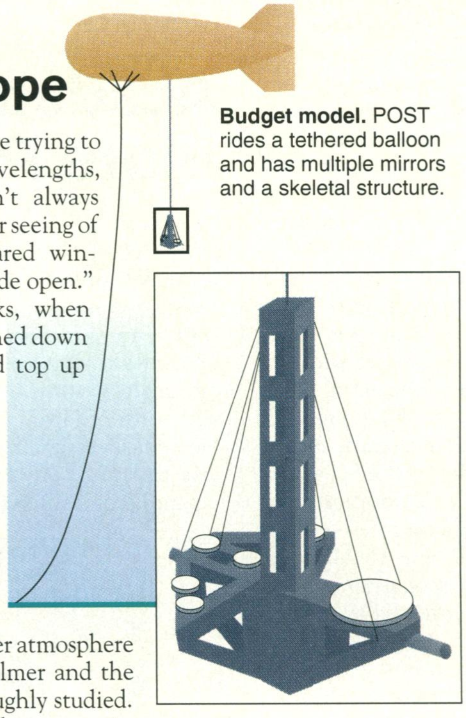
ASTRONOMY

A Scheme for a High-Flying Scope



Budget model. POST rides a tethered balloon and has multiple mirrors and a skeletal structure.

SOURCE: FORD ILLUSTRATION: C. FABER SMITH

In the expansive 1980s, astronomers planning a successor to the Hubble Space Telescope envisioned the Next Generation Space Telescope (NGST), with a 10-meter mirror and a price tag of $4 billion. In the chintzy 1990s, astronomers still want a bigger telescope above the atmosphere, but they are going downscale. In that spirit comes a proposal made this week at the American Astronomical Society meeting in Washington, D.C., by Holland Ford of Johns Hopkins University and the Space Telescope Science Institute (STScI) and Pierre Bely of the European Space Agency (ESA) and STScI. Their candidate for a Hubble successor is a 6-meter telescope—still more than twice the size of Hubble—slung beneath a tethered balloon. Ford and Bely need to do further design studies before submitting a proposal to the National Aeronautics and Space Administration (NASA), but they estimate that the setup could cost as little as $60 million.

A balloon may sound like a drastic comedown from space, but Ford and Bely point out that "space"—and the sharp seeing it brings—starts well below the space telescope's 600-kilometer orbit. That's especially true at the poles, where the atmosphere sags and the changes in temperature and wind speed that blur ground-based telescopic images ease off above about 8 kilometers. Accordingly, Ford and Bely would like to attach their gargantuan telescope to a 747-sized aerostat, or tethered balloon, stabilize it with gyroscopes, and fly it at an altitude of about 13 kilometers near Fairbanks, Alaska.

Called the Polar Stratospheric Telescope, or POST, the telescope should yield sharper pictures than the Hubble and also test technologies that might fly in some future space telescope. "It's a marvelous idea," says Garth Illingworth of the Lick Observatory, who helped plan the NGST. "It's a great test-bed and it'll do some wonderful science."

POST itself would depend on some new technology. A practical aerostat can't lift a single 6-meter mirror, so POST would gather light with seven smaller mirrors, spaced irregularly over a 6-meter-wide area: one 1.8-meter mirror and six 0.6 meter mirrors. The mirrors would adjust to form a single—if interrupted—surface, which would create a single image. Seven smaller mirrors can't gather as much light as a single mirror with a larger total surface area. But because POST's mirrors span 6 meters, its images would still have 2.5 times the detail of Hubble's, and reveal objects 2.5 times fainter.

Sitting in the cold polar stratosphere, POST would be able to do infrared as well as optical astronomy because, as Ford explains, the telescope "won't glow at the same [infrared] wavelengths you're trying to see at." At optical wavelengths, the stratosphere won't always permit the crystal-clear seeing of space, but "the infrared window," says Ford, "is wide open." And every few weeks, when POST would be winched down so that workers could top up the balloon's helium, new instruments could be installed. Eventually, the telescope could be moved to the South Pole, where working conditions are more challenging than in Fairbanks but the upper atmosphere is even colder and calmer and the skies are not as thoroughly studied.

But Ford and Bely have more in mind than high-resolution astronomy. "[Hubble] won't be the last optical space telescope flown," says Ford. "Someone, maybe not the United States, will fly a 6-meter, a 10-meter. But it won't look like the one we've got." Ford and Bely see POST as a test-bed for lightweight, cheap mirrors and structures that could make a larger space telescope practical.

