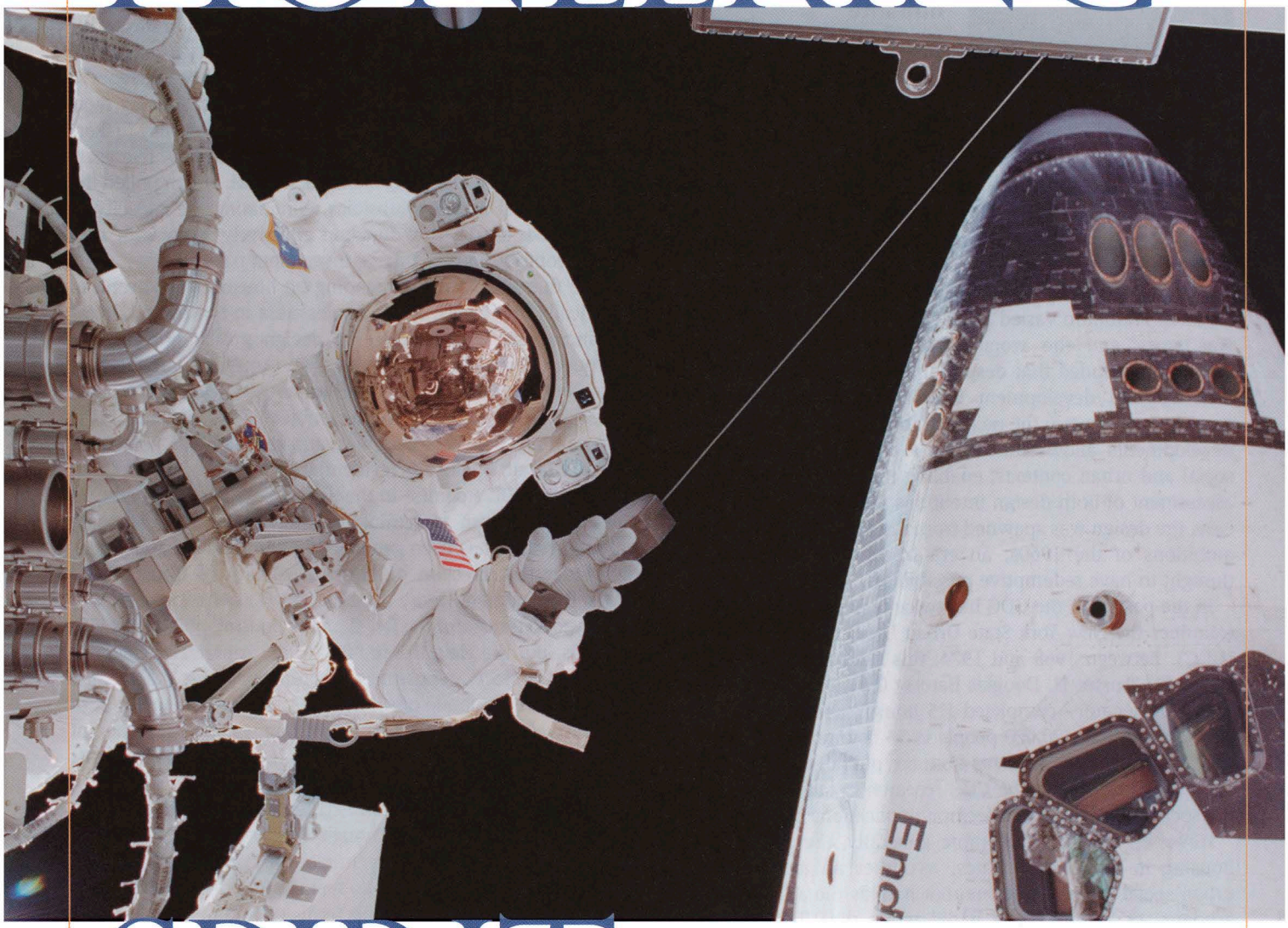
