Space scientists hope that robotic and human missions can coexist as President George W. Bush’s new exploration plan sparks an emotional debate over NASA’s future

How Much Space for Science?

U.S. space science was riding high last November when a group of scientists and engineers gathered at the National Academy of Sciences’ conference center in Irvine, California. Their task was to offer advice to the country’s ailing human space flight program—a $6-billion-a-year endeavor struggling with a grounded shuttle fleet and a half-completed space station and under heavy fire for poor management and lack of vision.

The contrast with NASA’s $4-billion-a-year robotics programs couldn’t have been more stark. The Hubble Space Telescope had achieved virtual celebrity status for its spectacular images, two rovers were headed to Mars, and the Cassini probe was gliding toward Saturn. Eager to provide input, the Irvine team suggested that NASA replace the shuttle, refocus station research on human physiology, and plan an exploration program with robots in the vanguard and humans following behind.

The group’s advice, released on the morning of 14 January, was astonishingly similar to the vision outlined that day at NASA Headquarters by U.S. President George W. Bush. What the team didn’t anticipate was that NASA’s science program might suffer as a result. Human exploration, not science, was the goal, Bush said.

A long-range budget chart unveiled later that day by NASA Administrator Sean O’Keefe appeared to back that up, displaying a new exploration program expanding dramatically in bright blue, whereas “aeronautics and other science activities” were flattened in dull gray. Two days later came word that no more shuttle missions would be flown to service Hubble, ensuring an earlier end for astronomy’s workhorse. “This is a kick in the teeth,” says one angry participant in the Irvine meeting. “It’s the worst outcome I could imagine.”

The speech and its aftermath, coming just days before the first anniversary of Columbia’s loss, have rekindled animosities between NASA’s science and human space flight communities. They have also divided scientists who stand to benefit directly from Bush’s new plan from those who fear losing their research funding. The dispute is sure to spread to Capitol Hill, as legislators take up NASA’s budget for next year. The controversy already has reversed a recent warming trend that has seen scientists, from clinical medicine to deep-space astronomy, seeking ways in which astronauts could help further their research goals.

White House and NASA officials insist that the sudden wave of fear and antipathy among researchers is all a terrible misunderstanding. “Don’t panic,” urges presidential science adviser John Marburger. The Hubble decision was purely about astronaut safety, say NASA managers, and the president’s plan for exploration will augment science programs, not undermine them.

But many scientists recall past broken promises involving human space flight programs. “If I were a science guy, I’d try to kill this thing,” says one Democratic congressional aide. “These manned programs get out of control and eat everything.” That’s also how it looks to John McElroy, a retired earth scientist, engineer, and longtime NASA adviser. “The stated schedule is too silly to comment upon, [and] the budget is so ridiculous as to be beneath consideration. I am not given to faith-based space programs.”

Of course, many scientists aren’t afraid of the human space flight bogeyman. For those who want to study the moon or Mars, Bush’s address gave them powerful political protection. And they dismiss the concerns of their colleagues. “For years, scientists have been saying that the human space flight program has no direction,” says a disgusted Paul Spudis, a lunar geologist at the Applied Physics Laboratory in Laurel, Maryland, who has proposed a lunar sample-return mission. “Well, now that it does, the whining begins.”

Tearing down the wall

The course change proposed by Bush would halt shuttle flights in 2010 and abandon the space station around 2016. Due to safety and scheduling, future flights to Hubble would be cancelled. A new launcher would transport humans to the moon by 2020 and eventually to Mars (Science, 23 January, p. 444). Those flights would be preceded by a new series of lunar reconnaissance robotic missions, while the current Mars science effort would continue unabated, and a nuclear technology program would reignite the outer solar system science program. A combination of new money, program reshuffling, and budget cuts would cover the cost, the details of which will appear next week in the Administration’s 2005 budget request.

The president’s plan marks the first time in 15 years that the space agency has been in the White House limelight. But a similar call for lunar and Mars bases from the current president’s father soon fizzled. And the early
1990s were plagued by cost overruns to the space station, delays in shuttle launches, Hubble's myopic mirror, and the inexplicable disappearance of the massive Mars Observer orbiter.

Daniel Goldin was hired in 1992 to untangle the mess, and he spent the decade trumpeting smaller and cheaper spacecraft. There were some successes, notably the landing of the Mars Pathfinder lander and rover in 1997, and space science underwent a renaissance in the latter years of the Clinton Administration. Hubble's scientific triumphs, aided by astronaut mechanics, dazzled the public. Putative evidence that a martian rock contained a fossil excited White House interest in 1996, and individual Mars flights coalesced into a long-term, scientifically vetted, and well-funded exploration plan. Despite the loss of two Mars missions in 1999 and feuding within the solar system robotic program, funding was on the rise and a host of new spacecraft were on the drawing board. But continued troubles with the space station made talk of human missions beyond completion of that facility taboo.

When O'Keefe arrived in December 2001, the former White House budget official imposed strict cost limits on the still-unfinished station but left space science largely alone. Although biological and physical scientists work closely with astronauts, the space science and space flight programs operated virtually as different agencies with vastly different cultures and an ill-concealed distrust of one another. Aside from Hubble servicing missions, they rarely intersected. And both sides liked it that way. "We've been careful in constructing a social, technical, and funding wall between the two," says Daniel Lester, an astronomer at the University of Texas, Austin.

O'Keefe almost immediately began poking holes in the wall, however. He proposed a multibillion-dollar effort to develop sophisticated nuclear power and propulsion systems that would benefit both human and robotic efforts in space (see p. 614). He tried to erase the ancient divisions among field centers and among headquarters offices. And he opened the door to human exploration beyond the low-Earth-orbit space station. At the same time, a small group of space scientists began to explore whether a human presence in space could further their research goals, through construction of large-scale telescopes and even large robotic planetary spacecraft in orbit (see p. 613).

