

WASHINGTON REPORTS

Goldin's 'Faster, Cheaper, Better' Approach Still Valid After NASA's Failures in Mars Missions

The fortunes of NASA are at their most wretched since the explosion of the space shuttle Challenger in 1986. The past year has been the space agency's *annus horribilis*. The agency has been plagued by avoidable mishaps of two high-profile robotic missions. The Mars Climate Orbiter failed to reach orbit around the Red Planet in September because of a navigational error caused by the prime contractor, Lockheed Martin Aerospace, providing operating data in English units rather than the specified metric units to mission controllers at NASA's Jet Propulsion Laboratory. Then, in December, the Mars Polar Lander vanished without a trace, along with two piggy-backing microprobes, and was presumed to have crashed to the planet's surface (see PHYSICS TODAY, January, page 47). The blunders have left the Mars program a shambles.

The events have been a painful and instructive experience for NASA Administrator Dan Goldin. Goldin was lured away from a management job at TRW in 1992 to shake up an agency suffering from cost overruns, technical glitches, and a ponderous bureaucracy—adversities that incited Congress to cut the space budget almost every year. It didn't help matters when the agency became the butt of jokes after launching the Hubble Space Telescope with a spherical aberration in its primary mirror (PHYSICS TODAY, August 1990, page 17). Last year's problems, by contrast, have been the subject of regret rather than ridicule.

Just prior to Goldin's arrival at NASA, Mars became the centerpiece in NASA's firmament. The Mars Observer, a \$1 billion project, failed to reach the planet in 1993. Its successor, Mars Global Surveyor, was launched in 1996 for a quarter of the cost. Surveyor was among the first spacecraft to be developed and deployed under Goldin's trademark mantra, "faster, better, cheaper." That was also the year that a scientific team claimed to have evidence of fossilized organisms in a chunk of a Martian

meteorite known as ALH84001. The same year the Mars Pathfinder and its accompanying rover were sent to the planet. Pathfinder landed encased in an airbag on the Fourth of July 1997, a symbolic date that helped excite the press, politicians, and public. JPL, NASA and Goldin were celebrated as American space heroes, even though funding reductions and space station battles continued to dog them in Congress.

JPL had achieved the Pathfinder mission for just \$165 million, a fraction of the cost of previous operations like the successful Viking,

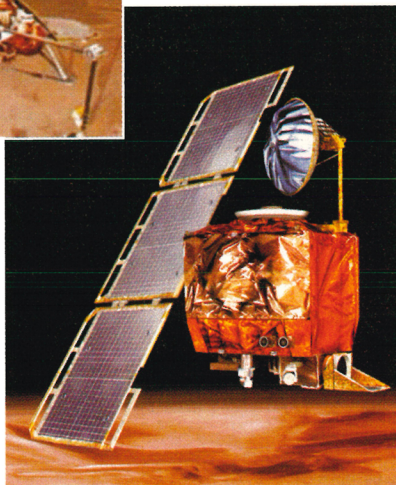
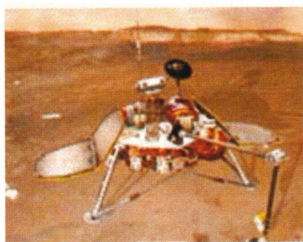
predicaments with the turn-of-the-century millennium bug.

Stunned and embarrassed by the failure of the Mars missions, Goldin appointed an independent panel of academic, government, and industry experts, led by Thomas Young, a former NASA manager and Lockheed Martin executive vice president, to identify what went wrong and report what lessons the agency could learn. On 28 March, Young released the panel's report. It spread the blame around—to NASA managers, engineers, and controllers, to contractors, and to Congress, but the Young panel found the faster, better, cheaper approach to space exploration inherently valid, as long as the risks are considered prudent.

In retrospect, the missions may have been doomed from the start. The program was underfunded, understaffed, and blighted by poor communication among NASA, JPL, and Lockheed Martin, according to the Young report. Moreover, the program suffered from a lack of sufficient oversight all around. "The pressure of meeting cost and schedule goals resulted in an environment of increasing risk in which too many corners were cut in applying proven engineering practices and the checks and balances required for mission success," the report declared.

The Young panel suggested that the two failed spacecraft were underfunded by 30%, and that to be thrifty the contractor had eliminated critical tests that might have detected problems early. As for the two microprobes that were intended to burrow into the surface of Mars, but had vanished along with the lander, they were simply not ready to launch, according to the report.

The Young team's investigation concluded that the "most probable cause" of the lander's failure was that its spindly legs, designed to detect contact with the Martian surface, had generated "spurious signals" when the legs unfolded, while the spacecraft was still about 40 meters (130 feet) above the planet, and prompted the braking thrusters to shut down, causing the lander to crash. Lockheed Martin engineers uncovered the potential for a spurious signal, which



MISSION UNACCOMPLISHED: The Climate Orbiter (directly above) and Polar Lander failed to reach the Red Planet.

which ran up a bill of more than \$1 billion. Though Global Surveyor was finally coaxed into its proper orbit only last year, it continues to relay riveting scenes and data on the Red Planet's landscape.

It's not just the Mars program that is in trouble. NASA's four space shuttles are causing concern. Last July, one of the shuttles had to make an emergency landing when two of its six computers went awry. Since then, several maintenance problems have come to light, from frayed wiring to dented fuel lines and faulty engine parts. In December, a shuttle flight to repair the Hubble Space Telescope was curtailed to avoid potential

could have been set off by a wiring error. The premature signal occurred in four tests of a second lander. NASA's plan to launch that lander in 2001 has now been postponed indefinitely, but an orbiter is still scheduled for 2001.

