Space Telescope (II): A Science Institute

Everyone agreed that the telescope should do world-class research; the question was how to make it happen

When the National Aeronautics and Space Administration (NASA) embarked on the Space Telescope project in the mid-1970's, it expected a technical challenge. What it got—aside from technical challenges in abundance—was a case of culture shock.

It was largely a matter of perceptions. Even then, a decade before launch, it was clear that somebody was going to have to run the science on Space Telescope once it was in orbit—someone who would evaluate proposals, allocate time, schedule observations, take care of visiting astronomers, process the data, archive the data, and generally do all the unglamorous chores that would make Space Telescope work as a research tool. The question was Who?

Initially, at least, the NASA managers assumed that Space Telescope would be run from the Goddard Space Flight Center outside of Washington, D.C., much as previous scientific missions had been run. It made sense. Goddard was already slated to coordinate the development of Space Telescope's scientific instruments. The center would be handling most of the communications with the spacecraft after launch. Moreover, Goddard already had a staff of professional astronomers, and NASA saw no reason why they should not become the cadre for Space Telescope.

To which a lot of astronomers outside NASA replied, in effect, "What has that bunch of overpaid and undertalented mediocrities ever done to deserve it?"

Yes, it was unfair. It was also understandable. Few astronomers had had much experience with NASA at that point. (Goddard's excellent handling of the International Ultraviolet Explorer and its support of the Einstein x-ray satellite were still far in the future.) More important, there was (and is) a profound distrust of NASA among outside scientists, a suspicion that NASA is very good at building *things*—and then very quick to cut back on long-term operations when the going gets tough on the budget.

Most important of all, however, was that to the astronomers, Space Telescope was not just another satellite. It was not going to be the preserve of one principal investigator and a small band of mission scientists. Space Telescope was going to be an *observatory*, with a lifetime measured in decades and a user community numbering in the thousands. Moreover, it was going to be an optical observatory, and the optical astronomers are a particulary assertive and independent-minded bunch. They are used to running their own affairs at the National Science Foundation's national observatories, which are managed by university consortia and which are research institutes as well as service organizations. They saw no reason why things should be any different with Space Telescope.

Calls for a separate Space Telescope science institute date back to a National Academy of Sciences study in 1962. In the early 1970's, when NASA started planning the mission in earnest, the calls were renewed. NASA headquarters would not hear of it. The calls grew louder, and among them was the august voice of Princeton's Lyman Spitzer, the man who had first conceived of the Space Telescope in 1946. The issue became harder to ignore. Another advocate was C. Robert O'Dell, NASA's own Space Telescope project scientist. (He was based at Marshall Space Flight Center in Huntsville, Alabama, not at Goddard.) The evident mistrust was becoming a serious embarrassment. So in 1976, headquarters reluctantly agreed to submit the question back to the National Academy.

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Thus, an ad hoc committee of senior astronomers was formed under chairman Donald F. Hornig, president of Brown University, and in due course a report was issued.* The conclusion: Space Telescope should indeed be entrusted to a separate institute, which would be operated by a consortium of universities or nonprofit institutions, and manned by a director and staff "of the highest professional stature."

NASA scientists, particularly at Goddard, bristled at the implied vote of no-confidence. Headquarters, however, was in a tight spot. Having asked for the study, the agency would now have a very difficult time ignoring it. Yet how could NASA not support its own people? Noel Hinners, then the director of the Office of Space Science, recalls a strong temptation to do Space Telescope the NASA way and tell the astronomers to take it or leave it.

"Why didn't I?" he says. "Because [a separate institute] was what the bulk of the scientific community wanted and was comfortable with. At the same time, it seemed necessary and desirable as a way to clear the air of what I was convinced were wrong impressions about the NASA scientists." Besides, he says, at least some of the suspicions were valid: NASA *is* a "build-it" organization, and when it comes to long-term operations, an outside operator and advocate is not such a bad thing to have.

So in the end, with the scientists pushing from outside and Hinners and his allies pulling from within, the science institute idea prevailed. The Hornig committee report is in essence its charter. (Life, however, does have its ironies: Hinners is now director of Goddard.)

This is not to say that NASA took all the Academy's advice. For example, there was recommendation number 27: "The selection of a consortium and the search for a site should be initiated in the near future."

Cynics suggest that Goddard was still lobbying behind the scenes to get NASA headquarters to reconsider. Perhaps it was simply that space shuttle cost overruns and ever-tightening budgets were making it hard enough to find money for Space Telescope hardware. Or perhaps the Space Telescope managers saw no reason to start the operations side of the program so early. Certainly they had no intention of letting a brand-new institute get involved in the development of the scientific instruments, which was what the Hornig report seemed to imply. The agency already *had* an advisory panel for

*"Institutional Arrangements for Space Telescope" (National Academy of Sciences, Washington, D.C., 1976).

that (the 18-member Science Working Group). Whatever the reason, however, the request for proposals on managing the science institute did not go out until early 1980, more than 3 years after the Hornig report.

