out paper tape. From 36 million miles away, data dribbles back to Earth a few bits per second as the Mariner 2 spacecraft comes within range of Venus. Hours later, the encounter is over, and data continues to stream homeward.

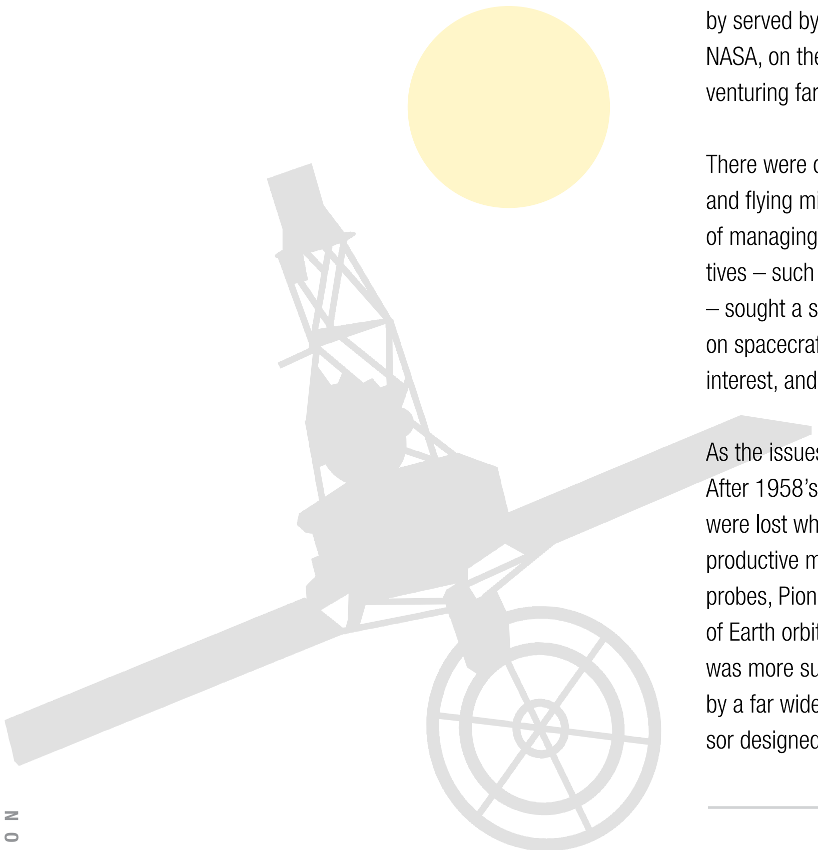
It's a jubilant moment for JPL and the country. After five years of playing catch-up to the Soviet Union in space exploration, the United States has achieved its first bona fide "first" – the first successful flyby of another planet. The mission delivers not only news about Venus itself, but discoveries about the realm of space between the planets. It will open a new era, decades of inspiring missions managed by the laboratory that take the world to all of the planets from Mercury to Neptune, revealing sights in many cases unimagined.

But Mariner 2 was far from easy. Cobbled together on a breakneck schedule, the mission endured one seemingly show-stopper crisis after another, only to recover and soldier on. "It barely worked," recalls one JPL engineer who worked on Mariner 2 early in his lab career. Years after the encounter, one news organization pegged it as the "Mission of Seven Miracles." It was a success that almost didn't happen.

The Times

The early '60s were hectic days in the country's young space program. After the success of JPL's Explorer 1 satellite in 1958, followed a few months later by the creation of NASA, the lab devoted its energies to getting out of missiles – which it had focused on for nearly two decades as an Army laboratory – and into what it saw as its new business, interplanetary exploration. But there were many growing pains as JPL got to know its new sponsor, NASA, and worked to establish its place in the young agency's family. It was complicated by the fact that JPL would be the only university-managed facility in a patchwork of agency centers otherwise overseen by government civil servants.

Both NASA and the lab agreed that JPL's charter would be the exploration of deep space with robotic spacecraft. Beyond that, there were conflicts. Since the Soviets had achieved high ground with the first Earth satellite, the first animal and human into space, and the first spacecraft to reach the moon, JPL's leaders felt that national honor could best by served by bypassing the moon and heading straight to the planets. NASA, on the other hand, wanted JPL to start with lunar missions before venturing farther into the solar system.



There were other differences. JPL preferred to concentrate on building and flying missions in-house; NASA wanted the lab to shoulder its share of managing projects sent outside to contractors in industry. JPL executives – such as its director, the New Zealand-born William Pickering – sought a strong role for the lab in picking science experiments to fly on spacecraft. NASA Headquarters viewed that as a potential conflict of interest, and thought it best to keep these decisions to itself.

As the issues were hashed out, flight projects gradually moved forward. After 1958's Explorer 1, JPL lofted four other Explorers, two of which were lost when their launch vehicles failed, the other two carrying out productive missions in Earth orbit. JPL next built a pair of lunar flyby probes, Pioneer 3 and 4. Pioneer 3's launch vehicle failed to send it out of Earth orbit; it reentered and burned up over Africa. 1959's Pioneer 4 was more successful, making it past the moon. But it missed the moon by a far wider margin than planned; while it collected some data, a sensor designed to detect the moon during the flyby never activated.

The lab next turned to more ambitious plans. Deferring to NASA's wishes, JPL started work on a series of larger lunar impact probes called Ranger. The lab also struck a cooperative note by planning a series of lunar soft landers, called Surveyor, that would be built outside by Hughes Aircraft. But most ambitious of all was what JPL had in mind for the planets. These were to be probes weighing more than a thousand pounds, called Mariners, that would be launched on rockets with a powerful new upper stage created at JPL called Vega.

NASA initially gave JPL the nod in 1959 to start on Vega, only to cancel the program a few months later. The reason for the change was a revelation by the Air Force that it had been working on a pair of upper stage boosters that it said could handle the job of flinging payloads out to the planets. One, called the Agena, had its first flight that year, while a more powerful booster called the Centaur was to be ready in 1962.

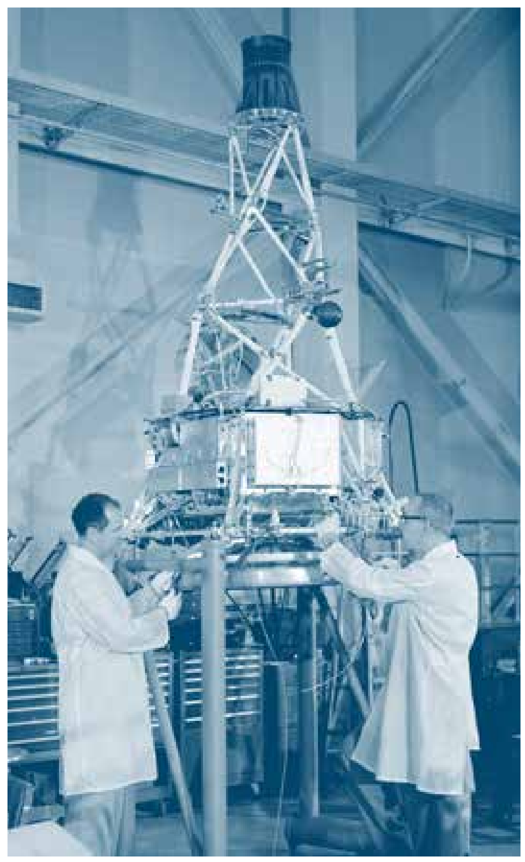
JPL lost no time in doing a reset. The lab would work on a 1,250-pound spacecraft design called Mariner A that would be sent to Venus on a Centaur during a launch opportunity in 1962. A more ambitious craft, called Mariner B, would be sent to Mars in 1964. Engineers got started on these even as other teams were designing and building the first Rangers to impact Earth's moon.

