Solving Hubble's double troubles

Both of the serious problems hobbling the Hubble Space Telescope — "micro-wobbles" and a defective mirror — can be overcome, NASA officials announced last week. But while engineers may solve the wobbles in a matter of weeks, the misshapen mirror will have to wait years.

Since its launch, the space telescope has wobbled whenever it moved between sunlight and darkness. The jiggling arises because Hubble's big solar panels warm much more slowly on one side than on the other. It's similar to what happens in household thermostats containing a layered, coiled strip made of two materials with different thermal expansion rates: As the temperature changes, the layers expand or contract at different rates, tightening or loosening the coil. The wobbles occurring when Hubble moves into darkness take 4 to 6 minutes to taper off, while those initiated when the telescope returns to light last about 20 minutes, says Edward Weiler of NASA headquarters in Washington, D.C.

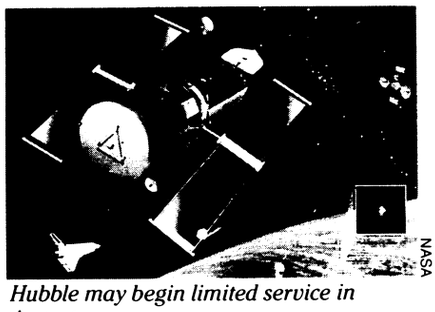
New computer software to cure the jitters is now in the works at NASA's Marshall Space Flight Center in Huntsville, Ala. NASA expects the software to let Hubble's pointing-control system sense even the first sign of wobbling and then cancel the unwanted motion through the spinning of heavy flywheels. According to Weiler, the new computer program will probably be radioed to the telescope from the ground in mid-July and then tested for two weeks to confirm that it works.

If all goes well, Weiler says, Hubble might begin its planned 15-year mission of studying the universe by the middle of next month.

The misshapen mirror would still distort the telescope's vision, however, and because that problem requires a hardware fix, resolving it will take more time.

Early images sent back from Hubble indicated that one of its two mirrors suffers from a classic case of spherical aberration, an optical distortion that blurs images (SN: 7/7/90, p.4). The aberration limits the telescope's ability to distinguish between close-together objects and to separate out the spectral emissions of faint objects, such as dim stars, from those of brighter objects in the visual field. The inability to focus sharply also makes it difficult or impossible to study part of a galaxy, forcing astronomers to settle for a blurrier view of the whole object.

But the mirror handicap "can be fully corrected," a panel of optical experts told NASA last week. Instead of changing the mirror itself, the panel recommends compensating for its flaw through modifications to several "second-generation" scientific instruments already under development and scheduled for delivery to the telescope beginning in 1993.



NASA

Hubble may begin limited service in August.

The second-generation instruments would include a redesigned replacement for the telescope's wide-field and planetary camera, one of two imaging devices on board and the instrument that detected the telescope's "first light" (SN: 5/26/90, p.325). Engineers at the California Institute of Technology in Pasadena, who have already spent five years working on the second-generation camera, are now striving for a precise understanding of the mirror imperfection so that they can compensate for it by redesigning the four small mirrors in the camera itself, says Edward Westphal, who is heading the effort at Caltech.

A spectrograph planned as a replacement for the two now on board would similarly undergo redesign to restore Hubble's ability to separately analyze light from several celestial objects at a time. Hubble would also receive a new instrument: the telescope's first infrared camera.

Hubble officials have noted that engineers might have spotted the spherical aberration before launch if the primary and secondary mirrors, which were tested separately, had also been tested together. Only computer simulations were used to see how these components worked as a pair. Weiler says both mirrors seem to have been shaped to the specified formulas, suggesting the error originated before polishing began.

An investigative panel assembled by NASA is seeking to determine whether the failure to test the mirrors together stemmed from the high cost of building an optical test assembly (OTA). This time, states the panel, "an OTA . . . which has a spherical aberration . . . which is the same as the [flawed mirror's] must be designed and fabricated so that the redesigned instruments can be tested prior to launch and installation in 1993."

Though Hubble's troubles represent a setback for researchers awaiting new astronomical data, "none of the scientists are even talking about leaving," Weiler says. Instead, they are poring over their lists of planned observations to figure out how much each of the five onboard instruments can accomplish despite the present handicaps. — *J. Eberhart*

Whale evolution: A sexual footnote?

Paleontologists working in Egypt have unearthed fossils of a 40-million-year-old whale with feet, documenting an important step in the whale's evolutionary journey from land to sea.

The bones belonged to a ancient species of whale known as *Basilosaurus isis,* a 16-meter-long giant with a thin body, a small "pinhead" and flipper-like forelimbs. The new finds indicate the species also had a functional pair of hindlimbs, each composed of a femur, tibia, fibula and three-toed foot, report Philip D. Gingerich and B. Holly Smith of the University of Michigan in Ann Arbor and Elwyn L. Simons of Duke University in Durham, N.C. These represent the first functional hindlimbs found on any whale, they say.

But lanky and leggy this whale was not. Its rear limbs were tiny compared with its overall body size, the researchers note in the July 13 SCIENCE. From the shape of the knee, Gingerich and his colleagues speculate that the leg had an extremely limited range of motion. They propose that the legs were too small to assist in swimming but could have come into play during copulation, serving as guides to help orient the reproductive organs during the tricky act of cetacean sex.

On the flip side, Lawrence G. Barnes, a paleontologist with the Natural History Museum of Los Angeles County, thinks *B. isis* used its hindlimbs to free itself when mired in the muddy bottom of the shallow coastal sea that once covered northern Egypt.

Future finds may clarify the function of the limbs. Among mammals, body parts related to reproduction are often larger on males than on females. If scientists find some early whale specimens with large legs and others with smaller legs, that would suggest a reproductive role. On the other hand, uniform limb sizes would back the locomotion hypothesis, says Barnes.

Whales evolved from four-limbed amphibious mammals that in turn developed from four-legged land mammals. The oldest known whale fossils date back about 50 million years but reveal little about the legs of these animals.

The Egyptian fossils resolve a standing debate among paleontologists, says Barnes. Most researchers believe that whales lost their hindlimbs long before *B. isis* arrived on the scene — implying the creatures adapted relatively quickly to their watery environment. Barnes has proposed that ancient cetaceans retained the limbs much longer. But until now, his theory lacked a leg to stand on. The feet of *B. isis,* he says, suggest its predecessors possessed even better-developed limbs. — *R. Monastersky*