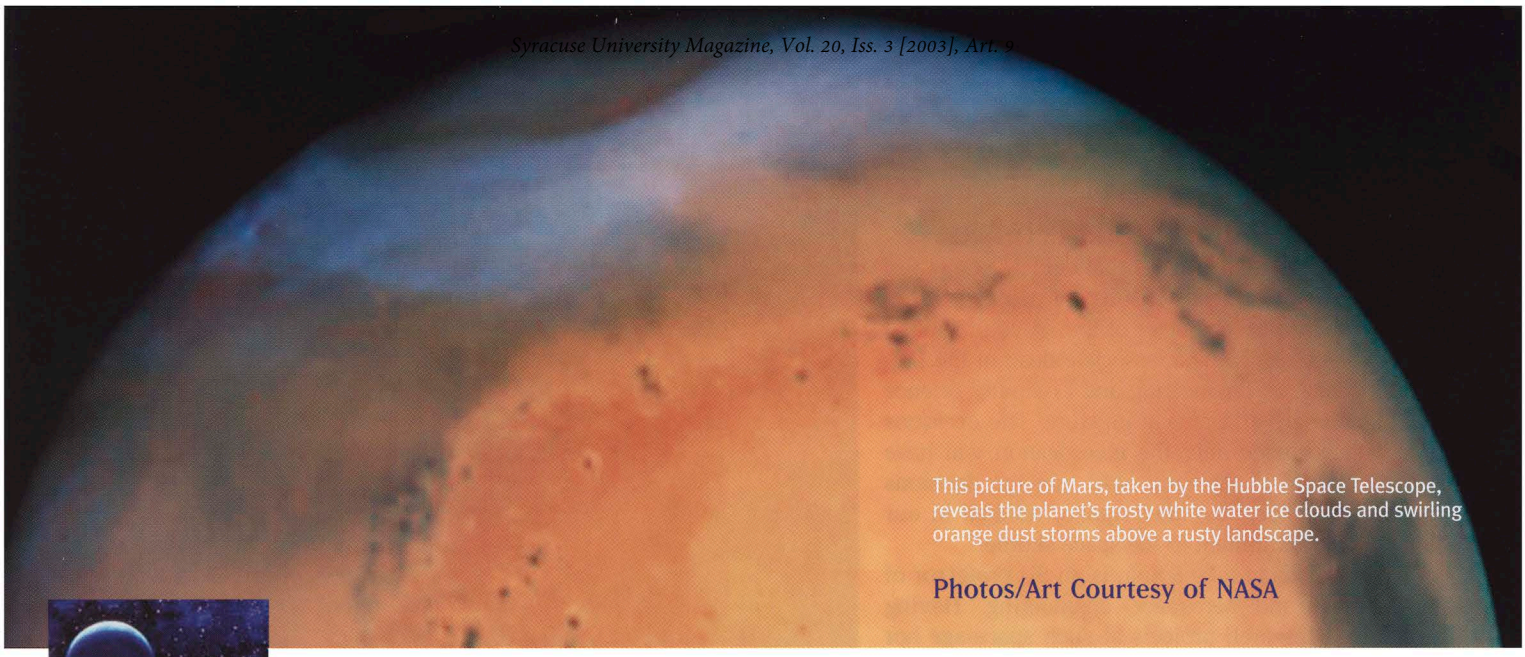
# PIONEERING SPIRIT