To serve as the project manager leading the Mariner effort, JPL picked Jack James. A Texas native, James was an electrical engineer who worked on radar in the Navy in World War II. Joining JPL in 1950, he developed ground and flight radar for the Corporal missiles, eventually becoming deputy manager of the Sergeant missile program under another seasoned engineer, Bob Parks. James later recalled that, as JPL moved from the Army to NASA, Sergeant "morphed" into JPL's planetary program, with Parks becoming the lab's planetary chief and James in charge of the first Mariner missions.

In the summer of 1961, the Air Force dropped a bombshell: The Centaur upper stage would not be ready for the Mariner Venus launch opportunity in 1962. This potential catastrophe called for fast thinking. JPL could still get to Venus on another upper stage – the then-available, but less powerful, Agena – if it cut the weight of the Mariner spacecraft by

Jack James

Technicians prepare one of the Mariner Venus spacecraft.



two-thirds. To make the extremely demanding schedule – reminiscent of the crash program to build Explorer 1 after the launch of Sputnik in late 1957 – Mariner would have to borrow designs and parts from the Ranger lunar probes then in production. In fact, the mission would have to be designed in a week.

Could they get from a blank sheet of paper to the launch pad in less than a year? James polled his subsystem managers. All were optimistic, except for the team in charge of the attitude control system that would control Mariner's orientation as it flew through space. In order for Mariner to get close enough to Venus as it sped past, it was to tweak its flight path by firing a rocket engine in what was being called a "midcourse correction." Though such a maneuver was also planned for the Rangers, it had never yet been pulled off successfully. Creating the system to control it was one of the more daunting tasks ahead for the Mariner team.

Could they get from a blank sheet of paper to the launch pad in less than a year?

James and Parks went to NASA Headquarters to see if the agency would sign off on the retooled Mariner plan, minus the midcourse correction. It was the tail end of summer 1961, and NASA was still in its first home, the 140-year-old Dolly Madison House on Washington's Lafayette Square. With no air conditioning, windows stood open in the sweltering heat as James pitched his plan to NASA executives.

The good news: JPL had the go-ahead to proceed with the new Mariner plan. But a weighty condition: It was only a go if JPL found a way to include the midcourse correction. Without it, the reasoning went, the chances were too great that the spacecraft would pass too far from Venus to collect valuable science. "No ifs, ands or buts," James recalled being told at the meeting. "No midcourse, no mission. You got a midcourse, you got a mission."

He returned to Pasadena, energized by the approval, and determined to find a way to make the mission work.

The Sister Planet

Though Mars may have been the planet that most stoked the early 20th century imagination with visions of alien life, Venus was only slightly less intriguing. In the 1890s, businessman turned astronomer Percival Lowell reported glimpsing canals not only on Mars, but on Venus as well. It helped that Venus was nearly the same size as Earth, and the closest of all the planets; it was commonly referred to as "Earth's twin." Later, scientists came to appreciate that Venus is cloaked by heavy cloud cover that obscures the surface. But that didn't put an end to extraterrestrial fantasies.

With its position between Earth and the sun, it seemed natural that Venus would be a hotter place. Popular fiction frequently depicted Venus as a swamp world, where visiting astronauts might do battle with creatures roaming a hot, wet landscape. As late as 1954, Isaac Asimov penned a tale called *Lucky Starr and the Oceans of Venus*. The campy 1958 film *Queen of Outer Space* took another tack, imagining Zsa Zsa Gabor among the denizens of a planet of women.

Scientists gradually came to realize that Venus was not so hospitable. Earth-based observations revealed that the atmosphere held carbon dioxide and nitrogen, but scant or no oxygen or water vapor. And it seemed that Venus was not merely hot, but possibly scorching. In the late 1950s, a team analyzing microwave radiation from Venus with a radio telescope dish on the roof of the Naval Research Laboratory in Washington reported a temperature at Venus of more than 600 F – hot enough to melt lead.

Scientists disagreed on how to interpret this news. Some speculated that the temperature readings might be misleading; the heat, they suggested, could be from Venus' upper atmosphere, and the surface might not be so hot after all. Others thought high winds and dust clouds might cause friction, creating heat. Still others imagined the planet as a desert covered with oil and smog.

Some scientists proposed that Venus might be the victim of what they called a "greenhouse" effect. The carbon dioxide in the planet's atmosphere might act as a blanket, trapping heat that reaches Venus from the sun. One proponent of this view was a young astronomer named Carl Sagan.

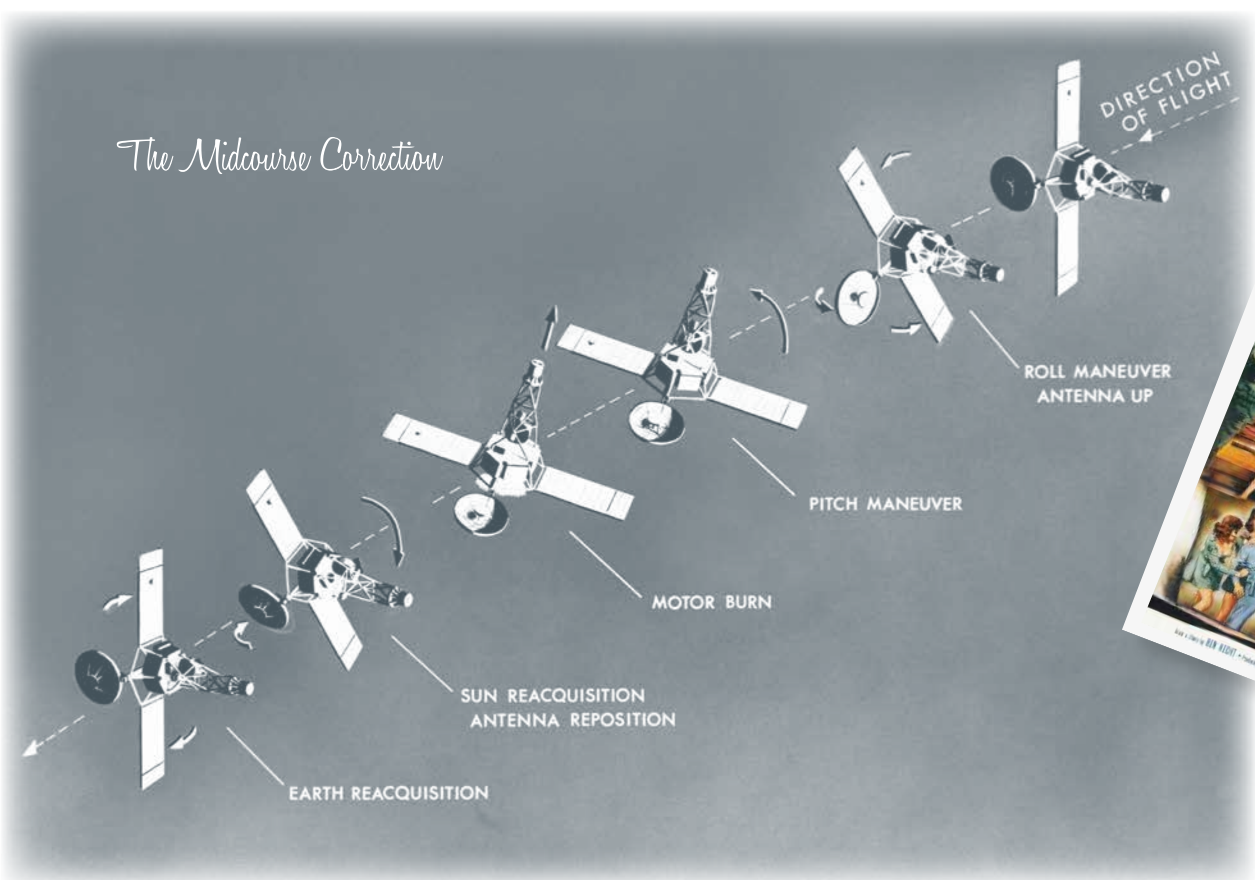
Born in Brooklyn, Sagan earned bachelor's and master's degrees in physics at the University of Chicago before starting a wide-ranging doctoral thesis that framed scientific questions across multiple planets. Heading west to UC Berkeley as a postdoc after receiving his Ph.D. in 1960, the energetic and outgoing 25-year-old became involved in a wide variety of activities, conducting research, giving public lectures and consulting for the government.

