New Worries About Space Telescope

Spare parts, maintenance, and refurbishment may be more complex and more expensive than anyone has realized

The good news is that after 18 months, some $400 million in cost overruns, and a heroic engineering effort by the National Aeronautics and Space Administration (NASA) and its contractors, the problems that threatened to derail the Hubble space telescope last year have largely been overcome (*Science*, 8 April 1983, p. 172). Final checkout and assembly is scheduled to begin this November at the Lockheed Missiles and Space plant in Sunnyvale, California; for the moment, at least, the project is proceeding apace toward an August 1986 launch.

The bad news is that now there is something else to worry about: the post-launch phase. In the aftermath of the development crisis, NASA, Congress, and the astronomical community have been taking their first hard look at the agency's plans for such mundane essentials as spare parts, maintenance, and refurbishment—the things that will presumably keep space telescope functional for 20 years or more. The results have not been reassuring.

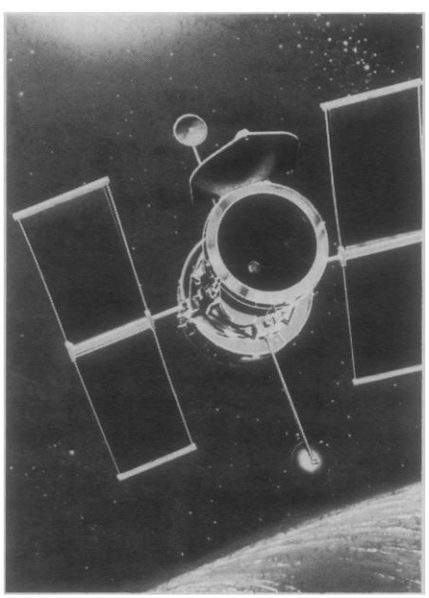
The concerns, and NASA's latest thinking on the subject, were aired on 22 and 24 May in hearings before the House subcommittee on space. Key issues that have emerged include:

Maintenance and Refurbishment Philosophy: All of space telescope's scientific instruments and most of its critical electronic and mechanical parts are designed to be replaced by astronauts wearing space suits. However, NASA's intention has always been to revisit the observatory only when something goes wrong, on the theory that a spacecraft that survives its shakedown phase will probably last a long time. In principle this policy minimizes the number of space shuttle flights. In practice it raises the specter of failed instruments, interrupted science, lost science, emergency flights, and urgent supplemental budget requests. If it were the power system that failed, the resultant chill could permanently damage all the instruments.

The alternative is the kind of regular maintenance and replacement schedule used by the commercial airlines. The subcommittee tends to like the idea and NASA has begun to take it a lot more seriously now that President Reagan has endorsed a permanent manned space station (*Science*, 24 February, p. 793).

Replacements and Spares: NASA originally planned to build about 100 plug-in subsystems, or "orbital replacement units" for space telescope. That figure fell to a low of 10 during last year's budget crunch and now stands at 25. NASA maintains that the most failure-prone subsystems are covered and, moreover, that the recent success of the Solar Maximum Mission repair demonstrates an ability to fix subsystems that are not covered. Skeptics would like to see a little more insurance.

Especially disturbing is the fact that there are no backups whatsoever for the scientific instruments. If one fails, the shuttle will thus have to go up, get it, bring it back to the ground for repair, and then take it back up again—two trips, as opposed to the one trip needed to plug in a backup. The cost of the extra trip alone would be a substantial fraction of the $30 million to $50 million cost of a new instrument.



Space telescope

Congress focuses on post-launch costs.

Besides, as the University of Wisconsin's Robert C. Bless pointed out to the subcommittee, new instruments built with 1980's technology would be a significant improvement over the existing ones. Why spend all that money to fix something that is obsolete?

NASA witnesses noted that the agency does have a program for commissioning advanced instruments for space telescope, with the first announcement of opportunity going out this summer. In addition, there is a good chance that there will be money to build a second Wide Field/Planetary Camera out of existing spare parts—that being the one instrument that is not out of date.

However, Bless pointed out that under NASA's current replacement schedule, at least one of the original instruments will have to last for an improbable 8 years. He would like to see that schedule considerably accelerated.

Orbital Reboost: Like all satellites, space telescope will slowly lose altitude due to drag against the outer fringes of the atmosphere. Once it falls to about 480 kilometers it will have to be reboosted, since the drag then begins to degrade its pointing accuracy. Fortunately, the drag forces fall off sharply with altitude; unfortunately, the shuttle cannot get the telescope any higher than about 515 kilometers. This means that during the peak of the solar cycle, when the drag forces are at their height, a reboost may be necessary every 9 months or so. That means a lot of flights and a lot of money.

On-Orbit Refurbishment and the Role of the Space Station: This area probably represents the biggest single change in NASA's thinking about the post-launch phase. The original idea was to bring the telescope back to the ground every 5 years or so for a complete overhaul. However, it is now generally agreed that the realities of such a process would be appalling.

Quite aside from the cost of the shuttle flight and the risk of landing 10,000 kilograms of exquisitely aligned optics, there is the matter of contamination. A good fraction of the cost overruns on space telescope can be traced to the need for special environmental chambers, clean rooms, and the like—all of which would have to be reproduced at the Kennedy Spaceflight Center for the refurbishment. Whole new teams of technicians would have to be trained. And if the worst came to pass and the telescope's main mirror had to be removed and cleaned, it would be 2 years before the observatory was ready to fly again.