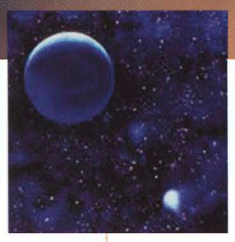
## Members of the SU aerospace community say it's time to get back to basics—and explore the universe

By David Marc



This picture of Mars, taken by the Hubble Space Telescope, reveals the planet's frosty white water ice clouds and swirling orange dust storms above a rusty landscape.

**Photos/Art Courtesy of NASA**



In October 1957, the Soviet Union successfully launched Sputnik I, the first artificial satellite to orbit the Earth, marking a beginning for what was then called "the race for space." For many Americans, it was a particularly chilling moment in the Cold War, an unexpected indication that the Communist superpower was overtaking the United States in science and technology. That following spring, another significant event in the space race, in some ways even less expected, took place on the Syracuse University campus. Franklin "Story" Musgrave '58, H'85, who had been admitted to the University without a high school diploma, received a B.S. degree in statistical mathematics. "They saw that the Marines had helped me make something more of myself—so they took a chance on me," Musgrave says. "I attended SU on the GI Bill and I was also a walk-on member of the wrestling team, for which I received room and board assistance on an athletic scholarship."

As has happened so often in Syracuse's long history of progressive admission policies, taking a chance on a promising applicant with an "untraditional" record paid off—for the student, the University, and society. In 1967, after completing medical school and serving as an Air Force doctor, Musgrave joined the astronaut-training program at the National Aeronautics and Space Administration (NASA). During the next 30 years he pioneered many facets of space flight, serving as everything from a spacesuit designer to the space-walking interstellar repairman who led the team that fixed the Hubble Space Telescope in 1993. "I became an astronaut," he says, "because I was thinking about questions like, 'What kind of a universe have I got? What's my place in it? What does it mean to be a human being?'"

Like many who have contributed to human space exploration, Musgrave worries about the American space program's future. "There's been no vision, no trajectory, for quite some time," he says. "*Columbia* highlights the problem." Indeed, when space shuttle *Columbia* disintegrated upon re-entry into the atmosphere last February, killing its crew of seven and shocking an already nervous nation on the brink of war in Iraq, the volume was turned up on a series of muted debates about the American mission in space that has been ongoing since the Apollo moon landings in the late '60s and early '70s.

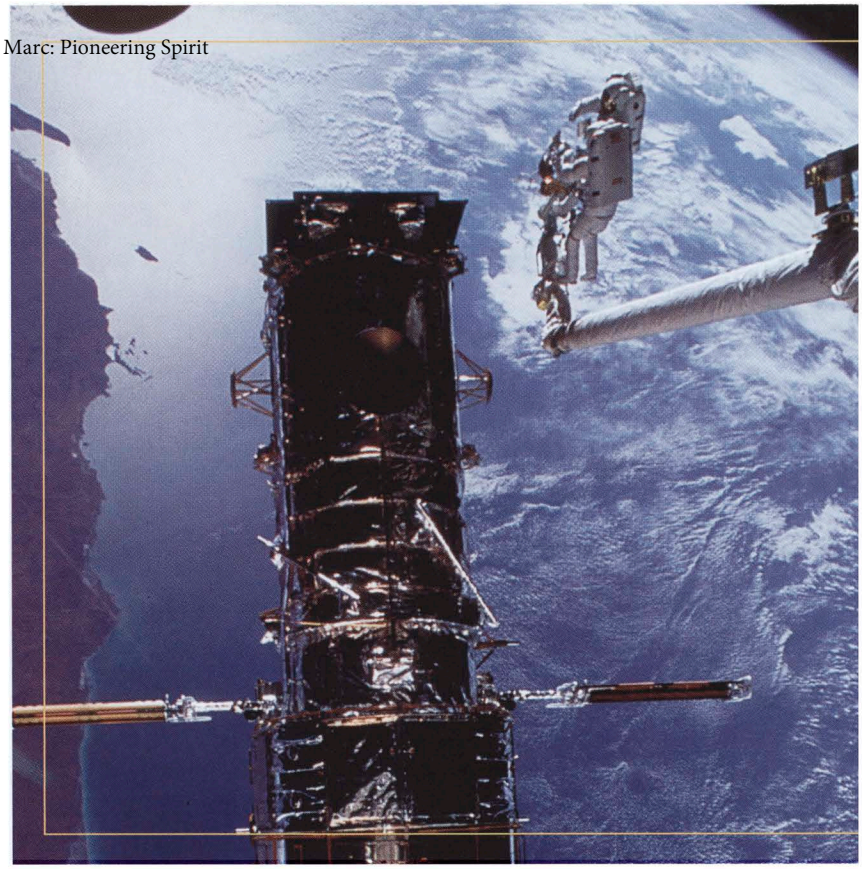
To comprehend the issues under discussion, it's first necessary to understand that the continued existence of the American space program is not on the table. In a society as vocally fractious as ours, it's significant that there is no apparent organized movement, inside or outside of government, that opposes the space program, per se. "The history of the scientific and technological development of space travel has made the Earth a better place to live, and we still have huge benefits to gain," says Air Force Colonel Eileen Collins '78, who will command the next space shuttle mission. Congressman Sherwood Boehlert '61, a member of the House Science Committee whose fingers are in reach of NASA's purse strings, agrees. "There's no question in my mind that NASA has a long-range future—a very productive future—and that the nation will continue to devote a considerable amount of money to NASA," he says. While it's difficult to find anyone to challenge that assumption, it's even more difficult

to find someone who is exactly sure about the details of how that "considerable amount of money"—which is currently more than $15 billion annually—is going to be spent.