In March 1961, the journal *Science* published "The Planet Venus," a paper Sagan adapted from his doctoral dissertation. In it, he argued that Earth's seeming twin in fact is the victim of a runaway greenhouse effect. He would emerge as a natural candidate for the science team on the first spacecraft mission to that world.

Particles and Winds

But a spacecraft venturing tens of millions of miles across the solar system could do more than study its target planet. En route, such a craft would be the natural platform to study charged particles thought to flow out from the sun. Eugene Parker, an astrophysicist who earned his Ph.D. from Caltech, proposed a "solar wind" of such particles flowing at a million miles an hour outward from the sun. Others believed that, if anything, the solar emission was a mere breeze. The question of which model was correct became the story that Marcia Neugebauer pursued.

The daughter of a businessman who gave her a slide rule to make high school physics easier, she majored in that subject at Cornell University. During her sophomore year, her lab partner in physics was Gerry Neugebauer, the son of an Austrian-American mathematician. After graduation, Marcia went to Illinois for graduate school, and Gerry came west to Caltech. After finishing her master's degree, Marcia came to California to marry Gerry, who was working on his doctorate. Marcia was offered a job at JPL, starting at the lab in June 1956.



Life on Venus? The word from Mariner 2: Hardly.

(Allied Artists Pictures. May be subject to copyright)

The same week she arrived, another new hire started at the lab named Conway Snyder. Born in Missouri, Snyder graduated from high school in Redlands, Calif., earning degrees at the University of Redlands and in Iowa. During World War II he worked on the Manhattan Project, witnessing the first atomic bomb test in person. After earning a Ph.D. at Caltech, he held various jobs on the east coast before coming to JPL.

Snyder, about 15 years older, led a very small group that included Marcia Neugebauer as well as Richard Davies. Their section was called "Physics"; later, the name was changed to "Physics and Chemistry." Only much later was a Science Division created at JPL.

At first, the minuscule group did studies on nuclear propulsion for rockets, investigating questions involved in heating gases in fission reactors. When plans for such rockets were scrapped, the group looked for other science questions. Ionized gases seemed like a natural topic to tackle. From there it was a short hop to investigating the hypothesized solar wind.

Eventually, Marcia's husband began working at JPL. Gerry Neugebauer had the obligation of working off his ROTC time commitment after completing his doctorate at Caltech in 1960. The Army assigned him to JPL to help evaluate science payloads for space missions.

Another young face in JPL's growing stable of scientists was Ed Smith. A Los Angeles native, Smith earned bachelor's, master's and doctoral degrees at UCLA. In the 1950s he worked for aerospace firms such as Northrop Aircraft and TRW's predecessor company. Urged by NASA to build up its cadre of on-site scientists, JPL hired Smith in 1961, just as the Mariner Venus mission was taking shape.

The Spacecraft

With a green light from Washington, project manager Jack James returned to Pasadena to get the mission done. All told, three spacecraft would be built – two to be launched to Venus, and a third as a spare.

In those days, JPL was smaller – with about 2,200 employees – and less formal. Many employees worked on one project and then another in quick succession; most who helped design and build the first Mariners were also putting in time on the Rangers. All told, about 250 JPL employees would work on the Venus project, supported by 34 subcontractors and more than 1,000 parts suppliers. By the time they were done, Mariner 1-2 required 2,360 work-years and $47 million to accomplish. At the time it seemed large, though by later standards even with inflation it was relatively small.

Though NASA Headquarters was reluctant to cede control over science payloads, the breakneck schedule for Mariner 1-2 meant that JPL was given more of a say in order to move the project forward. The tight timing was advantageous for local scientists. Marcia Neugebauer recalls that she and Conway Snyder had built an instrument to prove or disprove the existence of the solar wind, and were looking for missions it could fly on. It was selected for the first Rangers, but Neugebauer and Snyder assumed that a competing instrument from an east coast university would edge them out for Mariner Venus. It turned out, though, that the competing professor was out of the country when the quick-turnaround call for proposals was issued. The JPL-developed solar plasma instrument thus got the nod.

At a previous job in industry, Ed Smith had worked with scientists who later went to NASA. When the call for Mariner Venus experiments came out, it was natural that they would collaborate on an instrument to search for a magnetic field at Venus.

Another instrument, an infrared radiometer, was placed on the spacecraft mostly to help find Venus. Since it was onboard, project managers reasoned that it might as well be used to do science. Lewis Kaplan, a one-time U.S. Weather Service meteorologist who joined the JPL staff to conduct research on atmospheres, became its lead scientist, supported by Carl Sagan and Gerry Neugebauer. Working on the radiometer changed Gerry's career path from high-energy physics to infrared astronomy, a field in which he was later to achieve fame.

Hugh Anderson, a young scientist who had just earned his Ph.D. at Caltech and was working at JPL, saw Mariner Venus as an ideal opportunity to fly an experiment to measure high-energy radiation entering the solar system from more remote regions of the galaxy. He persuaded Caltech faculty member Victor Neher to join him. Neher was famous for having invented an ion chamber to measure such radiation.

Despite the strong presence by the home team, not all of the science on Mariner 1-2 was heavily canted toward JPL and Caltech. The spacecraft's microwave radiometer, which would make critical measurements to determine how hot Venus really was, was led by a scientist from MIT – but even that team included Doug Jones, a JPL scientist who was adept at building instruments.

James Van Allen, the Iowa scientist who used Explorer 1 to discover Earth's radiation belts, would put a similar experiment on the Mariners. A scientist from NASA's Goddard Space Flight Center was responsible for an instrument to detect dust particles between the planets. Even so, many outside scientists felt the mission featured too much home-grown science, and they lobbied forcefully for later missions to cast a wider net.

All of that science had to fit in small packages. Launched by the less powerful Agena upper stage booster, Mariner Venus could weigh only 447 pounds. At first, only 25 pounds was set aside for the entire science payload. Later, it was bumped up to 46 pounds. Project manager Jack James later recalled he was "considered sort of an ogre" in the science community, due to his insistence on control of the instruments going onto the spacecraft.

One instrument absent from Mariner was a camera. Years later, Sagan recalled there were debates about whether to include one, and he was among those lobbying in favor. Sagan was a believer in using science instruments to make serendipitous discoveries. By contrast, more conservative scientists argued that every experiment must be tailored to answer a specific question stated in advance. In the end, the fact that the photographic technology of the era probably wouldn't reveal much, given Venus' cloud cover, meant that Mariner carried no camera.

Adapted from the Rangers, the spacecraft were built around a six-sided box. A tubular structure that one newspaper reporter likened to an oil derrick was mounted atop the hexagon; it would serve to isolate instru-

The Scientists

Conway Snyder (below), Marcia Neugebauer, Ed Smith (upper right) and Hugh Anderson.

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ments such as the magnetometer that would be sensitive to interference from the spacecraft's electronics. Two wing-like solar panels unfolded from each side. Fully deployed in space, the spacecraft would be about 12 feet tall and about 16-1/2 feet from tip to tip of the solar panels.

The spacecraft would be stabilized in three axes, with 10 jets squirting nitrogen gas to fine-tune Mariner's orientation in space. Typically they would fire for 1/50th of a second once an hour to keep the spacecraft pointed to within half a degree of the sun. The midcourse correction would be accomplished by a hydrazine engine that could put out up to 50 pounds of thrust for about one minute total. The engine was so precise that it could tweak Mariner's velocity by as little as 0.7 feet per second, or as much as 187 feet per second.

Unlike later JPL spacecraft, there was precious little redundancy. "There were a lot of single-point failure spots," Jack James recalled later, "but it was the best we could do if we were going to go in a year."

