

NASA at the Edge of the Abyss

The agency's new boss, Daniel Goldin, must find a way to fit too many projects into too small a budget. He will find his options limited by congressional politics

Two weeks after George Bush named him to head the U.S. space program, Daniel S. Goldin was bursting with enthusiasm as he testified last week at his nomination hearing. He laid out his philosophy for running the space agency, stressing the need for quantitative goals: "If you can't measure it, you can't manage it." He also tried to dispel doubts about his independence from the National Space Council, the controversial White House panel chaired by Vice President Dan Quayle that is widely reported to have pushed Goldin's nomination. If approved, he said, "I will be in charge."

All this clearly impressed the senators, and they seemed ready to approve the former vice president of the California aerospace firm TRW in a week or two. Yet some couldn't resist throwing a little cold water on Goldin's enthusiasm. One chilly bucketful came from Ernest Hollings (D-SC), chairman of the Commerce Committee. Turning to problems in "the real world," Hollings warned the nominee that the job he was about to take had its unglamorous side: He would be acting "almost like a referee in a bankruptcy." The big question, Hollings explained, will not be how to start exciting new programs, but how to kill projects that the National Aeronautics and Space Administration (NASA) has already started. Hollings blamed Congress for helping to create a "horrible charade" in which NASA has been asked to start more and more projects while receiving less than enough money to complete them. "We want all of it," Hollings said—referring to the space station, the big telescopes, the aerospace plane, a trip to Mars—but no one is willing to ask for the taxes that are needed to finance them. "I'm sick of it," Hollings declared.

Melodrama aside, this outcry points to the first and biggest challenge Goldin will face, if confirmed: straightening out NASA's muddled agenda. Goldin cannot change the 1993 funding request, though he will have to defend it to Congress. But he will be able to shape the 1994 plan as it begins to develop this summer. The trick will be to fit all of NASA's ambitions within tight spending limits and still come up with a proposal that looks exciting. Some projects will have to be delayed, some will have to be

scaled back, and some killed outright. Already the retrenchment has begun in the shuttle program and in space science, for example.

On a personal level, the new director will need to rally NASA scientists and engineers. Morale is now low and could sink further in the shakeup that's likely to come following Richard Truly's departure on 1 April. Another challenge will be to deal forthrightly with the political winds buffeting the agency. These include requests from Congress to steer construction funds to key districts and directives from the National Space Council to work on pet projects like building a base on the moon. NASA could lose credibility if—during the time of retrenchment—it appears to favor mediocre projects just because politicians want them.

All these challenges would be easier to meet if NASA were getting the kind of budget increase the National Science Foundation has grown used to. But the indications are that it will not. After several years of significant growth, the president held the increase in NASA's request back to 5% in 1993—just the kind of ballpark the National Institutes of Health has been forced to play in. This is not adequate to support everything the agency has under way, and the knives are already out. For example, the Administration has proposed canceling a long-

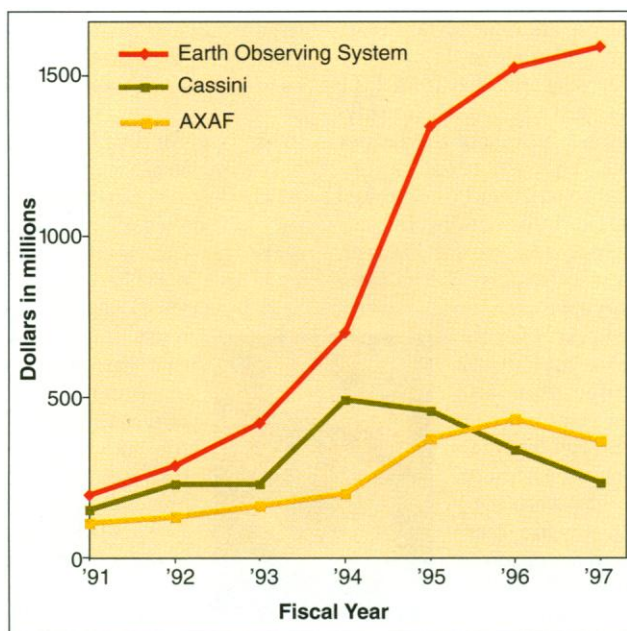
planned mission to take a close look at an asteroid (CRAF) and Gravity Probe B, a scientifically meritorious test of Einstein's theory of relativity (*Science*, 15 November 1991, p. 939). Cutbacks in shuttle operations that will remove 4000 jobs over the next 5 years have begun. And improvement of the shuttle's onboard engine system—long viewed as a top priority by propulsion experts—has at least temporarily been canceled, over the objections of NASA's safety advisory panel.