None of this, says Bely, "requires breakthroughs, nothing that couldn't be done yesterday." If all goes well, he says, POST could be fully operational within 5 years; the Hubble, from proposal to launch, took 30. POST's bargain-basement price tag should attract NASA, he and Ford hope, as should its international appeal. Australian and French astronomers have already expressed interest, Bely says, and "we should approach ESA. With international collaboration, it becomes *cheap*."

And if, like the space telescope, POST turns out to be marred by an unexpected defect, Ford and Bely don't foresee the anguish, expense, and delay that came with the space telescope's troubles. "This doesn't have to work the first time or the second or the third," says Ford. "We'll just keep pulling it back down until we get it right."

–Ann Finkbeiner

Ann Finkbeiner is a science writer in Baltimore.

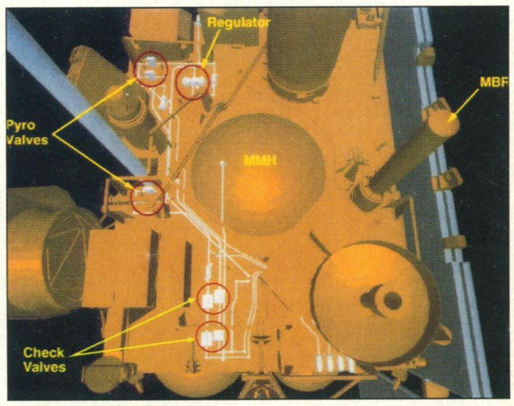
MARS OBSERVER

Management Faulted in Postmortem

Officials at the National Aeronautics and Space Administration (NASA) had barely finished celebrating last month's apparently successful Hubble Space Telescope repair mission when they were brought back down to earth by a new report criticizing the agency for a past mishap. The rebuke came last week from an external review panel charged with investigating the loss of contact with the Mars Observer space probe on 21 August 1993 (*Science*, 9 September 1993, p. 1264).

The panel acknowledged that no one will probably ever know exactly what happened to the spacecraft. But it listed the most probable failure scenarios, highlighting one in which a ruptured propulsion system could have led to a wildly spinning—and mute—Observer. The comments about mission management, however, contained few qualifiers. The panel, headed by Timothy Coffey, director of the Naval Research Laboratory, delivered a sharply worded list of admonishments ranging from overall mishandling of the $950 million mission to poor quality control and sloppy workmanship.

These problems were so significant that Coffey told reporters that "if you reflew Mars Observer and did nothing different, there's a high probability you would lose it again." The report "will certainly provide ammunition for critics of NASA's management style and also support [agency chief Daniel] Goldin's thrust for changes," comments space



NASA

Checked out? Leaky check valves on Mars Observer may have unintentionally mixed fuel components.

policy analyst John Pike of the Federation of American Scientists.

The panel's attempt to understand Observer's silence was hindered because telemetry from the spacecraft was turned off before the pressurization of its fuel tanks as it prepared to enter orbit around Mars. That was done to safeguard a few vital components, a protective move the panel concluded could have been avoided with a better design. Nevertheless, after sifting through 60 potential failure scenarios, the panel settled on four that were associated with the pressurization procedures. The most probable hypothesis is that two tablespoons of a fuel component, nitrogen tetroxide, leaked through "check" valves during the 11-month voyage. Then, during pressurization, the chemical reacted with another fuel component, monomethyl hydrazine (MMH), to rupture tubing within the propulsion system. This rupture, spraying out MMH and liquid helium, would act like an uncontrolled thruster, placing the spacecraft into a spin and disrupting communications.

As for management failures, the panel called Observer's design "generally sound," but it faulted NASA for using too much hardware and software and too many procedures designed for near-Earth satellite missions on a much more ambitious and rigorous interplanetary voyage. "The fundamental problem was they thought the spacecraft itself was low-risk," says Pike, suggesting that more attention was placed on Observer's instruments than on its platform.

A second major criticism centered on the use of a firm fixed-price contract between the Jet Propulsion Laboratory (JPL), which managed the mission, and Martin Marietta Astro Space (formerly RCA Astroelectrics and General Electric Astro-Space Division), which built the craft. Originally, Observer was part of a planned series of Mars visits in which a different payload of instruments would be launched on almost identical platforms. But Congress balked at the overall price tag and the mission became a one-shot deal that demanded constant redesigning as instruments were added and Observer grew in complexity.