Known by co-workers for his patriotic gestures, James later admitted that he personally placed a small U.S. flag under the thermal blanket of each Mariner as they were being built. He didn't announce the memento until Mariner 2 was well on its way to Venus.

Try Number 1

As the Mariners began taking shape, they were far from the only craft bound for space. By early 1961, the Soviet Union had made several attempts to launch a Venus probe. Most suffered launch vehicle failures. One, called Venera 1, appeared to make a good start after its launch in February 1961, but it fell silent a few days later. On the human side, Russia's Yuri Gagarin made the first trip into space in April 1961, followed by American astronauts including Alan Shepard, Virgil Grissom and John Glenn. In May 1961, President John F. Kennedy made his famous speech committing to land an astronaut on the moon by the end of the decade.

But JPL was running into trouble with its Ranger probes to the moon. When Ranger 1 was launched in August 1961 its Agena upper stage failed to restart; the probe was left tumbling in low Earth orbit, and reentered the atmosphere eight days later. Ranger 2 was similarly foiled by an Agena glitch during its launch in November of that year. When Ranger 3 launched in January 1962, its Agena upper stage worked only too well, dispatching it with too much speed; the probe missed the moon by 22,860 miles. In April 1962, Ranger 4 enjoyed a perfect launch, but the spacecraft failed to extend its solar panels or carry out mission functions; it impacted the far side of the moon, relaying no data. All this was worrisome for the two Mariners to Venus. They not only borrowed heavily from Ranger, but used the same upper stage launch vehicle.

There was other troubling news. Early in 1962, the Air Force discovered a crack in a wing spar in one of the large cargo planes used to ferry the first-stage Atlas rockets from San Diego to Florida, and grounded them. This meant that the large, cylindrical rockets would have to be shipped cross-country on tractor-trailer trucks. The challenge wasn't only that routing the trucks around obstacles such as low highway overpasses added up to a logistical nightmare. As Jack James later recalled, the Atlas people told him the rockets never ended up at the Cape without at least one bullet hole acquired as they traveled across the country. The Atlas team had a lot of experience in patching holes.

In the end, the two Mariners made it to the Cape, along with their Atlas rockets and Agena upper stages. A 56-day launch period would open July 18, 1962, and close on September 12. Mariner 1 went to the pad as the period opened in July.

Countdown began shortly before midnight on Friday, July 20, but problems with the range safety system caused launch to be scrubbed for that night. The count resumed Saturday night, and went into holds due to issues with the tracking and guidance systems. Finally, the clock went to zero and Mariner 1 blasted off at 4:21 a.m. Eastern time on Sunday, July 22.

At first, all seemed well. But then launch managers noticed that the Atlas rocket was starting to fishtail. The range safety officer grew concerned that the rocket might crash in the North Atlantic shipping lanes, or an inhabited area. After four minutes, 53 seconds of flight – just six seconds before the Atlas and Agena would separate – the range safety officer pushed the destruct button. Mariner 1 continued to transmit for more than a minute sailing Earthward before it hit the water.

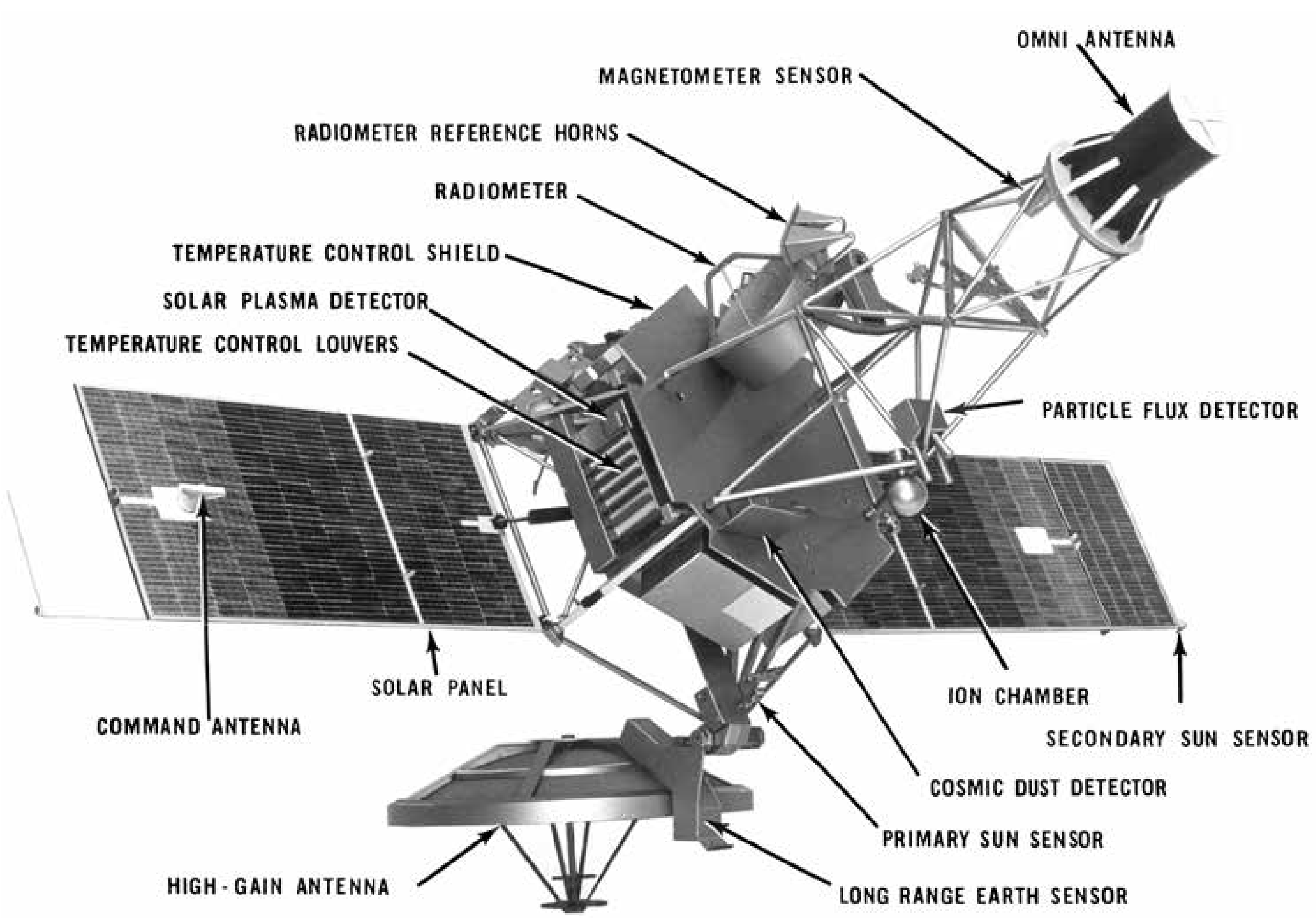
Years later, Mariner project manager James mused that he felt the range safety officer was "trigger-happy"; he doubted that the vehicle was headed anywhere it could cause damage. The Atlas rocket's problem, he recalled, was that the antenna it used to receive guidance commands from the ground was inadequate, resulting in noise in the system. Normally, that noise would have been suppressed, but a hyphen missing from software prevented the noise from being removed.

James was glum as he drove back to his rented apartment in Cocoa Beach after the launch failure. He remembered that Ray Charles' "Born to Lose" was playing on the car radio. He later reflected, "To be a hero, there are ten thousand parts that must work properly on a spacecraft. To become a bum, you need only one of them to fail."

Try Number 2

But there was no time for feeling dejected; if the team wanted to get a spacecraft to Venus that year, they had to forge ahead. Crews immediately started erecting Mariner 2 on a second Atlas-Agena launch vehicle on the pad. The problem with the Atlas software was quickly identified and fixed.

"We were incredibly busy," says Joe Savino, an engineer who joined JPL in 1956 to work on guidance and control, and who is still an active employee in the Autonomous Systems Division. Savino went to



the Cape in July, just a few days before the birth of his son in California. After his wife complained to his section manager, Savino was sent home for a few days before he had to get back to the Cape for the second Mariner.

