The Strange Case of Fobos-2

By Jim Oberg
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If Robert Frost had been the poet laureate of space flight, he might have written, "Something there is that doesn't like a Mars probe." And a comic cartoonist once drew an ugly, hungry space beast lurking near Mars to devour Earth's space vehicles (the painting hung on the wall of a mission manager at NASA's Jet Propulsion Laboratory for years). You get the picture.

This past decade has not been kind to Earth's Mars probes. There was NASA's expensive Mars Observer blowing up in 1993 as it warmed its rocket engines up to slow into orbit. And we've just seen both of NASA's 1999 missions fail.

Russia lost another ambitious probe in 1995 when its upper stage failed, dumping radioactive fragments onto the Andes Mountains. And a Japanese mission, their first to Mars, went off course right out of the gate in December 1998.

But the most bizarre loss of a Mars probe is unarguably the case of Phobos-2 (or Fobos-2, in the Russian spelling). It "disappeared" in March 1989, under very unusual circumstances that still mystify and excite many people.

Recent developments in the Russian space program have opened new insights into that failure. But first, here's some history.

Trying to lift the curse

The Soviet Union launched two probes towards Mars in mid-1988, trying to break a decades-old jinx. Its initial series of small probes (1960-1965) had been a total disaster, and a series of heavier probes (1969-1973) didn't do much better. But this third generation was much more promising.

The spacecraft "bus" -- the main body -- was of an entirely new design. It had new engines, new computers, new communications gear. And this new mission carried subsatellites to be dropped onto the inner Martian moon, Phobos.

But the old jinx still prevailed. The first probe was lost due to an erroneous command on the outbound leg. The second vehicle was crippled by electronics failures and by the time it reached Mars on January 30, 1989, it was operating on its last and lowest-powered radio.

Nonetheless, it slipped into orbit around Mars and slowly matched its path with Phobos. As it closed in, it also made observations of Mars.

A dozen times, it turned its cameras away from Mars and towards Phobos. This required the whole spacecraft to turn, since a movable "scan platform" hadn't been installed. The maneuver also turned the dish antenna away from Earth, cutting communications for several hours each time.

On March 27, 1989, the probe began another Phobos photo maneuver, and as expected radio signals ceased. But after the planned maneuver, when listeners on Earth expected to reacquire the signal, nothing was heard. More careful listening picked up brief bursts of radio signals, as if the dish antenna were swinging wildly through space and only occasionally beaming back towards Earth. Then -- only silence.

Strange shadows explained

But not for long. Soon a strange and wonderful story grew and spread, about mysterious structures observed on the surface of Mars. The probe's last view, so the tale continued, showed a miles-long oval object closing in. The object's elliptical shadow could be seen on the surface of Mars thousands of miles below.

And indeed, cigar-shaped shadows were plainly visible in many of the 37 photographs that the doomed probe sent back to Earth during the 60 days it survived circling Mars.

Such images are not unusual in the archives of American Mars orbiters, from Mariner-9 to the Viking Orbiter twins, to the Mars Global Surveyor, still at work there to this day. In those cases, what was seen were shadows of the moonlet Phobos, stretched by being projected at a low angle to the Martian surface.

But Fobos-2 was on a different orbit, and for the last few weeks it was fairly close to the moon Phobos. Thus, any view of that object's shadow on Mars would have to be fairly circular. Think about the geometry -- use props if you want to. It's an illuminating exercise in 3-D perspectives. If you're next to a roundish object casting a shadow, the shadow will look more-or-less roundish to you no matter how steeply tilted the surface it's projected on is lying.

So where did the cigar-shaped shadow come from?

Several years ago, mission scientist Aleksandr Selivanov explained the cigar-shaped shadow in the Fobos-2 images this way.

The imaging system is a "scanning radiometer," not a camera, Selivanov pointed out. A rotating mirror moves perpendicular to the line of the probe's motion over Mars. As a result, "a picture is generated by the motion of the spacecraft in its orbit." The probe did NOT gather an entire image in one snap, but accumulated it over a period of time, line by line.

Fobos-2 was staring straight back along the Sun-to-Mars line, to get the

best infrared readings. In contrast, visible light imagers prefer to look for shadows cast by surface features, so they are aligned at large angles to the Sun's rays. This made the visible-light images from Fobos-2 look washed out.

Now, Fobos-2 was quite near the moon Phobos in the last days of its flight, both circling Mars along the same path. So the roundish shadow of Phobos was on Mars's surface, within the field of view of the scanner, when the scanner was looking "down sun" at Mars.

Selivanov explained that if the probe had been rock steady, the Phobos shadow would have left a dark streak right through the entire center of each image, as the image was assembled line-by-line over the course of each orbit. Because of a slight rocking of the probe, however, the scanning beam "sliced" the Phobos shadow at different points, from back to front, over the course of each imaging session.

The resulting elongated shadow is thus an artifact of the imaging technology, and of the probe's motion through space and around its own axis. Selivanov argued that since these shadows are all precisely aligned along the probe's flight path over Mars, they are unquestionably not shadows of other objects near Mars. They show the shadow of Phobos.

One supposed photograph, the "last one before the attack," shows Phobos and a bright vertical line below it. Since the line runs right along the telemetry scan lines, space experts are confident it is some sort of transmission flaw, not a real object in space. Besides, the date on the image is March 25, two days before the probe's loss.

Hurry and other human errors

The breakdown of Fobos-2 was disappointing to experts associated with the program, but not surprising. They had seen human error doom its sister craft, Fobos-1, before it even got to Mars, and they had seen signs that Fobos-2 wasn't in much better shape.

Dr. Larry Soderblom was one of the American scientists who had instruments aboard the probe. "There is a feeling in the American space science community the Russians were in too much of a hurry," he later told a reporter. "The two satellites lost were launched without much thought to a system of checks and balances that might have prevented such problems."

And even the design was questionable. "Soviet scientists at the Space Research Institute in Moscow complained that the new, sophisticated spacecraft actually was designed for purposes other than those for which it was being used on the missions to Phobos," wrote a British space expert. "Engineers adapted it for the mission in order to flight-test it for future missions to which it was considered better suited."

These problems were recognized even as the missions were launched. I remember telling another reporter: "I'd be surprised if both make it -- and I wouldn't be surprised if neither do."

Everything returns

But space is full of surprises, and 11 years later, Fobos-2 has suddenly been reborn. A rocket stage based on its design was launched into orbit on February 9 and performed perfectly. A second and more ambitious test on March 20 also went perfectly.

The stage is called "Fregat," Russian for "Frigate" -- and in fact, on many Fobos-2 photographs from 1989, one can read the designation "Phobos-Fregat." In 1995, project manager Vladimir Ashushkin described to me his hopes for a commercial deal to carry paying customers into space by adapting and improving the interplanetary module.

That deal has now been signed with a number of European customers and Fregat spacecraft will soon be heading off into space again, into high Earth orbits, out to the moon, and even back to Mars -- a Fregat is slated to carry the European Space Agency's Mars Express probe in 2003.

With a better design, and better luck, the curse of Fobos-2 may be dispelled. But Mars may have its own ideas about that!