Hubble Hubris: A Case of "Certified" Blindness

The Allen panel blames the telescope's fuzzy vision on opticians who trusted their equipment more than their eyes

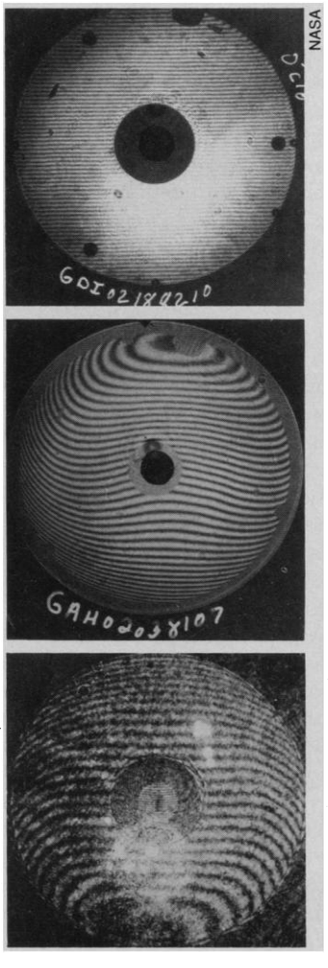
THE HUBBLE SPACE TELESCOPE'S DEVASTATING optical flaw was the result of sloppiness all around, concludes the final report of NASA's official investigation panel. There was sloppiness in the agency's supervision of its optical contractor, the Perkin-Elmer corporation of Danbury, Connecticut (now Hughes-Danbury Optical Systems). There was sloppiness in Perkin-Elmer's management of its own Optical Operations Division, where the telescope's 2.4-meter mirror was polished in 1980-1981. And there was sloppiness especially in the optical division itself, a "closed shop" where the polishing team operated with disdain for paperwork and outside interference—while ignoring at least three separate warning signs that might have allowed them to catch and fix the error.

"The story is not a happy one," says panel chairman and Jet Propulsion Laboratory director Lew Allen, who presented the report on 27 November at a NASA press conference.

As widely reported this fall, the Allen committee confirmed that the culprit was a device called the reflective null corrector, which the Perkin-Elmer opticians periodically used to test the mirror as they polished it. By illuminating the partially polished surface with laser light and capturing the reflections, the corrector was supposed to produce a map of the bumps and irregularities that needed more work. In reality, however, it contained a certain crucial lens that was 1.308 millimeters out of position. The opticians therefore ended up polishing the mirror very, very precisely to an incorrect shape, producing a massive optical flaw known as spherical aberration. And as a result, every star now seen by Hubble is enveloped in a halo of fuzz.

However, says Allen, knowing how the error happened doesn't explain the real tragedy: the fact that Perkin-Elmer's optical team managed to dismiss the warning signs that would have allowed them to correct the error before it was too late.

The first indication of trouble appeared as the polishing team was assembling the null corrector. As they tried to move the errant lens into position, they found that the lens' adjustment screws wouldn't turn far enough. The report concludes that the opticians were probably taking incorrect readings from a high-precision measuring rod. But at the time, they did not try to find out what was wrong. Instead they simply added some 1.3-millimeter thick spacers to extend the lens' range of motion. Once they were done, they henceforth treated this null corrector as being "certified" correct. (The panel was unable to find any documentation defining what "certified" meant.)



Ignored. *The mirror looked great to the reflective null (top)—but not to the inverse and refractive nulls (middle and bottom.)*

Another warning sign appeared shortly thereafter, as the opticians were doing a double check on the alignment of the reflective null before starting to work on the mirror itself. To perform the check, they beamed laser light at the reflective null with a second device known as an *inverse* null corrector—and produced a test pattern that shouted spherical aberration. The report cites testimony from several of the polishing team members that they did express concerns about these test results. And yet, as the team leaders admitted, the fact that the inverse null was known to be slightly imperfect and the fact that the reflective null was "certified" led them to discount the result.

A final warning sign appeared after the polishing of the Hubble mirror was completed, as the opticians were checking the mirror's overall curvature with yet a third null corrector, the *refractive* null. Once again, the test pattern said spherical aberration. And once again the results were ignored in favor of the "certified" device.

The panel could find no evidence that anyone outside Perkin-Elmer's Optical Operations Division heard a word about any of this. "The impermeability of [the division] seems astounding," says the report. For example, the polishing team kept NASA's quality assurance representatives off the shop floor during crucial operations, lest they get in the way. Moreover, none of the team members ever seems to have asked the advice of the people who developed the reflective null corrector. Nor did they consult with the company's in-house expert on making large telescope mirrors. These specialists were on the team that designed the mirror-polishing facility and that wrote the winning proposal to NASA. But when it came to actually making the mirror—well, that was the operations division's turf.

In the final analysis, though, the report lays full blame for the Hubble fiasco with NASA and Perkin-Elmer management—"100% each," says Allen. Officials at both organizations allowed themselves to be overwhelmed by the massive cost overruns and schedule slippages in other parts of the project. As a result, they neglected the mirror work, which seemed to be going relatively well, and failed to enforce their own quality assurance procedures.

The panel did find one piece of good news, says Allen: Perkin-Elmer/Hughes-Danbury seems to have cleaned up its act enormously in the past 10 years. The panel found that internal communications are now apparently excellent—which is a relief to NASA, since the agency had commissioned the company to build a Hubble-scale x-ray satellite known as AXAF before the space telescope's problem was discovered.

The company's new-found efficiency doesn't do much for Hubble, however. NASA space science chief Lennard Fisk estimates that devising optical corrections for Hubble's aberration will cost the taxpayer some $40 million to $50 million. When reporters asked him at the press conference whether NASA would take legal action against Hughes-Danbury, he called that option "premature"—but did not rule it out. ■ M. MITCHELL WALDROP