With only its aging Global Surveyor in orbit around Mars, NASA is reassessing its entire approach to exploring the planet. The agency has undertaken a comprehensive review

of the data relay and spacecraft tracking capabilities of Mars probes.

Goldin, to his credit, accepted some of the blame. He delivered his *mea culpa* to JPL employees on 29 March, a day after the Young report was made public, and a few days later at a House appropriations subcommittee hearing. "I pushed too hard . . . and in so doing, stretched the system too thin," he said in an uncharacteristically

apologetic tone. "It wasn't intentional; it wasn't malicious. I believed in the vision . . . but it may have made failure inevitable." He confessed to members of Congress that he and NASA had become too complacent with the string of successes in space and that many young and inexperienced managers and engineers had entered the program in recent years.

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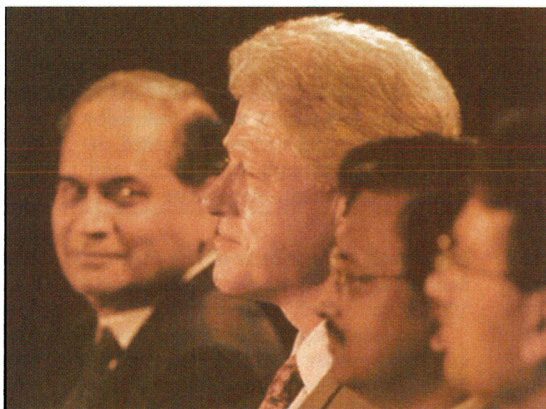
Clinton's One-Day Visit to India's Silicon Valley Leads to Science and Technology Collaborations

After devoting most of his week-long Asian subcontinent trip to issues of nuclear nonproliferation, environmental problems, and the political impasse over the disputed Kashmir area, President Clinton turned to matters of science and technology on 24 March in India's own Silicon Valley. Clinton and his entourage, which included his science adviser, Neal Lane, National Science Foundation Director Rita Colwell, and Commerce Secretary William M. Daley, visited Hyderabad, also known as Cyberabad and as Hitec City (an acronym for the Hyderabad Information Technology–Engineering Consultancy). Among the US computer, software, and information technology companies that have set up research shops there are Microsoft, Oracle, Lucent, and Sun Microsystems—though most of the enterprises in Hitec City are established Indian companies and small start-ups.

On the main streets were signs reading "Wel.com Mr. President" and children, given a day off from school, waving miniature US flags. Never one to miss a chance to address a crowd, Clinton spoke about the "new economy" and the "cyber revolution" flourishing in Andhra Pradesh, the southeastern state in which Hyderabad is located. He noted that India is "fast becoming one of the world's software superpowers," proving that "in a globalized world, developing nations not only can succeed, developing nations can lead."

India's exports of information technology have catapulted in value to \$4 billion last year from some \$150 million a decade earlier, and the Indian government has projected that by 2008 such exports may amount to as much as \$85 billion. What's more, one of India's principal exports is its strongly motivated and highly educated scientists, engineers, and tech-

nicians. Indian students compete ferociously to attend a top-notch science or engineering school. Last year, India's Institute of Technology in New Delhi had 130 000 applicants for 2000 places. The ratio is even larger to enter the Institute of Science, founded in Bangalore in 1933 by India's only Nobel laureate in physics, Chandrasekhara Venkata Raman.



AMID HITEC CITY LEADERS, Clinton extols India's information revolution.

To emphasize the quality of education in science and technology, Clinton noted that India produces 30% of the world's software engineers. The US benefits mightily from this talented workforce. Some 750 high-tech companies in California's Silicon Valley are led by executives of Indian origin, he stated. Clinton also extolled such expatriate superstars as Vinod Khosla, who helped elevate Sun Microsystems to its present technological status, and Vinod Dahm, who masterminded Intel's Pentium chip. On stage with Clinton was Ramalinga Raju, chairman of Satyam Computer Services, the first Indian information technology company to be listed on the Nasdaq exchange. Satyam has entered into an agreement with TechnologyNet.com,

one of several high-tech US–India business ventures.

With India's economy growing by 6% a year, and with 10% growth in sight, some of the country's skilled computer and software engineers and scientists are leaving Silicon Valley and returning home as entrepreneurs or as professors at Hyderabad's Indian Institute of Information Technology, which is already being compared with MIT and Carnegie Mellon University. "What we see is a movement from brain drain to brain gain," said Clinton.

During Clinton's visit, Lane and India's science minister, Murli Manohar Joshi, agreed to set up a forum to promote greater scientific collaboration among government research centers, universities and industry. The forum will consist of seven members from each country and is expected to commission studies on issues involving science and technology and to initiate joint research projects. The US is contributing \$4 million to operate the forum, using unspent funds from a moribund US–India Fund that was scuttled when India tested nuclear weapons in 1998. Scientific cooperation between India and the US peaked in the 1980s with the launching of some 250 collaborations. It went downhill in the 1990s over issues of patent protection and intellectual property rights, and came to a halt after India's nuclear tests.

In her talk in Hyderabad, NSF's Colwell spoke of the "rich potential for science and technology" in India. "Indeed, we can envision a time when young scientists from our country and other countries will pursue research and advanced training at centers of excellence throughout India," she said. The forum, said Colwell, is a new beginning of "a vibrant partnership for our nations."

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