The upshot is that NASA is now devoutly committed to the idea of never

bringing the telescope back. "We could probably save a half a billion dollars by doing the refurbishment in space," says Samuel W. Keller, NASA's deputy associate administrator for space science and applications.

Of course, it is President Reagan's endorsement of the space station that makes it possible to contemplate such an option. The idea is to include facilities that would make the station a kind of orbital dry dock for space telescope, as well as for later space observatories such as the x-ray telescope AXAF or the infrared telescope SIRTF. (One House staffer calls this the single most important use for a space station.)

Ideally, space telescope would be brought to the station not by the shuttle but by a remotely controlled robot spacecraft known as an "orbital maneuvering vehicle" (OMV). NASA plans to ask for OMV development money in the fiscal year 1986 budget. It would be based at the space station, it would burn hydrogen/oxygen fuel—much cleaner than the shuttle's hydrazine for working around the telescope—and it would be able to boost the telescope well above shuttle altitudes, virtually eliminating the atmospheric drag problem. In short, it would remove the shuttle from the process entirely. The OMV would also make it much easier to implement a regular maintenance schedule.

The down side to this rosy scenario is that the initial modules of the station will not reach orbit until 1992 at the earliest, which is 6 years after the launch of space telescope. How long can the telescope wait for that first refurbishment? Will NASA have to bring it home anyway?

Impact on future missions. The science community is understandably nervous about all this. The savings from a space station will not come soon and are hypothetical in any case. Meanwhile, missions such as AXAF and SIRTF have been marking time for nearly a decade because of space telescope. What happens to them now if the maintenance and refurbishment budgets, now estimated at $50 million per year, start to skyrocket? Will the new missions be further delayed? Or will NASA or Congress or the White House finally have to put a cap on space telescope?

"It's going to be a continuing tradeoff," says Keller, "especially as this family of observatories develops. Given certain budgetary constraints, do you concentrate on one, or spread your resources over the whole spectrum? That's a value judgment that the community itself will have to make."

—M. MITCHELL WALDROP

Carcinogenesis Without Controversy

After a prolonged effort, the White House science office has published its guide to the science of cancer-causing chemicals. It was released for public comment in the *Federal Register* on 22 May. The purpose of the report, according to the chief editor Ronald Hart, director of the National Center for Toxicological Research in Jefferson, Arkansas, is to produce "a document saying what is agreed and not agreed in the science of carcinogenesis for use in risk analysis by government agencies."

This is the Administration's second attempt to write a scientific basis for a government cancer policy. The first was scrapped in 1983 after the White House received many critical comments.

"It was a massive task. People may not realize how massive," Hart says of the heavily footnoted and cross-referenced paper. "It nearly killed me." The reviewers this time have responded favorably.

One of the stronger critics, Perry Gehring of Dow Chemical, says the report "does a better job than any document addressing the subject prior to this." He was unhappy with the report's tendency to favor what he sees as an overcautious philosophy on cancer. For example, he thinks more weight should be given to human epidemiological data and says it is "utter nonsense" to regard data on rats as more valuable than human data. He believes the report tends to do this. Gehring also argues that the risk models cited in the report can "grossly overproject the risk we know man is incurring." Nevertheless, he concedes this is the "most comprehensive" paper on carcinogenesis he has seen.

Environmentalists who were sharply critical of the Administration's 1982–1983 draft report are pleased with this one. Ellen Silbergeld, a neurotoxicologist at the Environmental Defense Fund, says, "It affirms the validity of animal studies" as a way of identifying carcinogens. "It affirms a single model for the risk of chemical carcinogenesis, throwing out the old genotoxic-epigenetic notions [distinctions based on mutagenicity]." And "it says that chemical carcinogens are a major problem requiring regulation."

The report is broadly framed, which is likely to mute opposition. It does not break new ground but instead describes what the authors call the consensus on the "state of the science." The most controversial aspects are likely to be sections that rule out the use of "threshold" theories in figuring risks. Thus, the report says that if a chemical is known to cause cancer, one cannot assume there is any "threshold" level of exposure below which the effect does not occur.

Chemicals that cause cancer in lab animals are to be treated as "suspect human carcinogens." And the report says that it is best to estimate risks for these problem compounds in a linear fashion. When data are hard to get—the "usual case," the report notes—the correct approach is to extrapolate in a straight line from effects measured at high doses to calculate effects that might occur at low doses. That straight-line technique is the "preferred" one.

Hart believes these principles and the extensive discussion backing them up will receive broad support in the scientific community. Before publication, they were read by 81 experts from environmental groups, industry, academia, and government laboratories. According to Hart, the paper was rated "very good" or "outstanding" by 75 percent. "Five percent didn't like it, meaning that we achieved the 95 percent confidence level." Hart says jokingly: "That makes it a significant report."

—ELIOT MARSHALL

Federal Court Strikes Down Baby Doe Rules

A federal district court in Manhattan has pulled the plug on the government's notorious "Baby Doe" regulations. Judge Charles L. Brieant, Jr., said they were "invalid, unlawful and must be set aside."

The judge took his cue from a ruling by the circuit court of appeals which denied the government's plea for access to the hospital records of "Baby Jane Doe," an infant born with grave defects and for whom surgery was deemed undesirable.