

Goldin Maps NASA's Past, Present, and Future

Dan Goldin has put an indelible stamp on NASA as its longest serving chief administrator. During his nine-year tenure, he has spearheaded efforts to cut the rising costs of space missions, overseen radical changes to the operation of the space shuttle, and helped put space-station construction back on track. He achieved those results with a flat budget and a 30% cut in the NASA workforce.

Although Goldin is generally seen as an outsider by NASA staff, he started his career at NASA's Glenn Research Center in Cleveland, Ohio, before moving to industry. After a 25-year career at the TRW Space and Technology Group, which built the Chandra X-Ray Observatory, among other things, he returned to NASA in 1992 as its chief administrator. With a \$14 billion budget, he oversees space sciences, Earth sciences, human spaceflight, and research into aeronautics. In an interview with *PHYSICS TODAY*, Goldin talked about NASA's past, present, and future, and the current challenges facing the agency.

Goldin highlights

Reflecting on his tenure, Goldin lists his major achievements: "The space shuttle is a lot safer, for a lot less money," he says. "The space station is not the wisp of an idea in somebody's mind, but is actually in orbit. The space science program has blossomed, and not just expanded but exploded. But . . . I feel that the rescue of the Hubble Space Telescope was NASA's finest hour."

Goldin highlights another achievement: replacing unrealistic, ambitious spacecraft designs with smaller, more focused missions. For example, the Earth sciences program was going to use three complex and costly satellites to measure 24 global parameters. "I don't know if we would have been able to build them," he says. But by breaking the missions into a constellation of cheaper satellites, NASA will soon be able to achieve similar coverage.

Less well known than its space program is NASA's involvement in aeronautics, including long-range technology studies in air-traffic control systems and aircraft design for the Federal Aviation Administration and other

With his future as NASA's chief still uncertain, Goldin insists the agency must continue to take bold risks.

government agencies. Goldin believes that the US cannot expect to remain a world leader in these technologies without radical change. "This is something that will take 5–10 years to fix, and we haven't got on the path to fix it. I don't think we [NASA] have been supplying the bold technology with the intensity that we should have."



GOLDIN with a model of the Mars Sojourner rover.

But it is clear that Goldin is most proud of the achievements of the space sciences program. He says he could sit for hours discussing the "spectacular set of discoveries" from NASA's Chandra X-Ray Observatory, NEAR spacecraft, and Mars missions. "And all this was done at a time when the NASA budget came down, and content went up. It now costs one-third less, on average, to build a scientific spacecraft than it cost in the early 1990s. We are able to have four times the launch rate of scientific spacecraft and we do it in 40% less time. I would also say that the agency is not terrified of failure any more."

Probably the most notable recent failures at NASA were the losses in 1999 of the Mars Polar Lander and Mars Orbiter missions. These failures have sparked Goldin's concern for, and confidence in, Jet Propulsion Laboratory (JPL) employees: "They had been doing such an outstanding job, but they still need to regain their self-confidence. They pushed the boundaries and didn't make it, but they are going to do great things." The handling of the Mars failures reflects Goldin's leadership style: "I feel a very strong commitment to the dignity of human beings and to the fact that the people who are willing to take risks should not be punished, unless there's malice or extreme incompetence. People who take risks cannot be punished; they have got to be encouraged. This is how I feel and I've tried to put that into practice. . . . I think it's absolutely crucial when you're dealing in high-payoff research to encourage people to take risks and to acknowledge that failures will occur." At the same time, Goldin points out that NASA has flown more than \$20 billion worth of payloads into space under his "faster, better, cheaper" philosophy and lost only \$500 million—a success rate of nearly 98%. "We are the most self-critical organization in the world," says Goldin.

Nevertheless, Goldin says his biggest concern is still the high cost and risks associated with getting into space. "The problem is bigger and broader than I ever thought, and I view it as one of the premier challenges for the next decade." Military, civil, and commercial space programs got "comfortable making small evolutionary changes" to their launch vehicles and are reluctant to try "bold" solutions, says Goldin. It is a problem facing the "entire NASA, contract, and academic communities."

Space-station nirvana

Since the mid-1990s, the Russian space program has collaborated with NASA through the International Space Station (ISS). "The Russians have unbelievable difficulties, with the economic collapse of their government, and as a result, they put a huge hurt into our program," says Goldin. Money for the Russian space program has dropped drastically but, Goldin

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adds, “they had done the right thing” in prioritizing their program around the ISS. And he points out that NASA has problems that could likewise affect the Russian space agency. Indeed, last month NASA admitted that cost overruns associated with the ISS will be between \$3 billion and \$5 billion over the next four years, money that has to come from the existing budget. To reduce costs, long-range ISS-related projects were immediately put on hold, and discussions began on limiting the ISS crew to three astronauts.