The request, when it finally came, was a bit unusual. Having agreed to let the astronomers run their own affairs at a separate institute, NASA was not about to take the political flack involved in choosing a site for the place. The astronomers could do that themselves, thank you; the consortia and institutions who bid on the management contract would have to include a choice of site in their proposals. On the other hand, they were *not* to include the name of a director. However miffed it might have been, NASA was genuinely committed to making the institute work. The Hornig committee had specified a director of the highest professional stature, and the agency did not want to see the choices limited to whomever happened to be in the winning consortium.

And so the scramble was on. The Space Telescope science institute was a major prize. Princeton, the University of Chicago, the University of Maryland, the University of Colorado—anybody and everybody who had a potential site invited the potential contractors in to look them over. And they came—Batelle Foundation; the University Space Research Association; the Associated Universities, Inc., which runs Brookhaven National Laboratory and the National Radio Astronomy Observatory; and the Association of Universities for Research in Astronomy, which runs Kitt Peak National Observatory and Cerro Tololo. The Universities Research Association even started preparing a pitch for Fermilab, which it already ran, on the grounds that particle physics is closely intertwined with cosmology.

Now, there was a certain element of strategy here. Did it maximize one's chances to make deals with as many potential contractors as possible? Princeton went with three and tried for more. Or did that diffuse the effort? Many institutions decided to join up with only one contractor.

Meanwhile, the contractors were working out their own strategies. The 16-member Association of Universities for Research in Astronomy (AURA), for example, started out well before the official request for proposals by setting up its own version of NASA's evaluation apparatus. Draft proposals for half a dozen different sites were sent up against a mock "Source Evaluation Board," then refined, and tried out again. European

Swagger/The Baltimore Sunpapers

Riccardo Giacconi

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astronomers were invited to give their views. An architectural consultant was called in to review the site plans and financial arrangements, and to pass on the general realism of the proposals.

One element of the AURA strategy was to get as close as possible to Goddard, where much of the spacecraft command, control, and communications would be concentrated. The obvious candidate was the University of Maryland. "It was nice," recalls Arthur Code of the University of Wisconsin, who was then the head of AURA. (He took a leave of absence to spearhead the science institute drive full time.) "With modern telecommunications it didn't really matter where you put the institute, but at Maryland you could have the staff co-located, and a high-speed data link would be easy."

Alas, Maryland was already deep in negotiations with University Space Research Association, and did *not* care to diffuse its efforts. Well, says Code, were there any other universities close by? Johns Hopkins, perhaps, in Baltimore? The astronomers there were good, although the department itself was too small to be a major power in the field. On the other hand, the science institute was going to dominate the scene anyway, so all the department had to be was adequate. "We approached them," says Code, "and they said 'No, we're a bit too small.' Then a few days later they called back and said, 'Hey, yeah, we're interested.' "

And so, negotiations began. Johns Hopkins offered low interest state bonds for the building, a professorship for the director and, not least, a truly marvelous location for the new building: an isolated, wooded glade overlooking a brook, within easy walking distance of campus. AURA decided to go with it. In March 1980, Code and the AURA board took the package to NASA, stressing the site and AURA's experience at running Kitt Peak, Sacramento Peak, and Cerro Tololo. On 16 January 1981, they won.

It was a jubilant moment for both AURA and Johns Hopkins. But there was no time to lose. Launch was (then) only 4 years off, and the fledgling institute had nothing—no building, no staff, no computers and, most especially, no director. Code took over as acting head of the institute while AURA embarked upon a 4-month search for a permanent director.

The association winnowed through a list of 60 candidates. Its choice, announced 12 June 1981, was 49-year-old Riccardo Giacconi of the Harvard-Smithsonian Center for Astrophysics. The name elicited cries of "fantastic choice," and "first rate!" It also raised some astronomical eyebrows.

Giacconi certainly had the stature the Hornig committee had asked for. Indeed, he had been one of the founders of x-ray astronomy. His group had discovered the first extrasolar x-ray source in 1962, using a sounding rocket. His proposal for an x-ray astronomy satellite had led directly to Uhuru in 1970. He had been principal investigator on the Einstein observatory mission since 1978. He was even then lobbying hard for an Advanced X-ray Astronomy Facility in the 1980's. But for all of that, Space Telescope would be an optical telescope, and Giacconi had never done optical astronomy in his life.

Meanwhile, the name Giacconi was causing more than a few groans within NASA. The agency works by team effort and consensus. Giacconi is driven, aggressive, and single-minded in pursuit of his goals. He had abraded a lot of nerves during Uhuru and Einstein, and there were many within NASA who were—to put it mildly—reluctant to work with him again. (To NASA's credit, officials at every level have since put aside these differences and worked hard to make Giacconi's efforts a success.)

As AURA saw it, however, these were not necessarily such bad qualities to have in an administrator. Giacconi's energy was legendary, his administrative abilities unquestioned. His subordinates were fiercely loyal, and that loyalty was returned. If he was not an optical astronomer, he was experienced with NASA and its ways, and he knew the vagaries of working from the ground with a telescope in space.

