NASA Sets Sensors for 1990 Return to Mars

By JONATHAN EBERHART

With the U.S. space program reeling from the impact of three successive launch disasters since the beginning of the year, it could almost seem that NASA has simply ground to a halt. But though the agency's primary ways of getting into space are temporarily grounded during a morass of technological and managerial investigations, NASA continues where possible with its ongoing activities and long-range planning.

One key focus is a return to Mars. The four spacecraft of Project Viking, which reached Mars in 1976, spent years conducting the most sophisticated study of another world ever attempted by a single mission. Yet major questions remained. The craft were not equipped to analyze the composition of the surface, for example, except at the two tiny spots where Viking's two landing craft touched down. Surface elevations, vital to such questions as figuring out the flow direction of the planet's apparently water-carved channels, could be derived only for limited areas and with limited accuracy by combining the orbiters' photographs into stereo pairs. There were not even instruments to resolve the seemingly simple yet still uncertain matter of whether Mars has an intrinsic magnetic field.

Viking even raised tantalizing new issues of its own, revealing such details as the spectacular ice-dust-ice layering of the Martian north polar cap, as well as complex patterns of cloud and windborne dust. Yet increasingly tight NASA budgets year after year forestalled hopes of going back for another look.

Finally, in 1984, a go-ahead was given to a project called the Mars Observer, one of the highest priorities of the NASA-chartered Solar System Exploration Committee (SSEC) and foremost on an SSEC-proposed list of missions for a new generation of interplanetary spacecraft. Though planned to be launched in 1990 by the space shuttle, it could also be sent, if necessary (with some attendant redesign costs), aboard an expendable rocket.

The Mars Observer is to be a relatively modest craft, based on a communications-satellite design with weather-satellite subsystems and limited as to cost, size, weight and data-handling capacity. Yet space scientists have been eagerly awaiting NASA's announcement of what instruments it would carry, and dozens of proposals were submitted last year as candidates for the few available slots.

Last month, the agency announced its choices, although they must survive several more months of study to see whether all seven selected sensors will indeed fit within the mission's tight specifications. Additional delay could also result, depending on the resolution of a protest filed by one spacecraft manufacturer (Hughes Aircraft Co. in El Segundo, Calif.) over the means by which the spacecraft contract was awarded to another (RCA Corp. in Princeton, N.J.). But NASA's sensor selection has outlined a path for the mission's science.

Some of the instruments are straightforward enough, such as a magnetometer, which the Viking orbiters did not carry and for which the only available Mars data are controversial findings from early Soviet missions. Others, however, fill multiple roles, conceived by researchers who have watched in frustration as numerous post-Viking return-to-Mars mission ideas came and went without ever getting off the ground.

A thermal-emission spectrometer (TES), for example, proposed by Phillip R. Christensen of Arizona State University in Tempe, is designed to study not only the surface of the planet but also the dust in its atmosphere. The key is a movable mirror, which lets the instrument lower its viewing angle from one that looks ahead toward the planet's limb, or edge, to a spot directly beneath the spacecraft. This changing "path length" through the atmosphere thus exposes the sensor to emissions from varying amounts of dust, from which the fixed surface emissions can be distinguished.

In addition, the TES works in the mid-infrared wavelength band from 6 to 50 microns, rather than the more commonly used visible and near-infrared ranges. This makes it sensitive to key geologic spectral "signatures" such as those of quartz and feldspar, which Christensen calls "the two most common rock-forming minerals," and which have no corresponding spectral clues in the visible and near-infrared bands. The Viking orbiters each carried a related though simpler instrument, but they provided only five mid-infrared channels, while the TES offers 130.

Also on the Mars Observer list, assuming that it can be accommodated with the other sensors, is an unusual camera capable of taking pictures with widely differing degrees of resolution, including the sharpest photos of Mars ever taken from orbit. Spacecraft cameras have a reputation for consuming the lion's share of the available data-handling capacity, and the original instrument payload considered for the tightly constrained Mars Observer mission did not even include one. The proposal from a team headed by Michael C. Malin of Arizona State, however, "struck the reviewers as being particularly imaginative," says program scientist Bevan French of NASA, while project scientist Arden Albee of Jet Propulsion Laboratory in Pasadena, Calif., calls it "very innovative."

The device includes two complete optical systems, one of which consists of a 4-meter telescope that follows a folded optical path to keep it compact, and which is capable of photos with resolution as sharp as 1 meter per "pixel," or picture element, compared with Viking's 5 to 6 meters per pixel. Heat could cause distortion in such an instrument on a spacecraft, disturbing its focus, but Malin's telescope would embody a support structure made of a graphite composite material that is particularly resistant to thermal stresses. That idea was borrowed from the Hubble Space Telescope's wide-field planetary camera, two of whose mentors are co-investigators on Malin's Mars Observer team. The Mars camera's super-sharp images would cover patches of surface barely 2.5 kilometers on a side, which would consume prodigious amounts of data if they were used to map the entire planet. But "thanks to Viking," says Malin, "we know enough about Mars to pick discrete targets."

Another major instrument for the mission is to be a radar altimeter, different from the data-hungry synthetic-aperture imaging radars used by U.S. and Soviet Venus orbiters. From the Mars Observer's nearly pole-crossing orbit, the craft will be able to map elevations over the entire planet to within a few meters. In addition, it will carry a gamma-ray spectrometer capable of mapping concentrations of such key elements as calcium, iron and magnesium, as well as radioisotopes, including uranium, thorium and potassium. No such instrument has ever been sent to Mars. Also on the list are an infrared radiometer to profile the atmosphere, including its dust content, and an infrared mapping spectrometer capable of distinguishing patches of different rock types.

In 1988, two years before the Mars Observer arrives, a Soviet orbiter is also due, but it will be much farther from the planet—about 6,000 km as opposed to 361 — and in a near-equatorial orbit. Researchers on both sides hope that data from the two craft can be coordinated. Now, if the Mars Observer can just get off the earth. . . . □