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## Piggy-back mission will hit Moon hard

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Kimm Groshong

The silence of a frigid, perpetually dark crater at the Moon's South Pole will soon be shattered. A new mission, announced by NASA on Monday, aims to smash an SUV-sized impactor straight into the crater in late 2008.

The Lunar Crater Observation and Sensing Satellite (LCROSS) was selected as a high-risk, high-pay-off, "piggyback" mission, to share a heavy launch vehicle with the Lunar Reconnaissance Orbiter. LCROSS has a \$80 million budget cap. It is designed to help determine the form in which the hydrogen detected by previous orbiters at the South Pole is held, and whether it could be used by future human explorers.

Previous observations found evidence of hydrogen in cold craters, but whether that is held as water ice or hydrogen-bearing minerals is not known. The question is important, NASA's Scott Horowitz told reporters, because to fulfil President George W Bush's Vision for Space Exploration, "we're going to have to learn how to live off the land".

Both the Lunar Prospector and Clementine missions reported relatively high abundances of hydrogen at the lunar poles, perhaps left from comet impacts in the always-shadowed floors of polar craters.

### Heating dirt

Michael Duke, director of the Center for Space Resources at the Colorado School of Mines says "if the hydrogen is there in a useful form and we can get to it, then it can become a resource" to make water or propellant on the Moon.

But he says its usefulness depends on how the hydrogen is distributed. "If it's spread out too thinly, or mixed too greatly with the soil, then to extract it you'd have to heat a lot of dirt to drive off a little bit of hydrogen or water."

Seeking answers about the mysterious hydrogen, LCROSS will use the launch vehicle's upper stage as a 2000-kilogram impactor. The blast should create a crater roughly 5 metres deep and about 30 metres wide, and throw 1000 tonnes of debris as high as 64 kilometres up.

A "shepherding spacecraft" will observe the hit with two cameras and four spectrometers. It will then fly through the plume of tossed-up material, relaying more images and data, before crashing itself 15 minutes later, perhaps 100 metres away.

At least a dozen ground-based observatories will also try to watch the event and its aftermath. Several Moon orbiters will have the opportunity to make follow-up observations, including the newly-arrived LRO and India's Chandrayaan-1 and Japan's Selene missions.

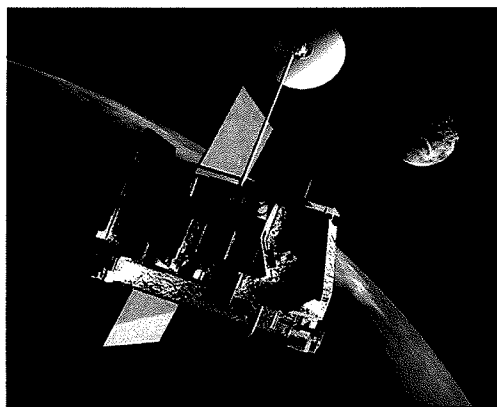
### Extra power

LCROSS was selected from 40 ideas to become LRO's piggy-back mission. In January, Horowitz decided for technical reasons that a larger launch vehicle than the Delta II originally slated should boost the LRO into space. The extra power meant an additional payload, up to 1000 kilogrammes in size, could be lifted to the Moon without additional launch costs.

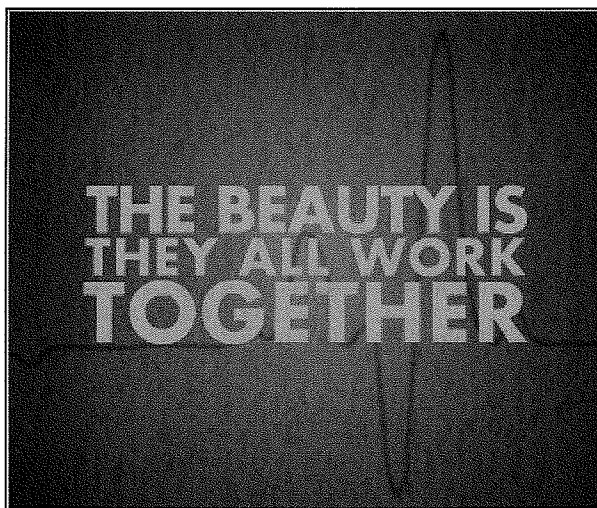
NASA quickly collected the 40 ideas from industry and 19 proposals were submitted by NASA centres for evaluation. In the end, the competition came down to four finalists from which LCROSS, led by project manager Dan Andrews of Ames Research Center in Moffett Field, California, was the winner.

The LCROSS mission will not be the first to deliberately hit the Moon. In July 1999, the Lunar Prospector orbiter was targeted at the surface, having reached the end of its primary mission.

But Butler Hine, deputy program manager for the Robotic Lunar Exploration Program at NASA Ames, says Prospector came in at a low angle, mostly skidding across the lunar surface. In contrast, LCROSS is aiming to crash into Shackleton Crater at an angle of about 75°, and therefore hit the surface harder.



LCROSS will hitch a ride to the Moon with the Lunar Reconnaissance Orbiter, shown here (Illustration: NASA)



If no water is observed in the plume of the impact, Hine says it would not completely rule out the presence of water. It could mean water ice is distributed in clumps and the impactor missed them.

Duke says for that reason he is more interested in the possibility of a rover that could study many spots within a crater, looking for the hydrogen sources. Hine says landers are planned for later in Robotic Lunar Exploration Program.

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