Faster, Cheaper Strategy on Trial

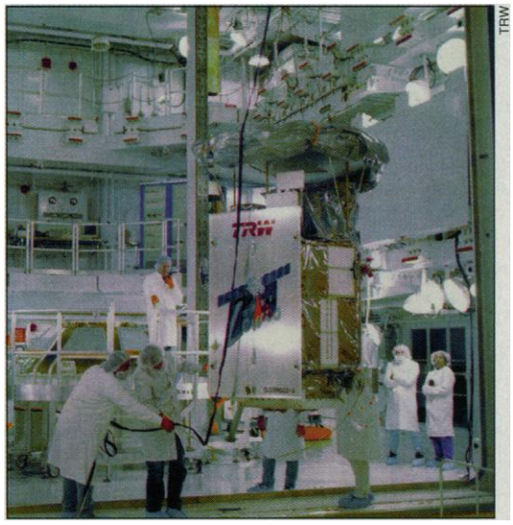
Technical problems with two pathbreaking satellites—Lewis and Clark—raise questions about Dan Goldin's streamlined approach to space exploration

Four days after a successful launch last summer, something went terribly wrong on the Lewis spacecraft, a small NASA satellite crammed with sophisticated remote-sensing instruments. A malfunction in the middle of the night sent the satellite into a tumble, pointing its solar panels away from the sun and draining its batteries. Lewis was in a death struggle, but no one witnessed it. Three hundred kilometers below, the control center run by TRW Inc. in suburban Washington sat empty and silent. By the time controllers arrived at 6 a.m. on 26 August, rescue attempts proved fruitless. The $71 million spacecraft, out of radio contact, spiraled down into the atmosphere and burned up a month later.

Lewis's failure was a bitter blow to NASA engineers and scientists who, at the direction of their chief Dan Goldin, have pushed for cheaper and faster ways to get low-budget and high-tech satellites into orbit. Lewis and a companion craft, Clark, were to be shining examples of what could be done under a new set of rules aimed at simplifying spacecraft design, procurement, and operation. But neither has lived up to expectations. Lewis's self-destruction last summer was bad enough; now the $61 million Clark—currently undergoing tests at a NASA facility in Maryland—is behind schedule and significantly over budget. Nobody argues that these problems will cause the agency to abandon Goldin's philosophy, but some view Lewis and Clark's travails as a cautionary tale about how that philosophy is being put into practice.

Last week, federal officials led by the Air Force began an interagency probe at NASA's request to examine what went wrong with Lewis, and what lessons can be applied to other NASA efforts. This week, a second panel of high-level NASA managers is meeting at headquarters to review Clark's development problems and consider whether the project should be canceled. Some insiders say these reviews will serve judgments on more than technical performance. Says one NASA manager: "What's on the line here ... are the benefits of the faster, cheaper, and better philosophy" that is the centerpiece of Goldin's strategy to shake up NASA.

Program officials insist that Clark will survive this week's review and that Lewis's failure does not damn NASA's new philosophy, but there's no denying that they and outside scientists are disappointed. The two satellite projects had multiple goals. They were designed to provide remote-sensing data for academic and industry researchers and pave the way for similar commercial spacecraft. In addition, Goldin hoped to use them to revamp the way NASA conducts such programs. In 1993, he championed the idea of creating a small team of NASA engineers, industry workers, and scientists who could circumvent traditional red tape that stretched some modest NASA programs into decade-long ordeals. "We had to try something to get out of the box, and this was the aggressive way to do it," says Sam Venneri, NASA's chief technologist.



Lost in space. After a successful launch, NASA's Earth-observing satellite Lewis went out of control.

NASA gave control of the Lewis and Clark program to a small group in headquarters, far from the field centers that typically assign hordes of government workers to oversee an aerospace company and its subcontractors. The new team moved quickly. By mid-1994, it had selected aerospace giant TRW of Redondo Beach, California, to construct and launch Lewis within 2 years. The satellite was to be the first to carry into space two hyperspectral radiometers, which image Earth in 384 spectral bands. Clark, built by a consortium of three small companies, was supposed to complement Lewis by providing a sophisticated camera to scan Earth with finer resolution, along with a batch of other science instruments, such as an advanced x-ray spectrometer to observe solar flares. The promised bounty of data excited researchers like Paul Bolstad, a remote-sensing analyst at the University of Minnesota, Twin Cities, who is mapping wildlife refuges. He says Lewis and Clark together could have provided a wealth of information for his studies of the carbon cycle in midwestern forests.