## Space: The Ambiguous Frontier

"One of the positive legacies that could come out of the Columbia disaster is a substantive national debate on the future character of the space program," says Professor Eric Spina, associate dean of the L.C. Smith College of Engineering and Computer Science (ECS). "We are at a critical juncture. The decisions that will be made after the investigation will have lasting effects, in the same way that the decisions made during the '70s, after Apollo, resulted in our long-term commitment to the space shuttle."

Barry Davidson, like Spina, is an SU professor of mechanical and aerospace engineering. Having conducted research projects at such space-age hot spots as the Jet Propulsion Laboratory in Pasadena, California, and Rockwell International's Space Systems Division, Davidson hopes the reassessment will lead to dynamic departures in the American space program. "We've been flying the shuttles for 20 years and it's only now, since *Columbia*, that the public is questioning why," he says. "After Apollo, we were supposed to develop an elaborate space transportation system, of which the space shuttle was to be only one part. Instead, we got just the shuttle, which was a tremendous compromise based on the political realities of funding. It was not the best way to advance NASA's mission. The whole program has become just bits and pieces. Nobody's put it all on the table and said, 'What do we want to do in space? Commercialization? Tourism? Mars? Deep exploration?'"



Astronauts Story Musgrave '58, H'85 and Jeffrey Hoffman perch atop a foot restraint on the remote manipulator system arm of space shuttle *Endeavour* while repairing the Hubble Space Telescope during a 1993 mission.

Spina stresses that there are larger questions to ponder before any specific new plans can be drawn up. "Do we have a 'manifest destiny' in space?" he asks. "What is the priority of space in relation to the range of our pressing needs: health

### From Piety Hill to Outer Space

**Former astronaut Story Musgrave '58, H'85 made a record-breaking six space shuttle flights, the last of these at age 61. The path that Musgrave cut between the Hill and the heavens has grown wider over the years.**

**Air Force Colonel Eileen Collins '78, a mathematics and economics major in the College of Arts and Sciences, became a NASA astronaut in 1991. The first woman ever to command a space mission, she piloted the shuttle to its historic rendezvous with the Russian Space Station Mir in the first joint space venture of the two countries.**

**Sean O'Keefe G'78, NASA's chief administrator, earned a master of public administration degree at the Maxwell School. He was a Maxwell faculty member before President George W. Bush called on him to lead America's civilian space program in December 2001. The delicate job of spokesman for the Columbia Accident Investigation Board was assigned to Air Force Lieutenant Colonel Tyrone "Woody" Woodyard '85, a Newhouse public relations graduate. The task force charged with performing an independent evaluation of NASA's implementation of the board's final recommendations includes SU Trustee Walter Broadnax G'75, the president of Clark Atlanta University.**

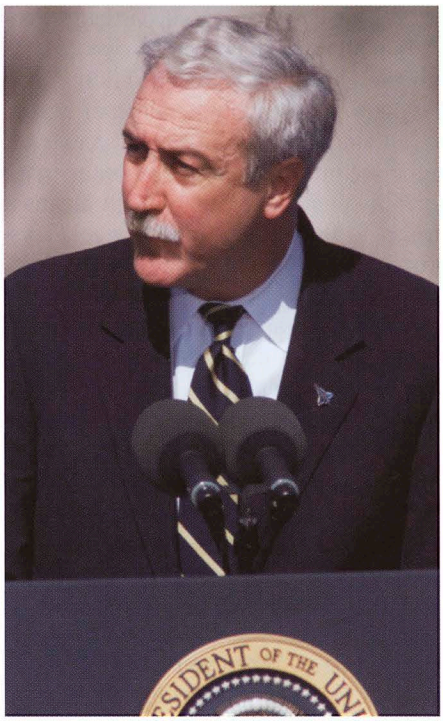
**Connections between SU and the space program extend beyond the launchpads and executive suites to NASA's research laboratories and even to the halls of Congress. At the Goddard Space Flight Center in Greenbelt, Maryland, Bill Anselm '74, who studied electrical engineering at the L.C. Smith College of Engineering and Computer Science, manages the Ice, Cloud, and land Elevation Satellite (ICESat) project, perhaps the most ambitious attempt ever made to monitor the Earth's climate (see "Earthly Observations," page 31). Congressman Sherwood Boehlert '61, a member of the House Science Committee, is charged with congressional oversight of the space agency. His colleague, Congressman James Walsh, whose district includes the University, was recently instrumental in bringing the new Institute for the Application of Geo-Spatial Technology, a NASA-related research facility, to the campus of Cayuga Community College in neighboring Auburn.**