On Saturday, August 25, the countdown for Mariner 2's launch began. The clock was stopped due to an issue with the Agena upper stage's destruct batteries.

The count restarted the following evening. There were four unscheduled holds in the countdown – one to replace a battery on the Atlas, three from problems at ground stations. Finally, at 2:53 a.m. Eastern time on Monday, August 27, the engines on the Atlas ignited, and Mariner 2 sailed skyward.

Then came the first significant hiccup.

A few seconds before the twin boosters on the Atlas rocket finished firing, control was lost of one of two vernier engines designed to stabilize the Atlas. As the boosters were jettisoned, the rocket began to roll, eventually turning once every second. Fortunately for mission managers, the roll didn't alarm the range safety officer enough to destroy the rocket. Even so, as it turned, the Atlas was unable to respond to guidance commands.

Then came the first of many Mariner "miracles." After the rocket had rolled for about a minute, the electrical short causing the guidance problem suddenly and mysteriously healed itself. The rocket stabilized, and continued into the heavens.

James later recalled that this recovery was all the more remarkable because of the extremely precise way that it had to occur. If the Atlas was to repair its flight path, the electrical short had to cease in a tiny window of time, perhaps no longer than a second. Incredibly, it did just that.

The rest of the ascent progressed smoothly. The Atlas and Agena performed normally for the remainder of their flight, and 44 minutes after launch Mariner 2's solar panels were unfurled. A few minutes later, the spacecraft's attitude control system turned itself on and began acquiring the sun. Mariner 2 was on its way to Venus.

A week after launch, the spacecraft's high-gain dish antenna locked on to Earth. The spacecraft transmitted data at a far-from-blistering 8-1/3 bits per second – a tiny fraction of the data rates of modern spacecraft.

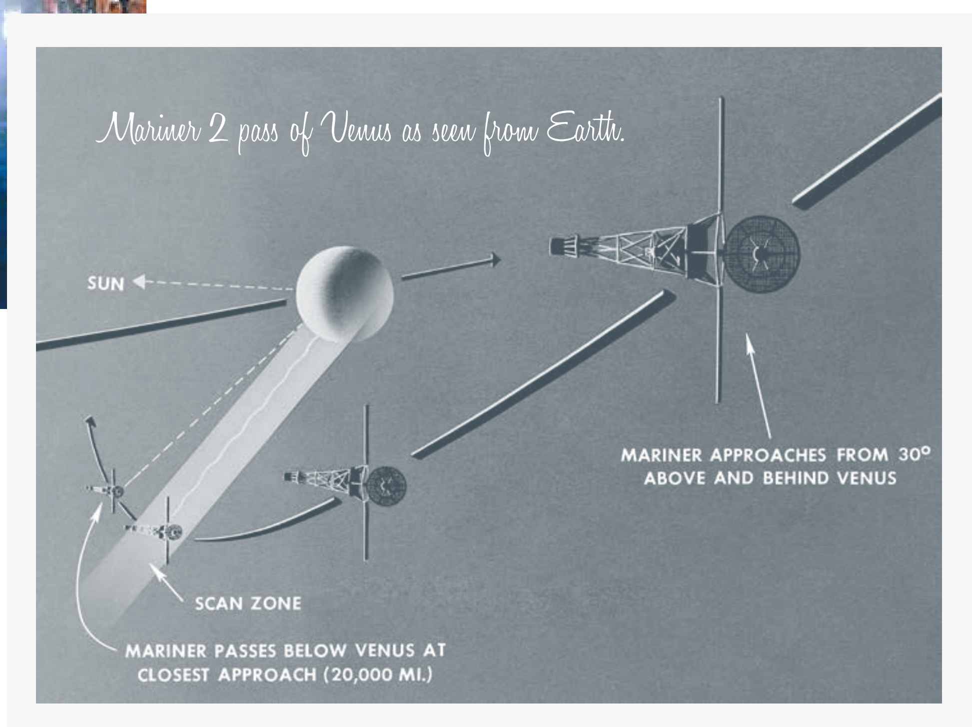
A few minutes later, the spacecraft's attitude control system turned itself on and began acquiring the sun. Mariner 2 was on its way to Venus.

Mariner 2's dispatches home were monitored by the ground stations of what was then called the Deep Space Instrumentation Facility – later to be known as the Deep Space Network. Like today, two of the three stations were in the California desert at Goldstone and in Australia. For Mariner 1-2, the third station was near Johannesburg, South Africa; later in the 1960s it was moved to Spain.

On September 4, when Mariner 2 was about 1.5 million miles from Earth, it fired its main engine to perform its midcourse correction. All told, the maneuver took about 34 minutes. Mission managers estimated that the burn would mean Mariner 2 would pass within 9,000 miles of Venus during its flyby.

Though successful, the midcourse correction was the occasion of another glitch. After the burn was completed, a valve didn't close properly. This meant that nitrogen gas used as pressurant would gradually be lost. The team tried sending a few commands to the spacecraft to exercise the valve. It began behaving itself again; the team shrugged and moved on.

As Mariner 2 sped away, engineers were also concerned about the behavior of the spacecraft's sensor designed to detect Earth. Telemetry showed that Earth was far dimmer than expected, at least as seen by the sensor, and it kept getting dimmer. Eventually, it would reach a point at which the spacecraft would lose its lock on Earth – and with that, it would be unable to transmit any information home. Later, the problem abruptly fixed itself. Engineers theorized that the sensor might have locked on to a glint of sunlight on the spacecraft itself; the situation fixed itself, they suspected, when the spacecraft's geometry changed.



On September 8, another serious hiccup occurred. The spacecraft's gyros unexpectedly turned on, and the science experiments that had been taking readings during cruise were turned off. Three minutes later, the system mysteriously fixed itself. Another miracle for Mariner. Weeks later, the glitch happened again, only to right itself just as mysteriously.

By early October, Mariner scientists had collected enough cruise data to announce the first major results from the mission. Jack James, Marcia Neugebauer, Ed Smith and Hugh Anderson traveled to NASA Headquarters to appear in a news conference on October 10 where they announced that Mariner had confirmed the existence of the solar wind. The stream of solar plasma – matching Eugene Parker's model of what amounted to a solar gale – was obvious as soon as instruments were turned on, and remained a constant throughout Mariner's flight.

At the news conference, James announced that the team had revised its estimate of the flyby altitude for the Venus encounter. Instead of adding a planned 45 miles an hour to Mariner's total velocity of 60,117 miles per hour relative to the sun, the midcourse correction burn sped up the spacecraft by 47 miles an hour. That extra 2 miles an hour was enough to more than double the Venus flyby altitude. Instead of passing within 9,000 miles of Venus, Mariner 2's altitude would be 20,900 miles. Though considerably farther away, that was still within the window in which Mariner could gather good science.

On October 18, the fifth attempt in JPL's series of Ranger probes to Earth's moon was launched. Ranger 5 got a good ride from its Atlas-Agena, but due to an unknown malfunction it ran out of power and stopped operating; it missed the moon by 450 miles. Two weeks later, the Soviets launched a robotic probe, Mars 1; it worked for 4-1/2 months, but failed before it got to the Red Planet.

En route to Venus, Mariner 2 ran into still more issues. On Halloween, one of the spacecraft's two solar panels stopped working entirely. Engineers concluded it was probably caused by a partial short circuit in the panel. The team turned off all the cruise science experiments to save power.

Eight days later, the solar panel mysteriously healed itself. All of the cruise science experiments came back on. But later in November, the solar panel went on the fritz once more. With Mariner 2 getting closer to the sun, the team concluded that the remaining solar panel was producing enough power, and all of the cruise science instruments were left turned on.

