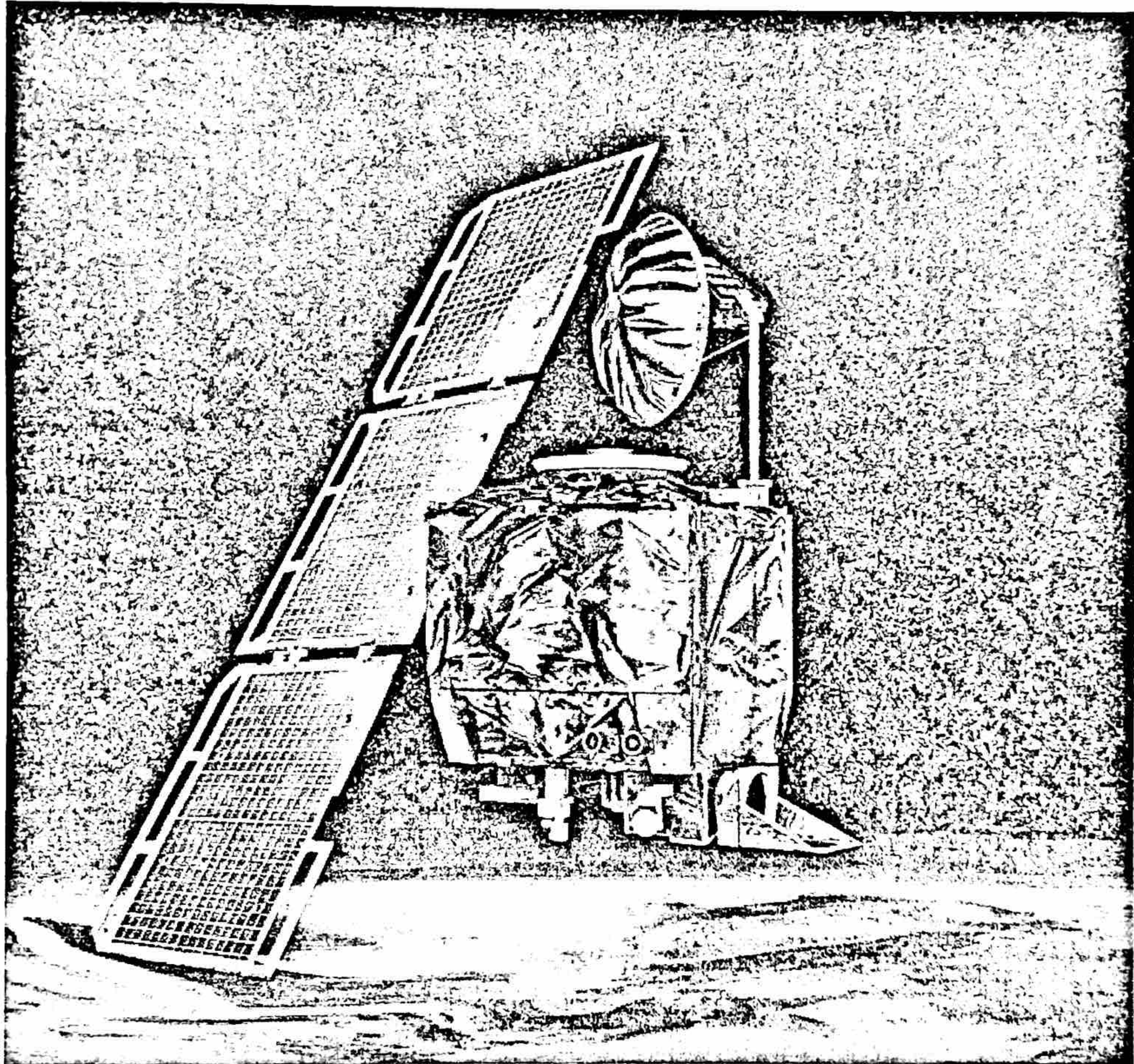


NOV. 10, 1999: METRIC MATH MISTAKE MUFFED MARS METEOROLOGY MISSION



1999: A disaster investigation board reports that NASA's Mars Climate Orbiter burned up in the Martian atmosphere because engineers failed to convert units from English to metric.

Mars Photo Galleries:



Where Will Next Mars
Rover Land?

The \$125 million satellite was supposed to be the first weather observer on another world. But as it approached the red planet to slip into a stable orbit Sept. 23, the orbiter vanished. Scientists realized quickly it was gone for good.



Exotic New Mars Images From
Orbiting Telephoto
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Strange Places on
Mars: What Do You
Want to See Next?

It was pretty clear that morning, within half-an-hour, that the spacecraft had more or less hit the top of the atmosphere and burned up,” recalled NASA engineer Richard Cook, who was project manager for Mars exploration projects at the time.

A NASA review board found that the problem was in the software controlling the orbiter’s thrusters. The software calculated the force the thrusters needed to exert in *pounds* of force. A separate piece of software took in the data assuming it was in the metric unit: *newtons*.

“The units thing has become the lore, the example in every kid’s textbook from that point on,” Cook said. “Everyone was amazed we didn’t catch it.”

There had been warning signs, the mishap board found. En route to Mars, 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 105 miles lower than it was supposed to go.

Ultimately, the Mars Climate Orbiter came within 37 miles of the Martian surface. Simulations showed that, at any altitude lower than 53 miles, atmospheric friction would tear the fragile craft apart.

The whole thing could be written off as a miscommunication. Propulsion engineers, like those at Lockheed Martin who built the craft, typically express force in pounds, but it was standard practice to convert to newtons for space missions. One pound of force is about 4.45 newtons. Engineers at NASA’s Jet Propulsion Lab assumed the conversion had been made, and didn’t check.

But there was an underlying issue in the culture of NASA’s space exploration at the time, Cook said.

“‘Better, faster, cheaper’ was the mantra at the time,” Cook said. “Certainly that project was trying to do a whole lot for a limited amount of money.”

The New York Times ran a preview article Sept. 21 titled “Beginning a Bargain-Basement Invasion of Mars,” foreshadowing the disasters to come.

The Mars Polar Lander, which launched 23 days after Mars Climate Orbiter, also disappeared on the way to the planet’s surface. Vibrations in that craft’s legs may

have convinced the craft's on-board computer it had already landed, when it was still 100 feet in the air.

"The specific reasons [for that failure] were totally different," Cook said. "But the underlying part[s], this overly ambitious appetite, were the same."

Cook said NASA made some "big-time" changes after that. Several planned missions, including a mission that was to bring Mars rocks back to Earth, were scrapped. The space agency went back to basics, rebuilding its Mars program based on conservative strategies and concepts that had already been tested.

And it worked. The fantastically successful Mars Exploration Rovers, Spirit and Opportunity, rose from the ashes. Not only did the rovers both land safely and complete their original 90-day mission, but they're still running six years later.

"In this business, you're either just shy of it working ... or the thing looks bulletproof," Cook said.

Source: Various

Image: Mars Climate Orbiter/NASA

See Also:

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- Dec. 7, 1999: RIAA Sues Napster
- Dec. 31, 1999: Horror or Hype? Y2K Arrives and World Trembles

Mars Rover Assignment

1. What was the purpose of the Mars Rover?
2. Why was the calculation error a major problem? How could that have been avoided?
3. After reading the article, what recommendations would you give to NASA? Provide a reasoning from the article.