care, the war on terrorism, and so on? We need to start thinking about these things—and we need to start talking about them. I expect manned flight to remain part of NASA, but I believe there will be less emphasis on it."

For years, some scientists, including some at NASA, have questioned whether the considerable costs and human risks of manned missions can be justified in an age when sensory robotics and virtual reality simulation techniques offer us digital eyes and ears as well as remote-controlled arms and fingers in space. If the scientists and administrators who share this belief tend to express it in private, this is probably because they fear the entire space effort might suffer devastating funding cuts without the "glamour" of manned missions to keep the media, the public, and the politicians interested. "I'm afraid the ultimate rationale for man in space is still an intangible," says Harry Lambright, professor of political science and public administration at the Maxwell School. "There is a need to explore, an instinctual thrill in the adventure of knowing the unknown. There is the opportunity to demonstrate what we are capable of as human beings. Travel through space becomes an irresistible model of what we can do."

An advisor on the history of space exploration to NASA, as well as to the National Academy of Sciences, and the National Air and Space Museum, Lambright would like to see the agency, and perhaps the entire society, reinvigorate itself by focusing on satisfying those "intangible" urges. He is discouraged, however, by a lack of political will that holds NASA back from following through on the possibilities of space exploration. "We accept, on the basis of faith, that the scientific research and development that goes into the space program is a good thing and that we will make use of it over time, if not right away," Lambright says. "Whether that's actually worth $15 to $20 billion a year is another matter entirely. But to get the kind of funding needed for a serious effort at space exploration, we would have to give politicians something to sell—something the public can put its hands on. We hear talk of commercial potentials in space: mining, manufacturing, or even tourism. But all that is still only speculation. How do we mobilize the public behind a program that no longer has national security as a driving force, whose economic payoffs are arguable, and whose real scientific payoffs don't necessarily require manned missions? The truth is, space exploration costs a lot of money, it's dangerous, and its rationales are not very clear."

Davidson agrees that the best reasons for space exploration are not material ones. He sees it as an endeavor essential to maintaining continuity with our heritage and fulfilling national destiny. "We need manned exploration to keep a sense of exploration and wonder and discovery. We need that new frontier and that new knowledge. It's just as important for this country today as it was 200 years ago. The necessity of keeping a pioneer spirit alive in young people is worth the cost of the entire space program," he says. NASA may be underestimating the power of these ideals by failing to plainly make the case for funding interplanetary landings and deep space exploration. "Lab missions don't galvanize the American public; an exploration goal, such as Mars, does," he says. "The only time the public seems to show positive interest in the space program is when exploration pictures—such as pictures of Mars—are sent back. But even that only holds interest for a short time. It's got to be something like the Apollo program. Feet have to touch new ground."



NASA Administrator Sean O'Keefe G'78 says a Mars landing and deep space exploration are among the space agency's long-term goals.

Even Spina, a self-described "good liberal" who worries about the toll that a NASA budget aimed at Mars might take on social problems, finds the possibility of attempting the trip irresistible. "In the big picture of the budget in this country, I believe we can afford it," he says. "Will we be doing anything on Mars worth being there for? I don't know, but I'd like to keep the option open. Unfortunately, I haven't heard anyone say anything about the space program, before *Columbia* or since, that has any degree of vision—and without leadership, it will not happen. There's a big vacuum out there."