The 1 February 2003 Columbia shuttle disaster put NASA's future onto the president's agenda. A White House interagency team began meeting last summer to consider a new direction for space exploration. Except for Marburger, no senior scientist inside or outside the government was part of that high-level, tightly held discussion led by the National Security Council, according to Administration sources. And although Marburger bristles at the notion that the views of scientists were ignored—"this was not something cooked up by a few people in one corner of the West Wing"—he declines to discuss who was included or even what was discussed.

The labors of senior White House staff shaped the president's speech this month, which labeled robotic missions as "an advance guard to the unknown." Although these machines have proven their worth, Bush said, "the human thirst for knowledge ultimately cannot be satisfied by even the most vivid pictures or the most detailed measurements. We need to examine and touch for ourselves."

**Spirited response**

Despite Bush's emphasis on human exploration, the four-page fact sheet accompanying his speech paints a more science-friendly vision of NASA's future. The document backs "robotic exploration across the solar system for scientific purposes," with an emphasis on Mars, the Jupiter system, and asteroids to seek evidence of life, understand solar system history, and pinpoint resources. The plan also supports "advanced telescope searches for Earth-like planets and habitable environments around other stars." That list covers the vast majority of NASA space science. And Marburger says that even the apparent outliers, "like the acceleration of the universe," might fit under the rubric of exploration.

What bothers many researchers, however, is the perception that science is taking a back seat to human flight. "Scientists are saying, 'Hey, wait a minute! We're the ones keeping NASA going,'" says Joseph Alexander, staff director of the National Academy of Sciences' Space Studies Board, which sponsored the Irvine workshop. As O'Keefe himself noted, the number of hits on the agency's Web site to access the latest findings from the Spirit rover far outnumbered those who logged on in the wake of the Columbia disaster. The White House, says one researcher, is missing the boat: "What excites people is Mars, Hubble, black holes—not the space station!"

Old hands can supply a litany of broken promises made to the science community. Apollo 18 and 19, devoted to intensive science studies, were canceled. Many of the shuttle's planned complement of scientific instruments, such as a solar telescope, never materialized, and innumerable space station facilities for biology, materials science, Earth observing, and astronomy were delayed or abandoned. Although science was touted as an important driver for NASA's major human space flight programs, other factors predominated. The Apollo program was the product of the Cold War, the space shuttle helped rescue a sagging aerospace industry, and the space station began as a race against the Soviet Union—only to become a tool for cooperation with post-Soviet Russia. Administration officials warn researchers not to assume that past is prologue. "This vision has greater scientific rel-
Asking for the Moon

The moon has been left in the dust in the stampede by U.S. researchers to study Venus, Mars, and the outer planets during the past 3 decades. The new White House vision for NASA promises to give lunar science its chance to shine, but NASA will have to play catch-up.

Although the American space agency has no approved lunar science mission, its European, Japanese, Indian, and Chinese counterparts are well on their way toward preparing spacecraft to explore the moon (Science, 2 May 2003, p. 724). A sample-return mission to the Aitken Basin at the lunar south pole will be part of a wider NASA competition now getting under way. Scientists can propose flights to Venus, Jupiter, and a comet as well as the lunar site. The winner, to be chosen next spring, must keep costs under $700 million and launch by 2010.

The president’s 14 January announcement certainly gives a leg up to two proposals that would return lunar samples, NASA officials say. Each would touch down somewhere inside the basin, a vast feature some 2500 kilometers in diameter and 13 kilometers deep near the lunar south pole. A National Research Council decadal survey last year strongly backed a sample-return mission deep near the lunar south pole. A National Research Council decadal survey last year strongly backed a sample-return mission to the roughly 4-billion-year-old basin, which geologists believe to be the oldest in the solar system and an important source for data on its development (Science, 2 May 2003, p. 727). The region is also the most likely site for the lunar base that Bush wants to build after 2015. Two U.S. orbiters in the 1990s sparked a still-unresolved debate on how much water exists at the moon’s poles and what form it takes. The presence of easily attained water would be a great help for lunar pioneers.

The chance to explore the moon, whether with humans or robots, excites researchers. The moon’s surface may preserve meteorites from ancient Earth, Venus, or Mars, and its regolith—lunar soil—may hold clues to the charged particle environment in the solar system’s early evolution. But NASA managers warn that even if the sample return is approved, that doesn’t mean a U.S. flotilla of research-focused spacecraft will follow. Robotic flights to prepare for a lunar base would be paid for by NASA’s technology office rather than out of the space science budget, says NASA space science chief Ed Weiler. “Out of 50 or 60 Discovery proposals, only three have been about the moon,” he says regarding NASA’s competitive program for robotic space missions. “The scientific community has not voted with its feet.”

That comment infuriates some space scientists. “I’m taken back,” says Paul Spudis, a lunar geologist at the Applied Physics Laboratory in Laurel, Maryland. NASA “systematically rejected proposals to do lunar science for the last decade,” he adds. “They locked us out.” That attitude forced those interested in the moon to look elsewhere, says Spudis, who is proposing a sample-return mission. The other competitor is a team led by Michael Duke of the Colorado School of Mines in Golden.

In arguing for more attention to robotic lunar exploration, Spudis urges Weiler’s office to consider history. Although the robotic Ranger and Surveyor spacecraft in the 1960s were designed primarily to test technology and ensure safe operation of humans on the lunar surface, he says they produced important science as well. “Those missions taught us a lot about how the moon works. So if we go back, there is scientific knowledge to be had.”

-M.L.