Lewis's launch, first set for summer 1996, was delayed a year because of problems with the new Lockheed Martin rocket, but on 22 August 1997, it was successfully blasted into orbit. Spacecraft typically are monitored continuously during their first days of flight, but with Lewis, NASA permitted a daily 7-hour gap in communications. Venneri says the Air Force requested that Lewis suspend transmissions to avoid the possibility of interfering with an Air Force mission. Others familiar with the program say the fact that NASA had no Indian Ocean facility to monitor Lewis when it passed overhead was also partly responsible for the gap. They add that TRW expanded the communications silence to 12 hours by leaving the control center in Chantilly, Virginia, unstaffed during the night. TRW officials decline comment until their internal investigation is complete.

It was during the night, 4 days after the launch, that an onboard rocket apparently misfired, sending Lewis into a spin. Had controllers been monitoring the satellite, agency and industry officials say there is a good chance the mission could have been rescued by sending commands to restabilize the craft. Venneri says the company limited control-room time to avoid exhausting the crew. Some NASA managers don't hesitate to point the finger at the contractor, however. "We consistently told TRW not to take short cuts," says Roger Avant, Lewis and Clark program manager. He suggests that TRW's decision to staff the control room for only 12 hours made a critical difference, for "if the hole was only 7 hours, then it's likely Lewis could have been recovered."

Other space experts in industry and government call Avant's assertion speculative. They place the blame on NASA as well as TRW. "It seems strange to me that you invest more than $50 million and don't monitor your satellite continuously, particularly in the first days," says one industry engineer. "It bewilders me completely." And one military official says NASA could have added an antenna to

Lewis—but at a pricetag of $1 million or more—that would have allowed it to communicate continuously with NASA's own tracking data and relay satellites without interfering with the Air Force mission.

The results of TRW's investigation will be passed on to the interagency panel looking into Lewis's demise, headed by Christine Anderson, space vehicle director at the Air Force Research Laboratory in Albuquerque, New Mexico. Anderson's group will look not just at technical details, but ask whether NASA's faster, cheaper, better philosophy is in part to blame—for example, by reducing NASA oversight of the contractor too dramatically. Anderson says the report should be ready by Christmas.

Clark inquiry. Air Force's Anderson leads review.

As the post-mortem gets started this week, NASA managers will be focusing on Clark, the surviving half of the satellite duo, which Venneri says is nearly 2 years behind schedule and at least $7 million—about 13%—over its $54 million original pricetag. Its launch date, planned for the summer of 1996, has slipped to May 1998.

Venneri cites late delivery of a camera designed to provide high-resolution pictures of Earth as a key setback. Officials at EarthWatch Inc. of Longmont, Colorado, which is responsible for the instrument, insist that it was only a couple of months behind schedule, less than many other components. "Venneri's flat-ass wrong," insists one peeved company source, adding, "Everyone failed to deliver." EarthWatch puts the blame on CTA Space Systems of McLean, Virginia—Clark's prime contractor—for failing to complete the satellite structure in time. NASA officials admit that they can't pinpoint exactly what went wrong and how, in part because they lack the detailed paper trail typical of the old NASA procurement process. But no matter how blame is apportioned, the situation is so bad that "this summer we were close to killing Clark," says Venneri.

What saved the program was the purchase of CTA's space business this summer by Orbital Sciences Corp., a larger aerospace company based in Fairfax, Virginia. "We made it very clear to the new management [at Orbital] that they weren't dealing with the old NASA," Venneri says. "We told them we'd terminate the program" if it wasn't whipped back into shape. And it appears Orbital has succeeded. Venneri and Orbital managers say they are confident the revamped Clark program is back on track and will survive this week's review by NASA officials. "There was no smoking gun" to explain Clark's past troubles, adds Orbital spokesperson Barry Beneski. Many things "just all piled up." Venneri insists the program has not strayed over the 15% overrun limit set up by Goldin as a cause for automatic termination. "We're not at 15%," says Avant. "We've been able to operate in a cost environment that is extremely frugal."

