

NASA'S SPACE

A Revolution in Planetary Exploration

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In nearly every home in America today, there is a virtual window to Mars. Tomorrow, there will be a virtual door. You and your children will walk through that door to explore new worlds.

Your virtual window to Mars was opened last July 4 when the Pathfinder lander and Sojourner rover began their explorations of the flood plain near Ares Vallis. These robotic explorers and their human colleagues sent Mars through the Internet to your home. This capability has great historical significance because never before have private citizens had such power to choose the course of their own extra-terrestrial explorations. Whenever you choose, you can gaze at the surrounding martian terrain as a continuous panorama, put on your red-blue glasses to visually wander among the flood-strewn boulders in dramatic stereo, watch the rover roll over and around obstacles, manipulate models of the rover, and even maneuver your viewpoint over a computer-generated model of the landscape. In a very real sense, we have become a nation of explorers.

Robotic exploration coupled with the Internet is helping to democratize planetary exploration, but the revolution is only beginning. New missions and new technologies will extend our reach. Today you can peer through a small window to Mars. Tomorrow you will also use better, cheaper, and more interactive virtual reality technologies to surround yourself with planetary environments. Walking through that door to Mars, you will visit the Viking landing sites, explore Valles Marineris, pick up and inspect rocks, and query the terrain about its composition. I know this is possible because I've already done it many times in my laboratory. The revolution comes when this kind of capability is as readily available as television.

NASA and its partners have been developing and using virtual planetary exploration techniques for more than 35 years. When NASA switched from merely photographing the planets to digitizing them, the revolution was born. Unlike individual photographs, digital models can provide

an infinite number of different views and behaviors. When the views are in accord with the viewer's head motion, the viewer feels as if she were actually present within the planetary environment. This sense of presence can be enhanced by enabling the virtual explorer to feel and act as if the environment were real. Thus, virtual planetary environments of the future will be not only realistic in appearance, but also genuinely useful and comprehensively informative.

While virtual reality allows us to extend our presence, it cannot replace physical presence because we cannot compute reality in all its complexity. Certainly no field geologist would prefer to explore a virtual Mars if she could wander the unexplored vastness of Mars itself with her rock hammer, 10X magnifying glass, sample bags, water bottle and backpack. Yet many earth-

bound planetary scientists and engineers can benefit from the sense of "being there," the natural spatial relationships, and the integrated wholeness that are provided by virtual planetary environments. The power of virtual reality is not that it is better than physical presence, but that it provides a greater sense of presence where there had been little. Further, a vastly greater number of people can experience that sense of presence.

But what about the dark side? Will robotic presence on the planets and moons replace human presence? Will virtual reality become just another crass and unsatisfying entertainment? Will the Internet become overwhelmed by commercial culture? And most frightening of all, will we lose our love of the frontier? The answers depend upon our choices. The incredible popularity of the Pathfinder/Sojourner Web sites and the continuing development of virtual planetary environments suggest that a new golden age of exploration is just beginning. In this new era, we can all be planetary explorers.

For a history of virtual planetary exploration, see <http://human-factors.arc.nasa.gov/IIIpublications/mcgreevy/VRPE/VRPE.abstract.html>

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