Then came troubling news from the radiometer instrument that would conduct the all-important scans to solve the controversy over Venus' temperature. Telemetry indicated that the instrument would not scan as planned during the flyby of the planet, with reduced sensitivity in one of two microwave channels. It would be able to collect data, but not everything that had been hoped.

And then, by mid-November, as the spacecraft drew closer to the sun, the temperatures onboard Mariner 2 itself started to climb. Seven temperature sensors, in fact, hit the tops of their ranges. Engineers worried that the spacecraft might cook itself before it got to its destination.

As data reached JPL from the spacecraft, it was fed into a massive IBM 7090 computer. Used as well by NASA for other missions like the crewed Mercury flights, the IBM was considered an innovation – it was entirely transistorized instead of relying on vacuum tubes. Data arrived via paper tape, and instructions were fed to the computer on stacks of punch cards. As for memory, banks of reel-to-reel tape whirring toward the back of rooms stored the mission's data.

And finally, the encounter day arrived. The glitches weren't finished with themselves, however. As one final problem, the spacecraft's overheated control system failed to execute the command triggering the sequence of activities that were supposed to take place as Mariner 2 sailed past Venus. The mission team hastily sent up a command from the ground instructing the encounter sequence to start.

Perhaps it was yet another miracle that Mariner 2, limping on one solar panel and heated to within an inch of its life, pulled off the flyby with remarkable success. Both of the key instruments trained on Venus, the microwave and infrared radiometers, worked better than scientists and engineers had hoped. The magnetometer and other instruments also held their own. The team put the final flyby distance as 21,564 miles.

After a busy Friday afternoon with many held breaths, Mariner 2 pulled away from Venus, continuing to radio a few bits a second of data from the Venus encounter sequence. On December 27, Mariner 2 made its closest approach to the sun, passing within 65.6 million miles of the local star. A week later – on January 3, 1963 – the spacecraft fell forever silent, continuing on to lap around the sun for ages to come.

The Legacy

As days and weeks went by after the flyby, science results gradually trickled out. In late December, the magnetometer team reported on their investigation at a science conference in Philadelphia. They said Mariner 2 found no magnetic field at all at Venus. If one exists, it must be so weak that it could not be measured at the distance Mariner passed Venus. At most, that would put it at 5 to 10 percent the strength of Earth's magnetic field. With no appreciable magnetic field, Venus also lacked any radiation belts of the kind that Explorer 1 famously discovered at Earth.

On its way to Venus, Mariner 2's cosmic dust detector tallied precisely one speck of dust. Scientists thus concluded that micrometeorites were not a significant threat to spacecraft that might traverse the inner solar system. The cosmic and high-energy radiation were likewise judged to be safe should astronauts ever visit the region that Mariner explored.

In late February 1963, NASA held a news conference to announce perhaps the most long-awaited news from Venus – the findings about the planet's temperature. The science team said their announcement was delayed because the data took two months to interpret.

The radiometers on Mariner 2 found the temperature at Venus to be in the range of 300 to 400 F. More crucially, the microwave radiometer scanned back and forth between the planet's limb and the center of its disc. This established that the heat was not in the upper atmosphere, as some scientists had predicted, but right at the

All told, about 250 JPL employees worked on Mariner Venus 1962.

planet's surface, as Sagan and others had suspected. It went a long way to confirming the greenhouse model that the young scientist had championed. And the surface was not only scorching, it was oppressive – scientists estimated the atmospheric pressure to be 20 times that on Earth.

Science unveiled at news conferences came not only from Mariner 2's dedicated instruments. Some was created by the study of how bodies like Venus and the moon shaped the radio signal of the spacecraft itself. Teasing out such science results became the specialty of a young JPLer named John Anderson.

Encouraged in science and math by his schoolteacher grandmother as a youth in Moscow, Idaho, Anderson graduated in 1956 from UCLA in astronomy and mathematics before spending a few years working for an aerospace consulting firm and completing his military service. In the summer of 1960, he saw a classified ad in the *Los Angeles Times* looking for people to work on spacecraft trajectories at JPL. Anderson hired on, joining what later became the navigation section.

When Mariner 2 took flight, Anderson was assigned to work out science questions that could be answered by studying radio signals coming back from the spacecraft. As Mariner was sped up by Venus' gravity, the frequency of its radio signal would change, like the pitch of a whistle from a passing train.

Not long after the Venus encounter, Anderson joined a news conference to announce that tracking Mariner's signal enabled him to make the most accurate measure ever of Venus' mass. By detecting how Venus sped up the spacecraft as it flashed by, he concluded that the planet's mass was 0.81485 times Earth's; the probable error was just 15 thousandths of one percent. Earth's moon caused enough wobble in Earth's orbit that Anderson could use Mariner's signal to come up with a refined figure for the moon's mass. Radio tracking of the spacecraft also resulted in a new value for the astronomical unit – the average distance from Earth to the sun. This was now fixed as 92,956,200 miles, plus or minus 300 miles.

By tracking Mariner 2's radio signal and combining it with measurements of Venus using radar from dish antennas on Earth, scientists also determined that Venus might rotate once every 250 days. (Eventually, the number was reduced to 225 days.) Interestingly, Venus rotates in the direction opposite to Earth.

Because Mariner 2 worked so well, a Mariner Venus mission with a nearly identical payload calendared for 1964 was canceled. JPL technicians focused on the problem-riddled Rangers and a new Mariner spacecraft designed to travel to Mars in 1964.

For JPL, the mission was a feather in its cap, though it came at a time when the lab was facing the gravest problems of its entire existence. After the failures of the first five Ranger lunar probes, that project stood down for more than a year; the first successful spacecraft in the series, Ranger 7, would not take flight for another year and a half. In the meantime, William Pickering and other JPL executives were called to testify before a skeptical Congress, and there were fears for the lab's future.

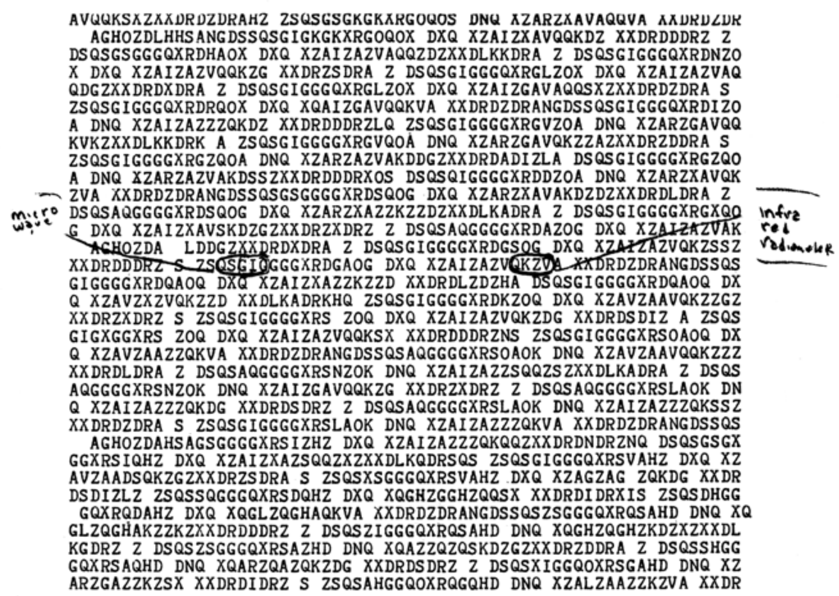
The American public met Mariner 2's achievement with both pride and wistfulness. Its scorching temperatures meant that Venus was no swamp world, and there were certainly no lifeforms like Zsa Zsa Gabor or anything else recognizably alive on its surface. "Venus Says No," announced a headline on an editorial in the *New York Times* lamenting how the mission had dashed hopes of Venusian life. The newspaper added melodramatically: "The message from Venus may mark the beginning of the end of mankind's grand romantic dreams."

