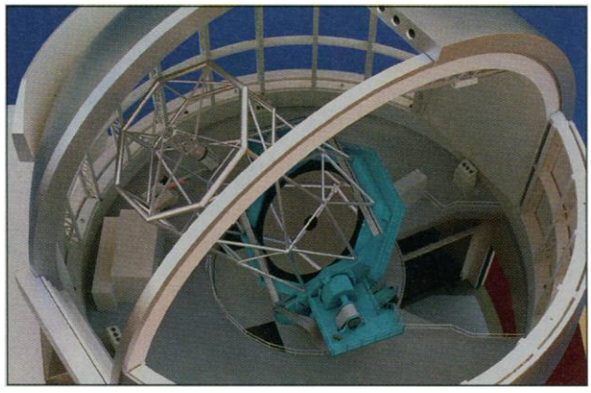
GRAVITATIONAL-WAVE DETECTOR

LIGO's Price Rises as NSF Debates Big-Ticket Items

The National Science Foundation (NSF), a bastion of support for individual investigators, last week took a potentially fateful step toward funding more Big Science. The National Science Board (NSB), a panel of outside scientists that sets overall policy for the foundation, reaffirmed its support for the most expensive project in NSF's history, a $365-million laser interferometer gravitational-wave observatory (LIGO). The board endorsed the project in spite of new estimates showing that LIGO will cost 40% more to build than was estimated only 4 years ago. And that's not all. The board also told NSF officials to continue planning for two other large projects, a $150-million array of radio telescopes in the millimeter range and a $250-million renovation of NSF's South Pole station in Antarctica.



MODEL BY BOB RICE; PHOTO BY MARK HANNA AND GLENN PRICE/NOAO

Model funding. NSF has funds to build the Gemini telescopes *(shown in model)*, but must find $9 million a year to operate them.

Speaking after closed-door meetings at NSF's headquarters, board members said these projects are essential if the United States is to maintain scientific pre-eminence in fields that will benefit from the facilities. But some members were decidedly uneasy about the possible consequences of pushing ahead with big-ticket items at a time when NSF's budgetary prospects are uncertain. "It's pretty scary to think about the cost of all these projects," says chemist Marye Anne Fox, vice chair of the board and vice president for research at the University of Texas, Austin. "We don't even know their true size. It's like making a big purchase when you don't know the cost of what you're buying or what your income will be."

By far the most contentious item on the agenda at last week's board meeting was LIGO, which will consist of nearly identical facilities at sites in Hanford, Washington, and Livingston, Louisiana. Physicists hope LIGO's detectors will be sensitive enough to make the first direct measurements of gravitational waves caused by such cataclysmic events as colliding neutron stars (*Science*, 30 April 1993, p. 612). Gravitational waves were predicted by Einstein's theory of general relativity, but they have never been detected.

Even LIGO's supporters acknowledge that the big project is risky. The concept behind it is that the speed of laser beams traveling up and down two orthogonal 4-kilometer vacuum tubes should be infinitesimally affected by a passing gravitational wave, creating an interference pattern that should provide information about the strength, shape, and polarization of the wave. But it will be a tall order to capture a separation of as little as 10^{-16} centimeters—while keeping out other sources of interference such as seismic vibrations.

Before it decided the risk was worth taking, the board had to be convinced the project would be properly managed. In a day-long session characterized as unusually intense and detailed, the board focused on the challenges facing the new project team. California Institute of Technology physicist Barry Barish, a co-leader on one of two detectors planned for the ill-fated Superconducting Super Collider, was brought in earlier this year to replace Caltech physicist Rochus Vogt, whose management of the project has been sharply criticized (*Science*, 11 March, p. 1366). NSB Chair Frank Rhodes, president of Cornell University, said the board was impressed with Barish and has given him "a vote of confidence." NSF, nevertheless, intends to keep a close eye on the project: It has assigned one program manager, Dave Berley, to the job full-time, and the board has demanded annual progress reports.

The biggest question, however, isn't management—it's whether NSF can even afford LIGO. New estimates produced by Barish's team show that the project will cost $297 million to build—40% more than the $212 million projected by Vogt's team in 1990. (Another $68 million is budgeted to run the facility and upgrade equipment during its first 4 years of operation, through 2001.) The increase stems from the need for a larger project staff, more costly equipment, and an increase from 4 to 7 years in the time required to build the facilities.

In light of the cost escalation, the board pushed NSF officials to make sure LIGO and other big projects weren't going to devastate NSF's existing programs. In the end, the board was reassured that benefits match the potential costs. "It's high-risk, but it's tremendously promising," says Rhodes. For NSF Director Neal Lane, LIGO is an investment that NSF cannot afford to pass up. "LIGO is a spectacular scientific opportunity," he says, "and the quality of the new team is so high that we want to continue it even if we have to make trade-offs."

Neither Lane nor Rhodes offered any examples of what those trade-offs might entail, however. They said they hoped Congress would understand the tremendous scientific potential of such projects and make allowances for them in NSF's annual budget. But some board members are not so sanguine. "The $84 million [in additional construction costs for LIGO] has to come out of somewhere," says Stanford University chemist Richard Zare, "and there's no use pretending otherwise. We're definitely mortgaging our future, and someday we may regret it."

