Pace Quickens for NASA Spacecraft Orbiting Mars

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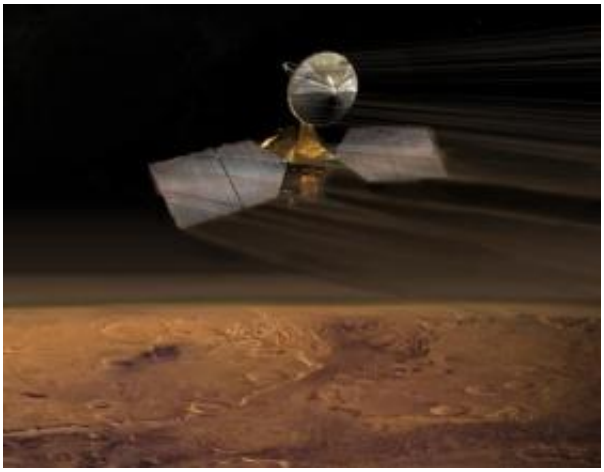

Artist concept of Mars Reconnaissance Orbiter during aerobraking. Image credit: NASA/JPL

NASA's newest spacecraft at Mars has already cut the size and duration of each orbit by more than half, just 11 weeks into a 23-week process of shrinking its orbit. By other indicators, the lion's share of the job lies ahead.

"The orbits are getting shorter and shorter. We've finished about 80 of them so far, but we have about 400 more to go, and the pace really quickens toward the end," said Dan Johnston, Mars Reconnaissance Orbiter deputy mission manager at NASA's Jet Propulsion Laboratory, Pasadena, Calif.

Supplementing the daily attentions of navigators, engineers and scientists, the orbiter has begun using unprecedented onboard smarts to schedule some of its own attitude maneuvers during each orbit.

The current phase of the Mars Reconnaissance Orbiter mission, called "aerobraking," began in late March with the spacecraft in a pattern of very elongated, 35-hour orbits. It will end in early September, according to current plans, once hundreds of careful dips into Mars' atmosphere have adjusted the orbit to nearly circular, two-hour loops. Then, after some touch-up engine burns, deployment of a radar antenna and other transitional tasks, the spacecraft will be in the right orbit and configuration to start its main science phase in November.

During the two-year science phase, Mars Reconnaissance Orbiter will examine Mars from subsurface layers to the top of the atmosphere. It will use its 3-meter (10-foot) diameter dish antenna to pump data Earthward at up to 10 times the pace of any previous Mars mission. Besides providing information about the history and extent of Mars' water, the orbiter will assess prospective landing sites for NASA robots launching in 2007 and 2009.

When the spacecraft first entered orbit around Mars, its farthest point from the planet was about 45,000 kilometers (28,000 miles). After 11 weeks of aerobraking operations, this distance has been reduced to about 20,000 kilometers (12,000 miles). On each orbit since early April, the nearest-to-Mars portion of the orbit has passed through the upper atmosphere, usually at about 105 kilometers (65 miles) above the surface of the planet. The drag created by interaction of the atmosphere with spacecraft surfaces slows the craft.

"Our biggest challenge is the variability of the atmosphere," Johnston said. "It's not uncommon to get a 35 percent change in how much drag the spacecraft experiences from one pass to the next. We need to

monitor each pass carefully and be prepared to change the altitude to a safe one for the next pass, if necessary."

While the orbiter is above the atmosphere, it can orient its antenna toward Earth and its solar panels toward the sun. Before it enters the atmosphere for each pass, it pivots so that the back surfaces of the solar panels and antenna face the direction of travel. An innovative capability of Mars Reconnaissance Orbiter's onboard software enables it to calculate the time when it needs to reorient itself for the next pass. This feature, called "periapsis timing estimator," was activated in May.

JPL's Jim Graf, project manager for Mars Reconnaissance Orbiter, said, "In the past, the times for turning to aerobraking attitude had to be calculated on the ground and sent to the spacecraft for each pass. Now, the spacecraft can do that itself. This will be especially helpful when the spacecraft gets to the point when it is doing several drag passes per day."

Mars Reconnaissance Orbiter is the third NASA Mars mission -- after Mars Global Surveyor in 1997 and Mars Odyssey in 2001 -- to use aerobraking to get into a desired, near-circular orbit. The strategy allows launching the spacecraft with much less fuel than would be required if using just rocket engines to decelerate into the desired orbit. Each drag pass this month is slowing Mars Reconnaissance Orbiter by an average of about 2 meters per second (4.5 miles per hour), which would otherwise require consuming about a kilogram (2.2 pounds) of fuel.

Transition activities during the two months between the end of aerobraking and the beginning of the main science phase will include unfolding two 5-meter (16-foot) lengths of antenna for a ground-penetrating radar instrument, removing the lens cap from a mineral-identifying spectrometer instrument and characterizing all instruments' performance in different modes of use. From early October to early November, Mars will be nearly behind the sun as viewed from Earth.

Communication with all spacecraft at Mars will be unreliable during portions of that period, so commanding will be minimized.

Source: NASA