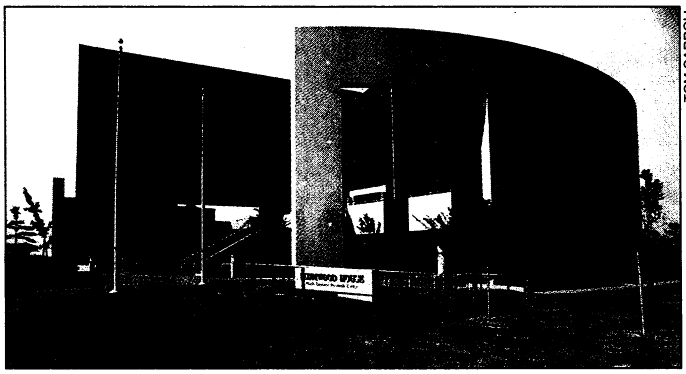
In that situation, a fixed-price contract was "inappropriate," says Coffey, since it placed pressure on the contractor to limit redesigns and consultation with JPL because that would drive up costs. The panel made a strong recommendation for future NASA missions: "Do not use fixed-price contracts when development is required, or when changes are anticipated, or when control over technical implementation is required." As NASA plans new planetary missions, including another try at Mars in 1996, those words—and many others in the report—will garner close attention.

–John Travis

U.S.-JAPAN COLLABORATION

Academic Biotech Deals Offer More Promise Than Product

BOSTON—In 1989, when Japanese cosmetics maker Shiseido Co. agreed to spend a record $85 million over 10 years for a new center on skin research at Massachusetts General Hospital (MGH), some biotechnology analysts saw it as the leading edge of a new wave of Japanese investments in basic biomedical research at U.S. universities. The fear that U.S. universities were providing Japanese companies with an entree into biotechnology intensified the next year, when Hitachi Ltd. funded a $20 million research center in the same building as the biochemistry department at the University of California (UC), Irvine.


TOM CARROLL

Windows of opportunity. Hitachi's bold investment has yet to be matched by other Japanese companies.

But the wave appears to have broken with barely a splash. The Cutaneous Biology Research Center (CBRC) in Boston and the Hitachi Chemical Research Center Inc. in Irvine are bold attempts by the Japanese to open a window on basic biomedical research—an area where Japan lags far behind the United States. But 4 years later, they remain the only Japanese investments of that magnitude in biomedical research at U.S. universities, and the only ones of any significant size not targeted at developing a particular product or drug. Neither has achieved the degree of success that might keep policy analysts up nights worrying about the independence of U.S. academic research or the health of the U.S. biotechnology industry. "What are Hitachi and Shiseido getting back?" says Mark D. Dibner, director of the Institute for Biotechnology Information in North Carolina. "Why would anyone want to do a similar deal now? The return in biotechnology has not been that astounding."

In fact, the lack of return is only one of several reasons why Japanese companies haven't followed in the footsteps of Shiseido and Hitachi. (A 1992 report from the National Research Council cited 28 biotech investments in the past decade by Japanese companies in U.S. universities, most for less than $1 million.) Within Japan, companies wanting to invest in biotechnology—whether already in the health care business or relative newcomers to the field—face formidable obstacles. The recent global recession, which has lingered in Japan, has left chief executives with little appetite for risky ventures of any type, much less in another country. Japanese companies also recall a string of failed attempts during the 1980s to develop products from research collaborations with U.S. start-up companies. What's more, any successful transfer of technology must overcome steep cultural hurdles, including the disparate research styles of U.S. and Japanese laboratories. "It takes a long time to set up a special system to acquire the technology. I'm not so optimistic," says Masato Mitsuhashi, a diagnostics researcher at the Hitachi center.

Heading home. Hitachi officials know firsthand about those obstacles. A project Hitachi funded at Irvine indicated that the receptor antagonist N-methyl D-aspartic acid may be a promising treatment for those with brain damage. But the company, which must obtain written approval from UC Irvine before pursuing any developments growing out of its financial support, did not exercise its first rights to license the technology. The reason: It couldn't afford to spend the amount—as much as $100 million—needed to conduct clinical trials. Instead, it invested about $150,000 in a venture company charged with the task. In addition, Hitachi has no infrastructure for marketing biotechnology to match what it has developed over decades in electronics and chemicals, further reducing its chances of success.

Hitachi's reticence to exploit its Irvine connection is reflected in the resources the company is putting into the venture. The Hitachi lab in California, which has room for 80 researchers, employs only 15, all Americans. Four Japanese scientists working there