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Return to the Moon: Mending Fences Between Exploration and Science
 By [Leonard David](#)
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HOUSTON, Texas - NASA's new goal of establishing a 21st century Moon base will require bridge building while [mending fences](#) between space scientists and exploration technologists.

Space agency planners foresee a step-by-step, module by module buildup of a [lunar outpost](#), one that starts with four-person crews making several seven-day visits to the [Moon](#). That initial encampment will later be fortified by power supplies, rovers and additional housing.

The first lunar live-in mission would begin by 2020, followed by 180-day stayovers to prep for journeys to Mars.

As space engineers hammer out a proposed lunar architecture, the call is coming for lunar scientists to aid in picking the best site for a base. Scientific direction is also needed to define what human explorers can uniquely do on the Moon. Also, there's need for scientists to help catalog and evaluate how best to utilize lunar resources so explorers can "live off the land" in support of long-term visits to the Moon.

At the 2nd Space Exploration Conference, held here December 4-6, NASA provided a status report on implementing the Vision for Space Exploration--one that will be measured by effectively employing both science knowledge and technological know-how.

Volley of Moon probes

NASA's robotic [Lunar Reconnaissance Orbiter](#) (LRO)--due to fly in late 2008--is seen as a key spacecraft that will chart the Moon as never before. Among its duties, LRO will hone in on site selection of a lunar outpost.

But LRO is but one of a volley of Moon probes being readied for their respective liftoff. Next year, China's [lunar orbiter](#)--Chang'e 1--as well as Japan's Selenological and Engineering Explorer (SELENE) will be bound for the Moon. India's [Chandrayaan-1](#) is to follow in early 2008.

Each lunar spacecraft can relay noteworthy science data--a collective bonanza of new information to promote fruitful human visits to the crater-pocked Moon.

The bridging of science with NASA's exploration rebound to the Moon was highlighted by Shana Dale, NASA Deputy Administrator.

Dale said that scientists from the European Space Agency, India, Japan, Russia and the United States recently met to strategize robotic Moon exploration plans. One objective of the gathering, she noted, was provided a technical basis for potential cooperative observations

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Moon Base would be built in increments over time, leading to permanent housing on the lunar surface for expeditionary teams. This drawing depicts a notional view of such an outpost. Image Credit: NASA

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One favorite site for a lunar base is at the Moon's south pole - a strategic locale on the rim of Shackleton Crater that's almost permanently sunlit. Operators at the solar-energized outpost could use in-situ resource utilization (ISRU) technology to plumb the depths of always darkened craters nearby for possible concentrations of water ice. Image Credit: NASA

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using NASA's LRO with other international missions.

The LRO Science Project Working Group, Dale said, is also endeavoring to create a common coordinate system with international missions to the Moon, as well as propose and discuss standard calibration targets for all lunar missions to observe.

The intention of these joint discussions is to foster "openness and flexibility in all parts of this evolving lunar architecture," Dale added.

Lunar data restoration

In other lunar science news, Colleen Hartman, NASA Science Mission Directorate Deputy Associate Administrator, announced creation of a Lunar Advanced Science and Exploration Research (LASER) program, shaped around four areas: basic science, exploration science, data analysis and lunar data restoration.

Moving outward to the red planet, Hartman added, the robotic Mars Science Laboratory is being readied for sendoff in 2009. That large rover will make the first radiation measurements from the planet's surface, she said, fact-checking measurements that are essential to the safety of any future expeditionary crew that lands on Mars.

Overall, in Moon, Mars and beyond exploration, "we are going today with the human spirit in our robots and our machines and our telescopes. Tomorrow we'll go with human beings," Hartman concluded.

Moon: school for exploration

"The Moon is a school for exploration...the springboard and stepping stone for the rest of the solar system," said Paul Spudis, senior scientist at The Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland.

"The Moon is a major scientific target--not only to learn about its own history and evolution but the history and evolution of the planets as well, Spudis said.

Among the many virtues of returning to the Moon, Spudis underscored its value as a platform to look out into the universe.

"It is possible to erect on the Moon instruments to do observations in areas of the spectrum and with capabilities that you cannot achieve from the Earth and even, in some cases, perhaps with free flyers in space," Spudis suggested.

As example, Spudis observed that the farside of the Moon is valuable scientific real estate. Equipment planted there is shielded from low-frequency radio noise crackling off the Earth. That being the case, he continued, the sky can be mapped at low radio frequencies with high payoff, yielding more clues about the origin and evolution of the universe.

New territory

Spudis said that one of the key goals of the Moon, Mars and beyond vision is to learn how to live off the resources of space, specifically the assets of the Moon as the first step. This skill is also dubbed [In-Situ Resource Utilization](#) or ISRU for short.

"Fundamentally, this is something we don't know how to do yet...this is new territory. It's something that NASA hasn't done. So there is actually a lot of science involved with this...it's not just engineering," Spudis said. "I call this applied science...and it's essential to both understanding how to do ISRU and how to use ISRU to maximum benefit."

Science also serves exploration by basically providing the information needed to go live on the planets, extract what's needed, and create a spacefaring capability, Spudis concluded.

But as NASA's exploration ideas zoom, budget realities have caused a disturbance in the space science force.

Patched up...anxieties removed

Significant funds are required to get NASA's exploration train to the Moon, Mars and beyond on track. Meanwhile, the International Space Station and flying space shuttles out to 2010 are big ticket projects too, demanding big cash.

"NASA and the science community need to work together to define an achievable space science and exploration program," said Andrew Christensen, Space Technology Chief Scientist for Northrop Grumman.

Underscoring the recent angst of space scientists seeing budget cuts, project slippage or outright cancellation, "it was a shock to many in the science community...not all of them have recovered," Christensen advised.


Christensen urged a reexamination of the science community and its relationship to NASA. "That needs to be patched up and some of these anxieties removed."

Proof of concept

Noel Hinners, a former space science chief at NASA and retired vice president of Lockheed Martin, suggested that a jointly managed science office should be embedded within the space agency's center of human exploration planning.

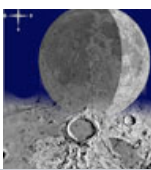
To establish a Moon base on a rapid time scale, lunar landers are a key technology. These craft could deposit cargo and crew onto the Moon's surface, to help foster a sustained human presence there.
Image Credit: NASA

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That management model worked well, Hinners added, not only for Apollo, but several follow-on human spaceflight projects. "It has had a 'proof of concept'...if you will," he told *SPACE.com*.

"There are major issues...and most of them frankly do come right down to the budget issues," Hinners advised. "The total NASA program is under-funded, in my view, for the schedule and goals that they are currently committed to...and this adds pressure."

Apollo was fueled by a reasonable budget, with plenty of money to foot the bill for additional science that was enabled by human exploration, Hinners said.

Still, the exploration program of today contrasted to Apollo is different.

"There is much more than science from day one," Hinners said, including preparation for Mars and development of crew habitation facilities. "Science on a relative basis plays a smaller role in lunar exploration today than it did in Apollo."

Hinners said that NASA's go-ahead to plant a base on the Moon provides "an interesting new opportunity" for scientists

"Indeed, some of the science you want means bouncing around point-to-point in a sortie mode. But clearly there are other parts of science that require a lot of detailed work at a single site. Critical to the science community is site selection for the outpost...where the total array of exploration goals can be accomplished while maximizing the science return."



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