Though no haven of life, Venus continued to be the destination for numerous American, Soviet and European missions over the decades that followed. The estimate of the surface temperature was gradually revised upward, and now stands at an incredible 900 F. The surface pressure is now known to be 90 times Earth's. By studying Venus with imaging radar on missions like 1989's Magellan, scientists concluded that the planet's surface was repaved by global volcanic eruptions several hundred million years ago. Active volcanoes may still rumble today. Venus' clouds are known to contain much sulfuric acid.

The science behind Mariner 2 had impacts beyond planetary exploration. Moustafa Chahine, who served for many years as JPL's chief scientist, credited Mariner scientist Lewis Kaplan with the inspiration for what decades later became the Earth-orbiting Atmospheric Infrared Satellite. It was ex-meteorologist Kaplan, said Chahine, who had the idea that temperatures within an atmosphere could be calculated from the energy emitted by molecules of carbon dioxide in that atmosphere.

And for JPL, Mariner 2 was just the first of dozens of missions to all of the planets, from Mercury to Neptune, as well as to comets, asteroids and other constituents of the solar system. As project manager Jack James reflected a few years before his death in 2001, "There will be other missions to Venus, but there will never be another first mission to Venus."

And, in a wider sense, there would be other missions to the planets – but never another first mission to the planets.



Above, Mariner 2 telemetry including science data. Right, JPL's Jack James, Bob Parks and William Pickering (from left) are congratulated by President John F. Kennedy.

CONTINUING INNOVATION
A KEY TO SUCCESS

Solar System Exploration Directorate plans for future

By Mark Whalen

Thom Wynne / JPL Photo Lab

With five decades of planetary exploration under JPL's belt, Firouz Naderi, director for the Lab's Solar System Exploration Directorate, believes the next half century will be as exciting. Here he discusses the directorate's near-term challenges and opportunities.

What do you see as the directorate's possibilities for the near future?

Most of our business is through the competed New Frontiers and Discovery programs. We also compete for planetary instruments, both for our own spacecraft and for others. The only exception to competition is large, assigned flagship missions, such as Europa. We have also contributed payloads to the International Space Station and will continue to do so.

When Mike Sander retired as manager of the Exploration Systems and Technology Office, those efforts were consolidated into our directorate. So, our work is synergistic not only with NASA's Science Mission Directorate but also potential missions that could involve human exploration as well.

President Obama has said astronauts would go to an asteroid by 2025. Currently, the budget isn't there. But one of the most interesting and intriguing concepts we're pursuing right now is, if the astronauts can't go to an asteroid, we'll try to bring an asteroid back to the astronauts. John Brophy's proposal calls for capturing a 500-metric-ton asteroid and bringing it all the way back to the moon system, where astronauts can interact with it.

Another concept is to potentially bring many kilograms of samples back from the Aitken Basin on the moon—but rather than with astronauts, we could land, pick up samples, and take them up to the hovering Orion spacecraft to bring them back. This would have an advantage relative to a pure robotic mission—rather than bringing a kilogram back you could bring tens of kilograms back.

The major focus for our directorate, however, is to define a cost-effective (under $2 billion) Europa mission and constructing the JPL portfolio for the next Discovery call.

How tough is it to plan with uncertainties surrounding both NASA's budget and its future direction?

There have been two periods recently—once in 1981 and more recently last year—where the planetary budget was decimated. When it happened in 1981, JPL was somewhat one-dimensional; we were very much vested in planetary. So when the budget went down, the existence of JPL was being questioned in 1981.

But in recent years, we have strategically positioned JPL so that we now have a strong diversity of activities in Earth science, astrophysics and non-NASA work. So even though this time the budget calls for a huge cut to planetary, it doesn't affect the Laboratory as much as it did back in 1981.

But we are working with our supporters in the community in trying to rebuild the planetary budget to what we think is a healthy level. In 2012 it was $1.5 billion, but it's headed to $1.1 billion over the next couple of years. Our effort is to build it back up to $1.5 billion. Then a lot of good things can happen. We could initiate Mars sample return in 2018/2020, which would be the right thing to do. We can also do Europa in 2021/2022, as well as Discovery and New Frontiers—by properly phasing in these missions. But at $1.2 billion, that's not a robust planetary program.

Ultimately, I think it's going to come down to how innovative we're going to be, in terms of instruments and spacecraft, in conceiving missions. We have to do more while being affordable.

Speaking of innovation and affordability, what are your thoughts on CubeSats?

The CubeSat concept has been around for more than a decade and there have been some 75 launches so far, but all to low-Earth orbit. We are looking to see if JPL should be an active participant in introducing interplanetary CubeSats, with cost in the single-digit millions. Not that they themselves would be expected to do very much as free flyers but they could be carried to a target by a mother ship (such as the Europa Clipper) then be deployed to make complementary measurements that the mother ship wouldn't be able to make.

To do this, we have to do things inexpensively. We have to develop the sociology and organizational approach to building things that are not at the scales of Cassini, Curiosity and Europa. And it is very important for my directorate that we master that to bring the next set of missions to JPL. So, I am interested in interplanetary CubeSats to demonstrate JPL can innovate both at the $2 billion scale as well as $2 million. This will also give us a good pipeline to universities and engage our younger employees.

What are the keys to the success of the directorate?

Very few people would contest the assertion that JPL is the premier organization globally in robotic exploration of the solar system. Maintaining that lofty status requires continuous innovation and that is only possible with exceptionally talented people and the right environment.

JPL's core competency is blending science, technology and engineering to conceive exceptional missions. We have talented people in each of these sectors but blending will not happen spontaneously. We need to facilitate it. We are going to push innovation across instruments and missions, be it a planetary CubeSat or a $2 billion Europa mission. I am determined to make close partnerships between the directorate and our planetary scientists in divisions 32 and 38 and elsewhere on Lab to make JPL a prominent provider of planetary instruments in some well-chosen product lines. At the end it all comes down to people and an environment in which they can excel.

Is this among your most challenging of times at JPL?

If I look back at my 30-year career at JPL it is made up of near-five-year clusters—somewhat intentionally. I made the point from the get-go that I wanted to learn, and hopefully be impactful, across the vast spectrum of activities that we undertake at the Lab. So, as soon as I got my arms around a particular discipline or assignment and started to get comfortable I deliberately switched to another area that I knew less about and that would require a steep learning curve (maybe I'm a masochist). And that's the time when I enjoyed my job the best. It's a time when you are intensely learning the tools of a new trade. And that is fun.

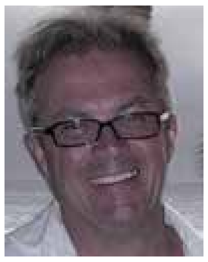
So, this journey has taken me through assignments in space communications, Earth science, astrophysics, Mars exploration, a two-year stint at NASA Headquarters and most recently as the associate director of the Laboratory. My longest tenure was probably as associate director, which was six and a half years. Given that the Lab director's position was not vacant (humor very much intended) I asked Charles if I could take on one last challenge before I call it a day and he was good enough to give me yet another new thing.

So, is this my most challenging job taking over at a time when planetary has fallen on hard times budget-wise? Maybe. But you may recall that I was also named Mars Program manager in 2000 after we had a couple of failures. At the time, that was one of the toughest challenges we were facing. But that is what makes the job interesting. That is the beauty of JPL. I give you Google, Apple and Space X. Give me JPL.

News Briefs

Freeman named to lead JPL Innovation Foundry

Anthony Freeman has been named manager of the JPL Innovation Foundry Office, which coordinates all JPL activities associated with the development and capture of business opportunities. He will continue to manage the Earth System Science Formulation Office as an additional duty.


Tony Freeman

Freeman has extensive experience in project formulation. He began at JPL in 1987 in the Radar and Engineering Section and later became instrument manager for the LightSar Radar Program, then managed the Mission and Systems Architecture Section. He has more than 29 years of experience in radar systems and remains active in research, most recently developing the SweepSar technique for the Deformation, Ecosystem Structure and Dynamics of Ice mission.

