

Post Mortem: The Lost Mars Probe

Assignment: Read this article and answer the questions on the other side of the page.

The probe was a 338-kilogram (745 lb) robotic space probe launched by NASA to study the Martian climate, atmosphere, and surface. The probe measured 2.1 meters (6 feet 11 inches) tall, 1.6 meters (5 feet 3 inches) wide and 2 meters (6 feet 7 inches) deep. The internal structure was largely constructed with graphite composite/aluminum honeycomb supports, a design found in many commercial airplanes. With the exception of the scientific instruments, battery and main engine, the spacecraft included dual redundancy on the most important systems.

The probe featured a single computer using an IBM RAD6000 processor. Data storage was to be maintained on 128 MB of random-access memory (RAM) and 18 MB of flash memory. The flash memory was intended to be used for highly important data, including triplicate copies of the flight system software. Spacecraft software was provided by the Jet Propulsion Laboratory (JPL) in Pasadena, and ground software by the Lockheed-Martin Corporation.

The cost of the mission was \$327.6 million total for the orbiter and lander, comprising \$193.1 million for spacecraft development, \$91.7 million for launching it, and \$42.8 million for mission operations.

The probe was launched by NASA from the Cape Canaveral Air Force Station in Florida. The complete burn sequence sent the probe into a 9.5 months, 669 million km (416 million mi) trajectory. At launch, the probe weighed 638 kg (1,407 lb) including propellant.

Mission scientists managed the spacecraft constantly to make sure it stayed on the right path. Spacecraft like this probe have reaction wheels—spinning units that keep it oriented in a certain way—and the spacecraft's angular momentum must be constantly monitored and adjusted to keep those reaction wheels working within range.

First, spacecraft data is transferred to the ground and processed by a software program written by Lockheed-Martin Corporation. The operations navigation team from JPL then used that information to model the forces acting on the spacecraft and adjusted its trajectory by firing its thrusters as needed. After every thruster firing, the change in velocity was measured and calculations about its performance carried out both by the spacecraft and by support computers on Earth.

Almost immediately it was apparent that something wasn't working right. The numbers from the spacecraft and the ground computers didn't match. The spacecraft had to make 10 to 14 times more minor adjustments than engineers expected. And the last few signals from the orbiter indicated that it was dipping dangerously low into the Martian atmosphere, about 170 km (105 miles) lower than it was supposed to go.

The probe began the planned orbit maneuver 9.5 months later. The probe went out of radio contact when the spacecraft passed behind Mars, 49 seconds earlier than expected, and communication was never reestablished.

Ultimately, the probe came within 60 km (37 miles) of the Martian surface. Simulations showed that, at any altitude lower than 85 km (53 miles), atmospheric friction would tear the fragile craft apart or send it bouncing back into space, damaged.

Sources: Wikipedia, Wired, Vice

Questions

Name: _____

What are possible causes why the probe either crashed or vanished into outer space? List as many as you can think of.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Hints:

- Is there something in particular that makes this article difficult to read?
- Which facts may be irrelevant to the problem?
- Specific problems with the spacecraft itself?
- Specific problems with the software?