Moreover, as principal investigator of Einstein, Giacconi had deliberately run it as a national facility, with lots of outside observers and a level of community in-

The Space Telescope Science Institute

A new building, dedicated 15 June . . . a lovely location, on a leafy hillside just off campus . . . and already, space is tight.

volvement approaching that of, say, Kitt Peak. Indeed, he had long been advocating a separate science institute for x-ray astronomy. Finally, the timing of the offer was especially opportune for Giacconi personally. Einstein had fallen silent that spring, and in the midst of the Reagan budget crisis NASA was showing no signs of approving the advanced facility. (It still has not.) Giacconi was facing a 10-year hiatus in his research career. "When they offered me the job," he says, "I thought about it for several seconds and said 'Yes.' It was exactly the kind of thing I had been thinking about."

Giacconi took over as director on 1 September 1981. It was none too soon. The consequences of NASA's 4-year delay in founding the institute were already manifest. "The Hornig committee advocated that the institute play a role in the development of Space Telescope as well as in the operations," says Giacconi. "But that was not what NASA had in mind. It didn't see the need." A case in point was SOGS, the Science Operations Ground System.

SOGS is the massive package of computers and software that will allow the science institute to plan the observations, operate the telescope, and evaluate the data afterward. The contract to develop SOGS was given to an independent contractor, TRW, at almost exactly the same time as AURA got the science institute contract. In fairness to NASA, a newborn organization should hardly be expected to tackle something that complex. But as it turned out, the fledgling science institute had to tackle it anyway.

"They [TRW] were designing SOGS from specs, without any real scientific understanding," says Ethan Schrier, who is in charge of the science institute's data processing development effort. "Well, you can't design a working system from different pieces of paper. Somebody has to do an end-to-end job of systems engineering from the user's point of view."

With SOGS in its original form, for example, Space Telescope would have a limited ability to track objects moving with respect to the fixed stars—key targets such as planets, comets, and satellites. Meanwhile, TRW had not seriously addressed the question of a high-level command language, the user's basic tool for communicating with the system as he or she sits at a terminal. For image analysis, TRW was planning to use graphics display terminals designed for the business world. The science institute's first review of SOGS identified 750 requirements for changes, and the better part of a year was consumed in getting it all straightened out—and some of the details are still murky.

Simultaneously, the science institute had to take on the Guide Star Selection System. Barry Lasker, who heads that effort, explains that the telescope will be held steady to within 0.007 arc second by fine guidance sensors that lock onto stars at the edge of the field of view. "But because the field of view is so small," he says, "you have to go to stars as faint as 15th magnitude—which means you need a huge catalog, 20 million stars."

None of the existing catalogs even remotely approach such a number, says Lasker, so it fell to the science institute to make one. One of Code's first acts as interim director had been to procure two automatic measuring engines—a year ahead of schedule. They are now hard at work on a new series of photographic plates taken at Palomar Mountain and at the United Kingdom telescope in Siding Springs, Australia. Of course, at the level of accuracy Space Telescope will need, one does not just measure the position of a dot on a plate. "It's forced us head-on into modeling the optics of the telescope [that took the plate], the bending of the plate in the plate holder, the off-axis effects," says Lasker. "Then you have to relate the plates to their absolute position on the sky. And then, by the time of launch the southern plates will be 10 years old, so you have to start worrying about the stars' proper motion across the sky."

It is an overwhelming task, says Lasker. Even with a year's delay in the Space Telescope launch (*Science*, 8 April, p. 172), there is simply not enough time to develop a complete catalog. So instead, the science institute will have a "Guidestar Feasibility" catalog, with 20 million stars measured to 3 arc second accuracy or better. That way, says Lasker, his team can find out what guidestars a given observer needs, and then get them measured to sufficient accuracy in the months before the observation.

Meanwhile, Giacconi was grappling with budgets, staffing, office space, relations with NASA, AURA, and Johns Hopkins, and all the other bureaucratic niceties involved in transforming a paper institute into a functioning entity. In his own mind, however, the exercise has been dominated by one central question. "What *is* this place?" he asks. "There's a philosophical difference. I think NASA basically thought of the institute as a data distribution center and a service institution [for example, in helping visiting astronomers to effectively use Space Telescope]. But *I* conceive of it also as a first-rank research institute. I think that the very best scientists will give the very best service."

Giacconi concedes that from the outside this may look like empire-building. And indeed, the staff is growing far faster than planned. Giacconi is asking for a new wing and more office space in a building that was only just dedicated on 15 June. "I'm wary of the institute growing to eat up everything else in space astronomy," says O'Dell, who has recently moved to Rice University. "No one's against having a center of excellence. But the balance of the science institute with the rest of the field has to be considered."

Giacconi, however, is undeterred. He will take the institute as far as he can. "I'm trying to carry out the wishes of the Hornig committee," he says. "I'd like to see this place like a sieve, with people coming and going, with ideas flowing. Space Telescope is a terribly important resource. It goes beyond national boundaries. The Europeans are already here, the Australians and the Japanese will be coming—and I'd love to see the Russians here.

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—M. MITCHELL WALDROP