## Mars or Bust?

Sean O'Keefe G'78, who assumed the leadership of NASA in December 2001, is well aware of the space agency's critics who see the space shuttle program as a political compromise between a Mars landing and no space program at all. He is quick to point out that *Columbia* was on a mission with a clear agenda of practical, beneficial research tasks. "Those seven brave crew members who lost their lives were pursuing 140 distinct scientific experiments, all requiring the microgravity conditions of the space shuttle," he says. "They were conducting cell growth experiments of value to the fight against cancer. They were improving crop yields, developing fire suppression techniques, aiding in the design of earthquake-resistant buildings, understanding the effects of dust storms on our water supply, and much more."

That said, O'Keefe, as much as anyone, has his eyes on the prize. He stressed that it's not simply the lack of a check in the mail from Congress that is delaying a human departure for Mars, but rather a very real list of scientific problems that need to be solved. "Before deep exploration involving humans can take place, we must gain a greater understanding of the prolonged effect of space travel on the human body. We know from having crews spend five to six months aboard the International Space Station that they typically experience about a 30 percent degradation of muscle mass and 10 percent degradation of bone mass, as well as other forms of cell degen-

eration. We've got to find a way to arrest that particular pattern," O'Keefe says. "The other major obstacle we face is mechanical: our propulsion capacity. We are certainly doing things today marginally and incrementally better than we did 40 years ago, but we're doing them very much the same way. Current propulsion methods limit us to speeds in outer space ranging from 17,500 to 35,000 miles per hour, which means it would take 15 years to get to the edge of our own solar system. We have to improve those speeds, while further miniaturizing our power generation sources. So, yes, a landing on Mars and deep space exploration are among our long-term goals. But we've got some work to do in human endurance physiology and power generation propulsion first."

Eileen Collins is just as proud of the shuttle program's achievements. She cites a list of successes that includes the growing of pure protein crystals in microgravity for biomedical experimentation and the in-space repairs made to the Hubble telescope and the Compton Observatory, extraordinarily valuable feats that would have otherwise been impossible. She goes a step further in evaluating the shuttle program's worth, as well. "Having people in low-Earth orbit is beneficial because we become better citizens for having been in space," she says. "When you look back at the Earth from that vantage point, you can see that the atmosphere is like the shell of an egg or the skin of a potato—that's how thin it is; that's how little air there is to breathe. You also see how beautiful the Earth is—the colors, the waters, the continents. You learn to love our planet and you want to take care of it."

Like O'Keefe, she couples her enthusiasm for the shuttle with optimism about the future of exploration. She believes that NASA is moving toward a Mars landing in much of what it does, even if that progress is, as she puts it, "by baby steps." For example, the new space station under construction will be capable of serving as a training facility for extended space travel and as an embarkation point for boosters heading for Mars and points unknown. "Eventually we will go back to the moon and on to Mars," she says with full confidence. "People will be traveling there for scientific research as well as for economic reasons. I think it's NASA's job to pave the way and to start the exploring."

## Tang Versus the Intangible

Can an undertaking as enormous as visiting another planet be done incrementally, without the bold leadership that ECS professor Eric Spina believes is necessary? The one shining example of political initiative on the issue of space exploration remains President John F. Kennedy's pledge in 1961 that American astronauts would land on the moon before the end of that decade. So why, then, have the eight presidents since Kennedy declined to set the same priority for a manned trip to Mars or some equally compelling destination? "To scale it up to a national priority, as Kennedy did, you have to have a reason, such as national security, and that worked very well during the Cold War," Lambright says. "Now, we need machines to find a pot of gold at the end of the rainbow before we commit to doing it ourselves."

Story Musgrave, who has debunked conventional wisdom with an overpowering effortlessness for much of his life, would not necessarily welcome another Kennedy-type national mandate for the space program. "Actually, the Kennedy moon thing is a big part of the problem we face today," Musgrave says. "We did just what Kennedy said—and then we packed up and went home. He couched it in terms of international competition, not space flight. If he was a more advanced thinker, he might have used the Cold War to get the infrastructure in place. But no, with

