

# Return to the Red Planet

## Tiny rover set to explore Mars

By RON COWEN

**T**his July 4 there will be fireworks on Mars.

Striking through the atmosphere and explosively discarding its heat shield, a spacecraft called Mars Pathfinder is set to parachute onto the surface of the Red Planet. The first craft to land on Mars in 21 years, Pathfinder marks the beginning of a parade of 10 spacecraft expected to visit the planet through 2005, when a NASA craft is scheduled to bring a sample of soil back to Earth.

Soon after Pathfinder lands, a six-wheeled rover the size of a milk crate will roll down a ramp from the mother ship. Operating on solar cells and a backup supply of D batteries, the rover, dubbed Sojourner, will investigate the rocks of the surrounding Martian terrain, becoming the first mobile robot to explore the fourth planet from the sun.

A half hour before Pathfinder strikes the atmosphere, if all goes according to plan, it will jettison the solar-powered arrays and navigation equipment it has relied on since its launch last December. At that time—roughly 12:30 p.m. EDT on July 4—engineers at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif., will command the craft to descend at an angle of 14° from the vertical. At too shallow an angle, the spacecraft will skip back out of the atmosphere. At too steep an angle, the craft will burn up.

Even at the correct angle, Pathfinder will slam into the upper atmosphere faster than a speeding bullet. A heat shield will protect the craft from the high temperatures generated by atmospheric drag and help slow it down.

About 2 minutes before landing, a mere 6 to 10 kilometers from the ground, the craft's parachute will unfurl, abruptly reducing its speed. After 20 seconds, tiny explosive charges will separate Pathfinder from the remnants of its heat shield.

Just seconds before ground zero comes a crucial maneuver: Pathfinder must rapidly inflate a cluster of airbags. Heavily swaddled, the craft will hit the ground

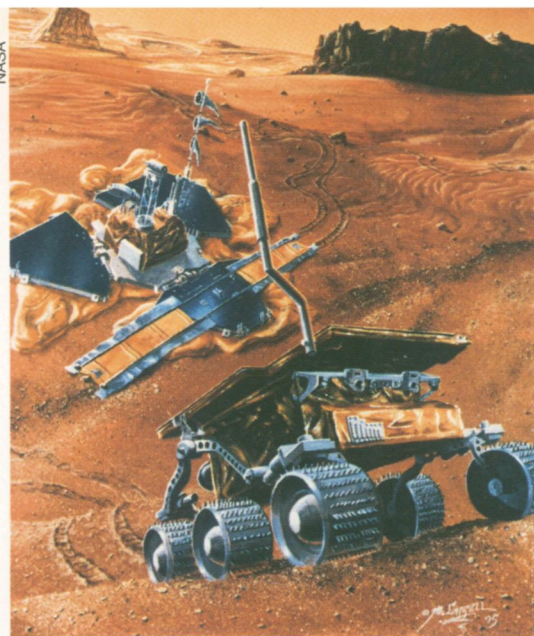
at 20 meters per second and bounce like a beach ball as many as 12 times before coming to rest on Martian soil some 3 hours before sunrise.

Even if the craft successfully completes all these maneuvers, Earthlings won't get a definite signal from Pathfinder until a nerve-racking 4 hours after the landing. Still in darkness, the craft must deflate and retract its airbags. Then, standing itself upright, Pathfinder will unhinge its side panels, allowing the first light of a Martian dawn to activate its solar arrays. Finally, at about 5 p.m. EDT, a small antenna will broadcast its first signals to Earth.

**I**f this transmission proves reliable, scientists will instruct the craft to deploy its stereo camera and its main communications antenna, roll out two ramps, and unlatch the 10-kilogram Sojourner.

A forerunner of more advanced robotic explorers, Sojourner is primitive, to say the least. It crawls at the painfully slow rate of 1 centimeter per second, cannot receive orders and move at the same time, and can stray no more than 500 m from the lander. Nonetheless, the mission will provide information on whether a small, remote-controlled device can navigate the dusty, rocky terrain and withstand the frigid, desertlike conditions of the Red Planet. Its primary mission will last a week or two, but it could continue to operate for up to 1 year.

Mission controllers aim to land Pathfinder within a 100 km by 200 km region called Ares Vallis, the mouth of a dried-up channel formed by ancient floods. Maneuvering out onto this flood plain, Sojourner will get up-close and personal with its surroundings—but only upon command from JPL scientists. Guided by the stereo images from the lander, they will decide in what direction Sojourner should proceed. The rover can climb rocks as high as 15 cm without tipping. A camera on the rover will record its



Artist's depiction of the Mars Pathfinder lander and its rover, Sojourner (foreground), scheduled to arrive at the Red Planet July 4.

surroundings.

To determine the elemental abundances of a rock, the rover will amble over and send a beam of helium nuclei into the material. Radiation emitted or scattered by the rock will be analyzed by Sojourner's spectrometer to provide a set of fingerprints that characterizes the rock's composition.

Exactly what kind of terrain Sojourner will sample remains a matter of debate. Ares Vallis lies at the mouth of a channel 1,000 km long, 100 km wide, and a few kilometers deep, notes project scientist Matthew P. Golombek of JPL.

A couple of billion years ago, says Golombek, this region "was eroded in a truly catastrophic event, in which the equivalent of all the water in the Great Lakes [rapidly] welled up and cut this channel." He suggests that the flood would have carried with it a smorgasbord of rocks, some from the neighboring ancient highlands, depositing them at Ares Vallis as the water drained away. Indeed, Golombek argues that Ares Vallis is tens or hundreds of meters deep in deposited material.

Raymond E. Arvidson of Washington University in St. Louis disagrees. Visible-light images provide evidence that volcanic activity after the flooding has smoothed over or obliterated many of the interesting rock types, he believes, leaving a relatively bland region for Sojourner to explore.

Given the mission's high stakes, Golombek and Arvidson have formalized their disagreement with a wager: The loser buys the winner a beer. The purveyor of the suds will be decided next week—assuming Pathfinder is successful.

"We'll be chewing our fingers to the bone, hoping for the best," says Golombek. □