Space Shots

Pictures from a far frontier

A mosaic of Mangala Vallis, on Mars: the 450-mile expanse is being examined for potential landing sites.

BY JAMES W. HEAD III

Exploration was once only for the few: for pioneers, mountaineers, sailors, adventurers. When artists, illustrators, and mapmakers began accompanying expeditions, however, they produced pictorial records that could be shared by many. Since the last century, cameras have allowed voyagers of all kinds to share their travels with millions: from Antarctica to the pages of National Geographic in a matter of months, or from Saturn to the front page of the New York Times in a matter of hours.

In the past few years, the extraordinary pictures coming back from space have made us all explorers of the cosmos. Through these photographs, we have all visited other worlds—seen dust in the craters of the moon, explored huge canyons on Mars, active volcanoes on Jupiter's moon on Io, and the enigmatic rings of Saturn. Some of these photographs were taken by the Apollo astronauts, some by automated deep-space probes whose cameras were set in motion by complex operations involving many hundreds of people. In the making of some space photographs, then, the cameraman and the camera were only inches apart (on the moon, an electronic Hasselblad was fitted to a bracket on the astronaut's chest), while in others they were separated by a good stretch of the solar system.

These tremendous ranges of distance have taxed our technological capabilities to the limit. Many of the things we take for granted when photographing our surroundings on Earth, such as scale, perspective, and light—perhaps light above all—can be wildly different from planet to planet and from moon to moon.

On our moon, which has no atmosphere at all, the light is harsh, the shadowing stark. Each time they arrived at a sampling station, the astronauts would take a 360 degree series of pictures—to be pieced together, on their return to Earth, into a panaoramic mosaic. When they stood with their backs to the sun, the lunar landscape stretching before them appeared as a bright, washed-out plain. As they turned from side to side, the shadows formed by craters, hills, and mountains became prominent. Since each earth day that the astronauts remained on the moon amounted to only one twenty-eighth of a lunar day, they observed neither sunrise nor sunset from the lunar surface.

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After returning to lunar orbit, however, the speed of the spacecraft allowed them to experience an entire lunar day in a matter of hours. Soon after lift-off, half the moon seemed saturated with bright sunlight. As the spacecraft approached the moon’s terminator (the line separating day from night), the shadows grew longer and longer and the surface detail became crisper and sharper. Suddenly the lunar landscape was plunged into night, with the only hint of the rugged landscape below being an occasional high peak catching the final rays of sunlight.

As the astronauts’ eyes became acclimated to the darkness, they realized that they could actually see some features on the lunar surface. But how? The moon was being illuminated by Earthlight — by sunlight reflected off the Earth and onto its satellite. Equipped with high-speed film, the astronauts were able to obtain pictures by Earthlight.

Soon the spacecraft passed out of view of both Earth and the sun, and the astronauts were plunged into total darkness. Distant stars became the only source of light in the sky, and the only sign of the moon was a black hole where no stars shone. As the spacecraft moved toward sunrise, the first rays of the sun shot like lightning bolts through the spacecraft windows, and in a brief second (there was no predawn glow) night was over and day had begun again.

Then, as the spacecraft rounded the moon, the astronauts saw — and captured on film — a sight that moved them deeply: Earthrise.

The astronauts, of course, simply carried home their pictures for processing on Earth. Most spacecraft, however, do not return to this planet. The Lunar Orbiter processed its film onboard, electronically scanned the developed image, and faithfully transmitted the image to Earth (including the occasional bimat bubbles that cropped up when the chemical smear in the processing system did not spread evenly), where it was reconstructed and printed. The Mariner spacecrafts scanned the planets with television cameras, whose
1. A ten-foot boulder at the rim of Cone Crater on the moon
2. The tripod serves as a gnomon for documenting the size, gray value, and location of lunar rock samples
3. Detail of the ice fields that cover the north polar region of Mars; they are melting during summer, as shown by the dark bands
4. Apollo 12 astronaut Alan L. Bean on the lunar plains of Mare Procellarum
images were converted to digital form and sent to Earth as streams of numbers. In the case of Mariner 9's images of Mars, each picture taken contained 700 lines, each line 832 picture elements (nicknamed pixels), and each pixel 512 levels of brightness—in all, more than five million bits of information.

As a deep-space probe travels outward through the solar system, the light slowly diminishes. The first Voyager spacecraft, launched from Earth, looked back and obtained an image of the earth-moon system in brilliant sunlight. As it hurtled by Jupiter and its moons, the sun's intensity dwindled to only four percent of its value near Earth. As it passed Saturn, the level fell to one percent, and the sun appeared as a very tiny, very bright light in the black sky. The farther away the probe travels, the greater must be the sensitivity of its electronic imaging system.

Conventional photography records a scene only in visible light. But with visible light alone, it is impossible to photograph the surface of a cloudshrouded planet like Venus. We all know how greatly clouds and haze affect the lighting within the atmosphere of Earth: Imagine, then, how little light penetrates to the surface of Venus, where the atmosphere is one hundred times more dense. The Soviet spacecraft that first descended to the surface of Venus carried floodlights, in case the surface was too dark to obtain pictures. But that was only one of many possible solutions.

Technological advances in the last few decades have enabled us to obtain images at wavelengths of light both longer and shorter than those visible to the human eye. Imaging systems designed to operate at radar wavelengths have been used to penetrate Venus's thick cloud cover and to photograph the planet's surface. In one sense, this procedure is analogous to studio lighting, in that the light source (the radar transmitter) can be oriented in relation to the subject to be photographed.

Images of planetary surfaces at these and other wavelengths allow us to see with different sets of eyes, and help us to appreciate the many ways in which other life forms might perceive and explore their worlds.