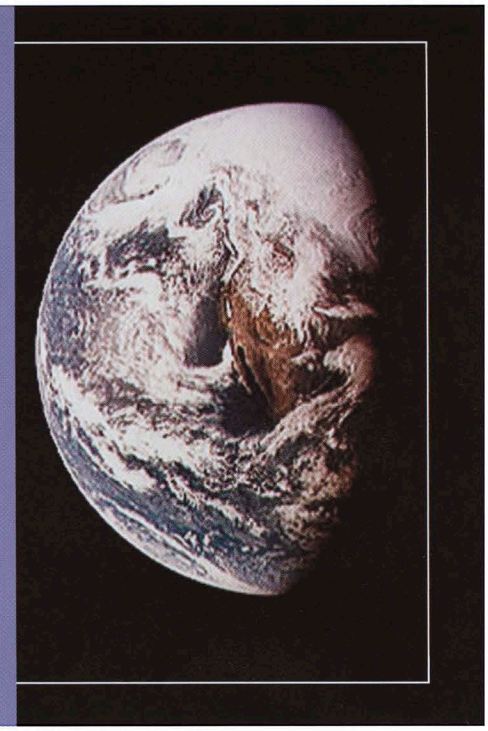
Astronauts Jeff Ashby and Eileen Collins '78 peruse checklists on space shuttle *Columbia* in 1999. As part of their mission, they deployed the Chandra X-Ray Observatory, the world's most powerful X-ray telescope. Collins also made history on the flight, becoming the first woman to command a space shuttle.

## Earthly Observations

**While many people associate NASA with manned space missions, the agency has many ongoing unmanned initiatives connected to studying the Earth from above. One such effort is ICESat (Ice, Cloud, and land Elevation Satellite), an altimetry project that is part of NASA's Earth Observing System. "Our mission is to measure the changing height of the surface of the Earth over the seasons so we can accurately measure beach erosion, vegetation, ice height, and the cryosphere [the part of the atmosphere where ice crystals form]," says Bill Anselm '74, who manages the project. "We have developed amazing systems that measure all these things with an enormous amount of accuracy."**

**Though ICESat and other unmanned programs might stand to gain more funding if manned missions were dropped or curtailed, Anselm is unabashed in his enthusiasm and support for human space exploration. "We've got to do it," says Anselm, a graduate of the electrical engineering program in the L.C. Smith College of Engineering and Computer Science. "We've got to push the envelope for all of humanity. Our strategic plan must include a permanent presence in space as a major element."**

**He hopes data gained by ICESat on the nature of ice will contribute to a Mars mission that will investigate ice formations that have been located on the red (or is it red and white?) planet.**



him it was, 'Go to the moon; you win the race; and that's all folks.' We were not allowed to develop a vision for space based on the real reason for space flight: human curiosity."

Musgrave is in no way ambiguous about his hopes for the space program. "I want exploration," he says. "That was what the space program was about when I joined it—and that is what we have totally abandoned. We need to show that we've made a Copernican shift and we know that the universe does not go around the Earth. We need to seek 'the other.' Exploration becomes a mirror for who I am as an individual. It's a mirror in which I can perceive my own existence and the existence of my species. Then I can address the existential question, 'What direction for myself and my species?' Those kinds of things are powerful and they touch people and move people. Exploration can give people two gifts that are otherwise just words: meaning and hope."

Astronaut Story Musgrave '58, H'85 (center), now retired from NASA, prepares for one of his six space shuttle flights. Musgrave is a staunch supporter of exploration.

Musgrave dismisses arguments over manned versus unmanned missions as irrelevant. "I'll take exploration any way I can get it," he says. "If you don't need humans, you don't send humans. We should integrate the human program and the robotic program in the service of exploration rather than see them as opposing forces with different aims. The robots should precede us and get a habitat ready for the humans. To me, it's all about exploration—whether you go out there in space or dive down deep into the ocean or use a microscope to get to molecular structure."

Maxwell professor Harry Lambright hopes that Musgrave's vision can somehow find a way into public policy. "Five hundred years from now, nobody is going to remember Tang or Teflon or any of those other products that came out of the American space program," he says. "They're going to look back at us the way we look back at the explorers—at Columbus and Magellan—and say, 'How far did they go? What did they find? What did they make of it?'"

Like Lambright, O'Keefe finds broader significance in the act of exploration. "During those periods in history in which there has been withdrawal from explorations, we have seen, as a cultural phenomenon, a trend toward isolationism and stagnation," O'Keefe says. "For example, 15th-century China had an expansive fleet and a capacity for maritime exploration that was without equal. They shut it down and there were long-term consequences for that society. I believe that if we withdraw from the human instinct for exploration and discovery, we will do so to our detriment."