“All the problems we have had to date have been bureaucratic,” Goldin says. “This is really at the edge. So we have huge problems ahead of us, which is fabulous. Just think about it: We have about a couple of hundred thousand pounds of equipment up there and we only have 800 000 pounds to go. And it’s all gone together flawlessly. We’re not going to be able to keep this up, and if we do, I’ll be absolutely amazed.”

If final construction of the ISS goes perfectly, then NASA is spending too much money rehearsing the assembly tasks on the ground, says Goldin. “We’ve got to learn how to get into an operational mode . . . so the challenge now is how to do it without being irresponsible.” Every mishap on the ISS is currently treated as an emergency that requires immediate attention, he adds. But by automating ground staff tasks and learning how to prioritize repairs, NASA could reduce its workforce dramatically. “I want the money to be available for research; I don’t want the money to be going to paying the salaries of thousands of people who sit and watch consoles around the clock.”

Goldin says he believes it will be three years before significant science is done on the ISS. He also hopes corporations will eventually use the space station for research. “I would say the anticipation of commercial work far exceeds where we are now. I would love to see competition between commercial and government-sponsored research. That would be nirvana for me.”

NASA’s priorities

Goldin regards balancing budget demands among competing NASA divisions as one of his main achievements. He puts his success down to increasing efficiency, hiring outside



INTERNATIONAL SPACE STATION.
(Artist’s rendering courtesy of NASA.)

contractors, and more narrowly focusing on four main priorities. “Safety is the number one priority,” he says. “Safety of the public, safety of the astronauts and pilots who get into high-risk situations, safety of the workforce, and safety of the high-value assets, in that [order]. Our second priority is to fund and complete the assembly of the ISS. Third is to develop much safer, much lower cost access to space. And our fourth priority is to do outstanding science and technology,” says Goldin. “And we’ve accomplished all but one of them [less expensive space launches].”

While attempts are being made to rein in the cost of hardware, software costs are increasing. The percentage of a space-mission budget devoted to software has risen from 5% to 20%, and will soon reach 50%. Goldin points out that 25 years ago the Voyager spacecraft had 5000 lines of computer code, whereas the ISS has 1.4 million lines. “For some of our new missions, we’re projecting 1 billion lines of code.” To improve reliability, Goldin formed the Higher Software Consortium: “We have every major software player in the country working with us to see how you can build high-assurance software when you have very large, complex programs.”

A poster child for the “faster, better, cheaper” way of doing things is the NEAR spacecraft developed for NASA by Johns Hopkins University’s Applied Physics Laboratory. NEAR came out ahead in terms of both science and money. Goldin ascribes its success to one significant advantage—a small, localized, integrated team—and he credits mission managers Tom Coughlin and Robert Farquhar. “We will

probably debrief them and find out what they did differently, and make sure everyone else understands their success,” says Goldin. He hopes that the experience with Johns Hopkins will help lower the average space sciences mission costs from \$200 million to \$100 million.

The constrained 2002 budget means that NASA has to abandon hopes of sending a mission to Pluto in five years’ time (see PHYSICS TODAY, November 2000, page 45). A short window between 2004 and

2006 is the only period in the next 20 years when the planets will be suitably aligned for a gravitational slingshot to Pluto. Goldin has been the target of heavy lobbying by members of the planetary sciences community to go ahead with this mission, but has turned them down. “When people can start supplying money to us that we don’t have, we’ll be able to respond really well,” he says, adding that NASA has to set priorities within its budget. Goldin also points out that NASA has reached every goal of the 1991 decadal survey conducted by the National Academy of Sciences (see John Bahcall’s article, PHYSICS TODAY, April 1991, page 24). “The last thing to be done is to launch the Space Infrared Telescope Facility and, in 1995, I committed to the American Astronomical Society that I would lay my body across the tracks to protect that program . . . and we’re probably a year away from launching,” he says. “I believe we have been unbelievably responsive . . . but we can’t make a check list and satisfy everybody.”

A golden future

Ten years from now, NASA will be well on its way to building instruments for identifying extrasolar planets, says Goldin. “And we’ll probably have a gravity-wave long-baseline interferometer up there.” He believes that NASA will eventually image the event horizon of a black hole. Furthermore, Goldin speculates that the major health and safety problems associated with long-duration space travel will be solved, and that NASA may be close to sending astronauts to a carbonaceous asteroid by 2011.

The future, he thinks, looks bright. “I am convinced we will have developed the technology to do the one thing we haven’t done yet, and that’s to make space vehicles 10 to 100 times safer at one-tenth the cost.”

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