"Depressing possibility"

Even these planned sacrifices will not be enough. Congressional leaders have said NASA probably won't get even the 5% it is counting on. Representative Robert Traxler (D-MI), chairman of the House appropriations subcommittee that handles the space program, told *Space News* recently that it was a "very, very depressing possibility" that NASA will get no increase at all in 1993. And Senator Lloyd Bentsen (D-TX), chairman of the Finance Committee, warned during Goldin's confirmation hearing that competition from other domestic needs (housing and veterans affairs) will be "enormous" this year—suggesting that NASA should not expect much.

Worse, NASA leaders were counting on a sizable recovery by next year—for a total increase of 15% over the period 1993-1994—to keep their grand plan afloat. But that now seems out of the question. Which is why NASA's congressional supporters earlier this year began to ogle a piece of the "peace dividend." Perhaps the agency agenda could be saved if Congress were to shift large chunks of funds from military to civilian agencies? That hope is now dying, though, and asked at a recent hearing how the agency would manage its affairs if it received no funding increase in the mid-1990s, Truly admitted he had no idea: "We can't do this program on flat budgets," he said curtly.

The only choice may be to slash existing programs. But which ones? The space station, whose funding would climb from \$2 billion to \$2.25 billion this year in the proposed budget, looms as a likely target. Senator Robert Byrd (D-WV), chairman of the Senate appropriations committee, in a brief comment early this year suggested that Congress may take an-



The big three. EOS, AXAF, and Cassini are all facing the knife.

Space Council to NASA: Think Small

Arthur L. "Lonnie" Lane, a physicist, and his colleagues at NASA's Jet Propulsion Lab (JPL) have been working for months with researchers from the Massachusetts Institute of Technology's (MIT) "insect lab" to create a new kind of planetary explorer. The creature in Lane's laboratory is not a bug but a miniature robot with good survival skills, like its cousins at MIT. Its mission, if approved, would be to fly to Mars inside a small capsule, scramble about the landscape, drop seismic sensors, and report back on what it finds.

Lane has already built a small test rover with a chassis weighing only 5 kilograms and carrying a science package of about 2 kilograms. The micro rovers will need to rely on their own reflexes to steer around rocks and avoid crevices, because the time lag in signal transmissions between Earth and Mars is too long (40 minutes) to permit earthlings to guide them by remote control. With sophisticated software, the robots should be able to take instructions from Earth and do their work without any back seat driving.

Insignificant though they may seem, the micro rovers may represent the wave of the future. As NASA struggles to pay for its grand old behemoths of the 1970s and 1980s—the shuttle, the space station, and massive space telescopes—it has begun to move in a new direction, experimenting with simpler technology that costs less to deliver.

NASA's science office is using this approach for what it calls the Mars Environmental Survey or MESUR. Wesley Huntress, direc-

tor of NASA's solar system programs, describes the scheme as including 12 to 16 low-cost monitoring stations—launched four at a time on medium-sized Delta rockets. The sensors would be distributed across the Martian surface, creating a planet-wide network. Beamed back to Earth would be video images of the descent of each lander, panoramas of the ground, reports on the atmosphere, tests of the geochemistry, and possibly data on Mars quakes. According to Huntress, NASA might support a test of the idea with the launch of a "Pathfinder" scout vehicle as early as November 1996. If successful, the main flotilla might be launched starting in 1999.

This "faster, cheaper" approach has been touted by the National Space Council, chaired by Vice President Dan Quayle. It also reflects the style of the human exploration office at NASA, headed by associate administrator Michael Griffin, which has requested \$32 million this year to develop robots that would survey the moon and Mars for future human investigation.

Griffin, formerly with the Strategic Defense Initiative Organization, claims that if the government could become a more savvy buyer, it could get much more science for the buck. For example, he proposes to build and launch by 1996 two moon probes—a lunar scout and small surface mapper—at a total cost of less than \$300 million (including the rockets). This is about half the cost of a single, large Lunar Orbiter proposed earlier by JPL. Griffin concedes, however, that his probes won't collect as much information.

—E.M.



Two for one. NASA is planning to replace this proposed lunar orbiter with two small missions for half the cost.

other look at the station. Senator Dale Bumpers (D-AR) has begun organizing a campaign to kill it. And there may be new opposition in the House, although the respected Science Committee chairman, George Brown (D-CA), has said he favors the project.