NASA managers say the problems with Lewis and Clark are simply bugs that must be worked out of the system, but that the overall idea of the cheaper, faster, better approach is doubtless sound. "There's uniform agreement that we can cut costs dramatically," says Bill Townsend, acting chief of NASA's Mission to Planet Earth effort, which includes several small as well as large satellites. "It's a learning experience," says Townsend. "And we're not there yet."

–Andrew Lawler

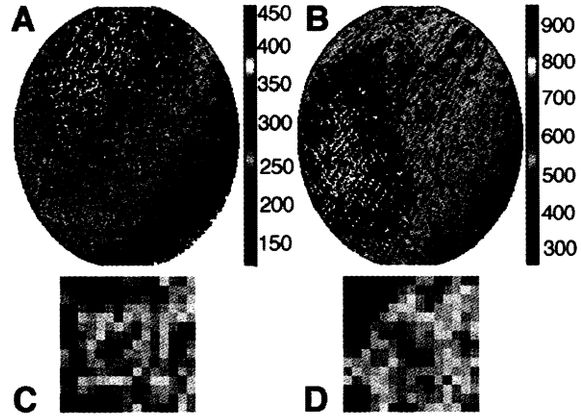
PLANETARY SCIENCE

Tiny Comets' Spots Called Artifacts

At a geophysics meeting last spring, space physicist Louis Frank had the whole community seeing spots. He flashed stunning satellite images on the screen, showing dark spots silhouetted against the ultraviolet (UV) glow of Earth's upper atmosphere. Those spots, he said, restored to grace his discredited theory that Earth is pelted with fluffy, house-size snowballs 30,000 times a day. Frank had proposed these small comets back in 1986 (*Science*, 10 June 1988, p. 1403), but no one believed him because the idea conflicted with so much other evidence. The new images didn't win converts to small comets either, but they did persuade a number of researchers that something unusual is going on in Earth's upper atmosphere.

Now the tables have turned once more. An analysis of UV images from a similar camera on the same satellite suggests that the mysterious spots are nothing more than instrument artifacts. In a paper to appear in the 15 December issue of *Geophysical Research Letters* (*GRL*), space physicist George Parks of the University of Washington, Seattle, and his colleagues present analyses of their images from the Ultraviolet Imager (UVI) aboard the Polar satellite. They conclude that "there is no scientific evidence from UVI that snowballs pelt Earth." The spots are not clouds of water left from high-altitude impacts of small comets, they say, but simply artifacts produced inside the camera—so much snow on a UV television.

"Parks's paper is absolutely devastating," says longtime small-comet critic Alexander Dessler, a space physicist at the University of Arizona, Tucson. But Frank, of the University of Iowa in Iowa City, counters that the problem lies with Parks's analytical methods, which he says dismiss real spots as mere mirage. Meanwhile, echoing past chapters in the saga of small comets, Parks removed his name from a paper with Frank, and other researchers are grumbling that Frank is keeping his raw data to himself. With Frank once again the only person who can see dark spots, even his newfound supporters are taking a cautious tack. "It would take some independent person to try to referee this," says Robert Meier of the Naval Research Laboratory in Washington, D.C., who spoke up for spots at the spring meeting. "That's probably the only way to resolve it."



G. PARKS/UNIV. OF WASHINGTON

Signal or noise? Ultraviolet images of Earth (a) and a lab calibration test (b) show similar dark spots (c and d).

Frank's spring announcement—billed as a triumphant vindication in the popular press—was largely based on data from his UV camera aboard Polar. Although they rejected small comets, some space physicists were convinced that the spots, at least, were real (*Science*, 30 May, p. 1333), in part because the same specks apparently turned up in Parks's UVI. That camera records UV images in much the same way Frank's does, just in a narrower part of the UV spectrum.

Bolstering the case even more, Frank said that water from some of the same spots could also be seen in images from the vis-