Does low cost mean low-value missions?

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Despite an increase in the number of planetary missions, views are mixed about whether NASA's policy of 'better, faster, cheaper' is working.

Scientists have not all been convinced about the effectiveness of the 'leaner' approach to planetary exploration — in the wake of the Cassini launch to Saturn, the selection of two Discovery missions and the Pathfinder landing on Mars.

Five years ago, the US National Aeronautics and Space Administration (NASA) introduced its Discovery line to bring down the price and complexity of planetary missions. Discovery projects are capped at about \$280 million and a maximum development time of three years.

Six Discovery spacecraft have now been approved for launch, after last week's selection of the Comet Nucleus Tour (CONTOUR) to visit near-Earth comets and the Genesis mission to return samples of solar wind particles. NASA hopes to choose one or more new missions every 18 months.

Conventional wisdom is that large, expensive projects such as Cassini (total US investment of \$2.6 billion) have become politically and economically impossible. That leaves Discovery and a separate line of Mars missions as the only approved US planetary projects for the future.

Yet these alone do not constitute a full, balanced programme of Solar System exploration, some scientists argue. Discovery has unquestionably increased the number of planetary spacecraft in the launch queue. But the scientific return on these missions has not been demonstrated, and some of their drawbacks are already apparent.

What priority for science?

So far, the only completed mission has been the \$200-million Mars Pathfinder, which was primarily a demonstration of new technology, with science as a secondary goal. It was an engineering and public relations triumph, and an important demonstration of lean mission management — all of which scientists applaud. At the same time, says one, it contributed "damn little" new scientific information.

The past existence of water on Mars was already well known. Pathfinder's most intriguing results remain ambiguous, partly because of the limited capability of low-cost instruments. The onboard rover, for example, photographed what appear to be conglomerate rocks formed by water, but the image resolution is too low to settle the

matter conclusively. The same goes for hints of quartz and other Earthlike minerals in Martian rocks: chemical data without mineralogy are unlikely to nail down the answer. In short, says one scientist who still praises Pathfinder as an engineering and management experiment, "our perceptions of Mars haven't changed that much".

Discovery missions also appear limited in the kinds of objects they can study. Officially, the programme is open to any destination in the Solar System. But of the six missions selected so far, four will target nearby comets, asteroids or the solar wind, which are relatively easy and inexpensive to reach.

The \$63-million Lunar Prospector, the cheapest concept yet selected, has experienced another kind of problem, also related to low cost — repeated delays owing to its reliance on an unproved launcher, which has suffered teething troubles.

Scientists interested in the small bodies of the Solar System may now be getting their just rewards, after enduring NASA's cancellation of several planned asteroid and comet fly-bys over the past two decades. But it is not yet clear that Discovery missions can afford to go anywhere else.

The three losers in the most recent round of competition were a spacecraft to orbit Mercury, another to return samples of the Martian moons Phobos and Deimos, and a third to study the atmosphere of Venus. The first two were priced at the high end of Discovery's \$280-million cost cap, whereas CONTOUR came in at \$154 million and Genesis at \$216 million. It is widely believed in the planetary science community that the cheapest Discovery proposals tend to win.

Christopher McKay of NASA's Ames Research Center — who admits that his own unsuccessful Discovery proposal to send a spacecraft to Jupiter's moon Europa might have broken the cost cap — says that the cost constraints mean it is appropriate to send these spacecraft to comets and asteroids.

Because instrumentation is limited on these cheap flights, it makes sense to pick destinations that have not yet been explored, where one or two focused experiments can advance scientific knowledge, says McKay. "Perhaps the only good science you can do with these missions is to go to new places."

But that means some of the Solar System's most intriguing destinations, including the

Pictures versus data? Pathfinder produced great images of Mars, but little scientific information.

innermost and outermost planets, may be out of Discovery's reach. The more powerful launch vehicles, nuclear-powered batteries, thermal controls and other extras that they require eat up most of a mission's cost, with little or nothing left for experiments.

NASA, however, is aware of the problem. The agency's plan — which most planetary scientists support — is to develop technologies it hopes will cut mission costs. Spending has been increased on developing lightweight spacecraft parts, efficient power sources, solar electric propulsion and other enabling technologies, particularly those required for deep space exploration.

Aiming for the outer planets

NASA also hopes to begin a new line of outer planets missions in fiscal year 2000 to fill the void left by Discovery. They would presumably cost more, but how much more is not clear. The top contender is a Europa Orbiter, with a solar probe and a mission to Pluto and the Kuiper belt also under consideration.

But the Pluto project has been struggling for several years to meet strict cost targets set by the NASA administrator, Daniel Goldin. Engineers at the Jet Propulsion Laboratory have so far been unable to meet those targets.

Jonathan Lunine of the University of Arizona, a Cassini investigator who also led a science definition team for the Pluto Express concept, says that doing meaningful science at Pluto for \$250–\$300 million continues to be "very challenging".

Most US planetary scientists accept the need to bring down the cost of planetary exploration, and applaud NASA's drive for economy. But McKay says: "People may have prematurely said there will be no more big missions." It may be, he adds, that "dollar for dollar, Cassini is doing a lot more science" than the Discovery missions will.

Lunine says: "If we're going to explore the Solar System in a scientifically and culturally exciting way, we're going to have to pay for it." In other words, there should be a mix of small and intermediate missions. And perhaps 'expensive' should not always be considered bad. □