He received a bachelor's in mathematics and a Ph.D. in astrophysics from the University of Manchester's Institute of Science and Technology. He is an adjunct professor at USC, teaching remote sensing systems from space, and also teaches systems engineering at Caltech.

Van Houten honored for engineering, outreach efforts


Tracy Van Houten

JPL systems engineer Tracy Van Houten has received a Distinguished New Engineer Award from the Society of Women Engineers, which honors women who have been actively engaged in engineering in the first 10 years of their careers.

The honor was bestowed for her commitment to excellence in aerospace engineering and engineering outreach, and developing the society's future leaders.

Van Houten was a surface operations verification and validation systems engineer for Mars Science Laboratory. She has since transitioned to the Soil Moisture Active Passive mission, an Earth orbiter scheduled for launch in 2014. Previously, she served as lead systems engineer on Team X, a conceptual design team.

Van Houten holds a bachelor's degree in aerospace engineering from Cal Poly San Luis Obispo and a master's in astronautical engineering from USC. She currently serves on the Cal Poly Women's Engineering Program advisory board.

New Yeomans book examines near-Earth objects

Donald Yeomans, manager of NASA's Near-Earth Object Program Office and supervisor of the Solar System Dynamics Group, has authored a new book, "Near-Earth Objects: Finding Them Before They Find Us."

NASA and JPL missions to observe asteroids, comets and meteors are featured prominently as Yeomans outlines the likelihood of—and plans to derail—any possible Earth impact. He also notes how the same objects most likely to collide with Earth could also be mined for natural resources such as water and oxygen.

Yeomans previously wrote "Comets: A Chronological History of Observation, Science, Myth and Folklore." For more information on his new work, visit *http://press.princeton.edu/titles/9817.html.*

Earth system proposals advance

Seven proposals led by JPL principal investigators were recently selected for funding through NASA's Research Opportunities in Space and Earth Sciences program. NASA received 81 proposals and selected 27 for funding for the solicitation, which focuses on the creation of Earth system data records, including climate data records.

JPL submitted 17 proposals led by principal investigators and four with co-investigators, one of which was selected.

The winning proposals, with principal investigator:

"Creating a New NASA Digital Elevation Model and Associated Products" (Sean Buckley); "A Multi-Sensor Water Vapor, Temperature and Cloud Climate Data Record" (Eric Fetzer); "Small-Scale Kinematics of Sea Ice of the Arctic and Southern Oceans: A New Data Set Based on Envisat" (Ronald Kwok); "An Earth System Data Record of Earth's Surface Mass Variations from Grace and Geodetic Satellites" (Felix Landerer); "A Long-Term Record of Upper Stratospheric and Mesospheric Temperature Profiles" (Nathaniel Livesey); "A Data Record of the Cloudy Boundary Layer" (Joao Teixeira); "A Climate Data Record of Altimetric Sea Level Change and Its Mass and Steric Components" (Josh Willis).

Also selected was "Solid Earth Science Earth System Data Record System" with JPL co-investigator Sharon Kedar. Yehuda Bock of the Scripps Institution of Oceanography is principal investigator.

Lab wins two awards for systems-engineering excellence

JPL has been honored for excellence in systems engineering with two awards from NASA's Office of the Chief Engineer.

The Lab shared honors in both categories of the 2013 NASA Systems Engineering Excellence Award. The Dawn Flight Team was one of the two award winners in the Programs and Projects category, while the Europa Habitability Mission Systems Engineering Team/Integrated Model-Centric Engineering Initiative—led by Steve Jenkins and Todd Bayer—was one of the two award winners in the Techniques and Methodology category.

For more information, visit the NASA systems engineering community website at *https://nen.nasa.gov/web/se.*

Curiosity up for Time's 'Person of the Year' honor

JPL's Mars Science Laboratory Curiosity rover is one of 40 candidates for Time magazine's Person of the Year.

The honor recognizes not the most popular person but rather the person who most influenced the news this year, for better or worse. Voting is underway through Dec. 12 at *http://www.time.com/time/person-of-the-year/2012.*

Passings

Ellis "Ray" Morser, 87, a retired contract negotiator, died Sept. 30.

Morser joined JPL in 1962 and retired in 1990. He worked in procurement in the areas of fabrication and facilities as well as space sciences services and facilities.

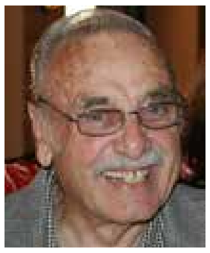
Morser was predeceased by his wife Mary Lou. He is survived by sons Mark and Michael, daughter-in-law Laura, and grandchildren Nicholas and Meagan. A celebration of his life was held Oct. 14.


Ray Morser

Stephen Sollock, 85, a retired technical group supervisor in the Quality Assurance and Reliability Office, died Oct. 4.

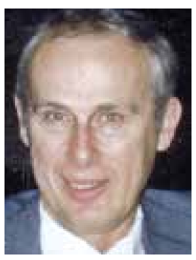
Sollock joined JPL in 1963 and retired in 1995.

He is survived by his wife, Sue; children Sherry Armijo Cash, Elaine Christen, Penny (Richard) Cash Nep and Monica Dearborn Barientos; grandchildren Tammy Cash, Michael and Sherry Nep, Nicole Levinson and Jacob, Jordan and Jayden Barientos. A memorial service was held Oct. 28 in Oak Park, Calif.


Stephen Sollock

Richard Cowley, 76, a retired propulsion engineer, died Oct. 18.

A Caltech graduate, Cowley worked at Boeing for 25 years, including the Saturn V program. Joining JPL in 1974, he provided propulsion support for the in-flight operation of the Voyager, Galileo, Mars Observer, TOPEX, Cassini, Deep Space One, Mars Exploration Rover and Dawn spacecraft. He retired in 2005.


Richard Cowley

Cowley is survived by his wife, Ann, and brother Stanley. The family requests that in lieu of flowers, donations be made in his name to a charity of choice.

Herman Bank, 96, a retired engineer who supported JPL's early missions in space science, died Nov. 2.

After joining JPL in 1947, one of Bank's first assignments was as project engineer for the Bumper Project, the first U.S. two-stage rocket that resulted in the first human-made object to reach extraterrestrial space. Bank also supervised the structural design for Explorer 1, the first U.S. satellite to orbit Earth, in 1958. He later was a supervisor on the Ranger and Surveyor missions to the moon.

Following his 1984 retirement, Bank founded Volunteer Professionals for Medical Advancement, a group that included JPL retirees and others with science backgrounds that worked with Los Angeles–area hospitals to advance medical technology.

Bank is survived by his wife, Irene; sons Sidney, Ron and Michael; and seven grandchildren.


Herman Bank

Letters

Many, many thanks first to JPL for the beautiful dracaena plant, then to my wonderfully patient co-workers in Facilities for their kind words and prayers, and finally to the awesome Protective Services security staff for their support and thoughts and for the cards that were sent with the passing of my mom. Everyone has been so loving in helping me get through this time that I feel lucky to be a part of this family. I miss her terribly, but I know that the time I spent with her will provide me with beautiful memories. "The pain becomes a part of you, like learning to wear a ring or a pair of eyeglasses. You get used to it. And that's good. It's good, because it makes sure you don't forget."

Gratefully,

Daryl Victor

Retirees

The following employees retired in November: **Kenneth Peralta**, 50 years, Section 2820; **Michael Kobrick**, 39 years, Section 3242; **Robert Ibaven**, 37 years, Section 3000; **Merle McKenzie**, 37 years, Section 1011; **Terry Gentry**, 27 years, Section 2814; **Laura Dunn**, 25 years, Section 5112; **Elizabeth Wilson**, 22 years, Section 318D; **Randolph Thompson**, 14 years, Section 5128; **Roberta De Lao**, 11 years, Section 5128; **Donald Osborne**, 10 years, Section 2812.

Correction: The retiree listing in the November 2012 Universe indicated that the employees shown had retired in November. In fact, they retired in October.

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