Representative Traxler, who last year led a lonely campaign to delay the station—and failed—is not eager to try again. Instead, he said recently that it may be time to focus on cutting big science programs or other new ideas such as a proposal to build a less expensive launcher, plans to explore the moon and Mars, or the national aerospace plane. Other members of the House appropriations committee—such as Representative James Sensenbrenner (R-WI)—object that this would mean sacrificing more interesting projects to keep the station alive.

CRAF and Gravity Probe B are already in that category, and Joseph Alexander, NASA's assistant to the associate administrator for

space science and applications, sees more to come. NASA has already clipped the wings of the Earth Observing System (EOS), the largest item in the science budget. Instruments that were to have flown on two enormously complex satellites will now be distributed among a large number of small and intermediate platforms. By congressional order, the total cost may not go above \$11 billion through year 2000.

AXAF on a diet

Alexander says scientists and agency staffers involved in two other high-ticket programs have been ordered to hunt for cuts. Team one is focusing on the Advanced X-Ray Astrophysics Facility (AXAF), a large, heavy, many-layered mirror telescope due to fly on the shuttle in 1999. If its operational costs are included, the total price comes to more than \$5 billion. NASA's aim is to reduce AXAF's weight dramatically, possibly by splitting off and indefinitely delaying the launch

of a spectroscopy system. This might enable AXAF to fit on an unmanned rocket.

Meanwhile, team two is trying to tear down and redesign the Cassini project—a robotic probe to Saturn—the last of a long line of large, planetary missions. Cassini is a plump target for surgery or even cancellation, because it could cost \$1.7 billion to develop, and as much as \$3 billion over its lifetime. Even one of Cassini's strongest advocates, Bruce Murray, planetary scientist at the California Institute of Technology and vice president of the Planetary Society, agreed in recent testimony that Cassini had become an example of the "dreadnought syndrome" at NASA: large, hard to manage, and overburdened. He concluded that it made sense to scale it back, though not to scuttle it. Protesting that funding of planetary projects has already been reduced 9% in the 1993 request, Murray warned: "If Cassini is canceled, as the Administration has threatened...it would end the historic U.S.

exploration of the solar system.”

The two teams are to report back to NASA leaders in early April at which point tough decisions will be made. Goldin, if confirmed, will preside over all such decisions except the one involving AXAF. TRW is the prime contractor for AXAF, and Goldin is TRW's top manager on the contract. Sensibly, he has vowed to recuse himself from all TRW business for 1 year after being sworn in.

Some NASA officials would argue that not everything on the new director's plate will be of nouvelle cuisine proportions. NASA science official Alexander predicts there will be growth in a new category of small, less complex projects called the “Discovery” probes. The goal, Alexander says, is to provide a steady flow of fresh new data on the solar system over the next decade. Discovery missions will cost no more than \$150 million each. And NASA has already begun to put more funding into very small explorer satellites to collect data on Earth's electromagnetic envi-

ronment. Other low-cost exploratory missions to the moon and Mars may be in the offing (see box). But getting them onto the agenda, and moving other outdated proposals off, will require some skillful negotiating among all the interested parties: scientists, congressional leaders, and industry.

Goldin, in fact, got a premature invitation to join in some of this horse trading during his confirmation hearing. Several senators brought up a politically hot subject known as the Advanced Solid Rocket Motors (ASRMs). These are a new version of the external rockets that strap onto the shuttle, completely redesigned to eliminate the O-rings that caused the Challenger accident. The factory that's supposed to manufacture them is being built now with federal funds in the district of House Appropriations Committee chairman Jamie Whitten (D-MS), right next to Tennessee. NASA's safety advisory panel has said repeatedly that the new motors won't do much to improve the safety. But NASA

backed the project anyway, arguing that they would increase the shuttle's lifting power.

Suddenly this January, in a money-saving gesture that also seemed aimed at provoking Representative Whitten, NASA reversed itself and asked Congress to kill the ASRMs. Half of the \$3 billion planned for the project might be saved, NASA argued, and spent on more meritorious programs.

When the subject of ASRMs came up in Goldin's confirmation hearing, the senators' handling of it illustrated how difficult it will be for any one person to rewrite NASA's agenda. Senator Trent Lott (R-MS) stated flatly that he wanted the ASRMs built. Hollings and Al Gore (D-TN), despite their warnings about the need for budget austerity, said they favored the project, too. Goldin—welcome to Washington—was pressed for his own views. Ever so gingerly he said that this was something “worthy of evaluation.” He would “get on that issue” right away, he said...if confirmed.

—Eliot Marshall

OZONE DEPLETION

Warm Reception for Substitute Coolant

In the modern American supermarket, you're happy to encounter greens that haven't wilted in the room-temperature produce department. Shoppers at the Hannaford Brothers' Shop 'n Save in Glens Falls, New York, have a leg up on most of us in this respect: The produce and meat they purchase has not only been kept cool but the system doing the cooling may help preserve the tattered ozone layer. The secret is hydrofluorocarbon (HFC), a coolant that might replace ozone-eating chlorofluorocarbons (CFCs) in the cooling systems all around us. If the experiment works—and there are still some worries about the ability of HFCs to contribute to global warming—then a new industry may be born that will not threaten the environment but improve it.

You've heard of pesticide-safe produce. Now, Thomas Mathews, energy manager for Hannaford Brothers, offers ozone-safe shopping—the first time, he says, that a supermarket has used refrigeration and air conditioning systems breathing HFC-134a (tetra-fluoro-

ethane). The key to HFC-134a's ozone-friendly nature is that it's dechlorinated—no chlorine there to seep into the stratosphere. Hence its obvious attractions to a variety of industries.

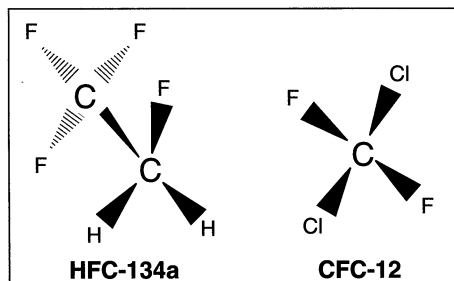
In addition to the grocery industry, which, according to Raymond Albrecht, an engineer at the New York State Energy Research and Development Authority who helped develop the HFC refrigeration system for the Glens Falls supermarket, consumes about 20% of the total CFCs that are used in the United States, there's the automobile industry. Already manufacturers are offering cars with HFC-134a air conditioners. And there are chemical manufacturers such as DuPont and Allied Signal, which are developing HFCs to supplant CFC refrigerants and solvents.

So HFCs are in vogue. Last month Environmental Protection Agency (EPA) researchers announced that from hundreds of candidates, they had culled 11 chemicals worth further investigation as alternatives to CFCs. Nine were HFCs. One EPA researcher, developmental engineer Dean Smith, has been studying HFCs at EPA's Air and Energy Engineering Research Laboratory in Research Triangle Park, North Carolina. “People are coming to the conclusion that no single compound will do all the jobs of CFCs,” he says. Together, several properties of CFCs make them hard to duplicate, Smith says—their nonflammability, low toxicity, and such performance characteristics as boiling point, heat capacity, and thermal conductivity. As a family of chemicals, however, HFCs might have all the right stuff. “HFCs seem to be the best substitute that anyone's identified,” Smith says.

So much for the unadulterated good news. Arjun Makhijani, an electrical engineer and president of the Institute for Energy and Environmental Research, a nonprofit think tank based in Takoma Park, Maryland, is just a tad worried about HFC hype. They may be ozone-friendly, he agrees, but hydrofluorocarbons are also greenhouse gases. Yet, even in that respect, they're better than CFCs—HFC-134a is only about one-fourth as potent a contributor to global warming as some CFCs. But to Makhijani, “this may be a sleeper of a problem,” because the steady-state calculations currently used to calculate global warming might underestimate HFCs' contribution to that problem. Use HFCs in the short term, Makhijani concludes, but keep doing research on the possible effects of an increased buildup of fluorine in the stratosphere that might accompany HFC usage.

And then there's the possibility—albeit remote—that HFCs carry with them long-term toxicity. Everyone is waiting for results—not available until early next year—but a battery of short-term toxicity tests conducted by the Program for Alternative Fluorocarbon Toxicology Testing Activities, run by an international consortium of CFC producers, indicates that HFC-134a has “low toxicity.” Still, HFC-134a “is only the answer to half our problems,” says Bob Bittner, engineering manager for Landover, Maryland-based Giant Food, Inc. Because HFC-134a doesn't work in freezers, the Glens Falls store must also use HCFCs, an ozone-depleting CFC substitute. And that's enough to suggest that, although HFCs are useful, they aren't a complete solution to global problems.

—Richard Stone



Plug for the ozone hole. HFCs lack the ozone-eating chlorine carried by the CFCs.