The financial squeeze could become even tighter if NSF proceeds with the other two big projects. Last week, the board paved the way for a $1-million study for the millimeter array (MMA), which would be the world's most powerful telescope of its kind, capable of testing theories on the birth and evolution of stars, galaxies, and the early universe. The study will include a detailed analysis of possible sites in the southwestern United States, Hawaii, and northern Chile. NSF officials are already pinching pennies to make room for the MMA, the top priority for U.S. astronomers, putting a $150-million ceiling on the U.S. contribution to the instrument. NSF hopes other countries will contribute

LES LITZENBERGER

Catch the wave. Caltech's Barry Barish, third from right, digs into his new job as head of the $365-million LIGO project.

25% to 50% of the overall cost of the project, which carries with it an annual operating budget of $8 million.

The board last week also gave its first, tentative endorsement of plans to renovate the South Pole station. The new station would replace a deteriorating, 20-year-old facility with one that can handle the increasing opportunities for scientists from several fields to do world-class research at the bottom of the world (*Science*, 24 June, p. 1836). Last summer, an outside panel called the new station essential for continued progress in some areas of astronomy, astrophysics, and geophysics, and Cornelius Sullivan, head of the Office of Polar Programs, was optimistic that plans might move ahead quickly. But last week the board asked for a better explanation of how the station meets both the nation's national security requirements and its scientific agenda before agreeing to spend serious money on the renovation.

"Everybody wants the United States to demonstrate world leadership in science, and a new South Pole station would go a long way toward doing that in a very visible fashion," says Sullivan, who estimates the renovation will take 6 to 8 years. "The panel identified the opportunity to do world-class science, and it'll be too late if we wait until the current station starts to fall apart."

Although Lane admits that the new projects "might mean a squeeze" in existing programs, he hopes that a new accounting device might ease the pain and make it easier for Congress to support such projects. This year's NSF budget contains a separate account for major research equipment that isolates the cost of building big-money items from the rest of NSF's programs. LIGO and the twin 8-meter Gemini telescopes are already being funded from this pot of money, as would MMA and the South Pole station if they are built. Because the account is reserved for construction, which is spread over several years, its immediate impact on the federal deficit is reduced. But a staff member of the Senate appropriations committee warns that such an arrangement is only a temporary fix. "Frankly, I think the arguments [for budget increases that take advantage of different funding rates among programs] are specious," he says. "Even when you outlay funds slowly, you will spend the money eventually. And there are statutory ceilings on budget outlays through 1998."

NSF may therefore be faced with paying for these projects from a budget that is likely to grow slowly, if at all. And that prospect will require some tough administrative decisions down the line. LIGO offers "terrific science, a valuable resource for the community, and topnotch management," says Fox, who supports the project. But those issues often took a back seat during last week's meeting. "The most gut-wrenching aspects of the discussion," she recounts, "were entirely about money."

–Jeffrey Mervis

SCIENCE AND THE LAW

Court Says No to Copying Articles

Thinking of photocopying an article from your favorite journal? Think again. Last month a three-member federal appeals court in New York ruled that a Texaco Corp. scientist violated copyright laws by making one copy each of eight articles in a scientific journal and placing them in his files. The 2–1 ruling dramatizes the uncertainty over what constitutes fair use of copyrighted material, say lawyers familiar with the case, adding that the ruling should prompt companies and universities to review their policies toward copying.

The suit was filed in 1985 by a group of scientific organizations and publishers, led by the American Geophysical Union (AGU). (The American Association for the Advancement of Science, which publishes *Science*, was one of more than 80 plaintiffs in the case.) The publishers alleged that Texaco violated U.S. copyright law by copying and distributing hundreds of scientific articles to hundreds of its researchers. To simplify the case, the parties agreed to focus on just one example of this alleged wholesale copying—the actions of Texaco chemist Donald Chickering, who made one copy each of eight articles that appeared in *Catalysis*, an AGU journal.

Although copyright law allows "fair use" of published material, the court ruled that Chickering's actions did not fit that category because, rather than using the articles, he simply copied them and filed them in his office. "It was as if he created his own personal library," says Paul Berman, a lawyer with the Washington, D.C., firm Covington & Burling who has followed the case. The court may have viewed the matter differently if the researcher had made immediate use of the material, Berman added, referring to a recent Supreme Court case upholding the use of copyrighted material that the defendant had transformed through satire.

The court also ruled that Texaco should have ordered more subscriptions to the journal or bought a license from the Copyright Clearance Center, which sells a range of photocopy rights for publications. The court considered only the fair-use aspect of the case and therefore did not rule on the statutory damages requested by AGU. It did not, however, issue an injunction for Texaco to halt such practices.

The dissenting judge in the case, Dennis Jacobs, wrote that Chickering had copied the articles to aid his research and was therefore engaging in fair use. The court's decision, he warned, could lead to lawyers hovering over every copy machine.

Several lawyers following the case said the judge's comment should be taken with a grain of salt. In their view, the court was simply upholding existing laws designed to protect the value of intellectual property.

"I don't find it overwhelming, remarkable, or terribly disruptive for a court to say that before making copies, [Texaco] should have sent a check to the Copyright Clearance Center," says Berman. But Joseph Mello, a lawyer with the New York firm of Reid & Priest, says, "This will cause a lot of scientists to re-examine their policies" about photocopying. Many companies do not have policies about how, when, and whether to make copies of copyrighted material without purchasing the rights, he says, and few forbid it entirely.

Chickering declined to discuss the ruling, but Texaco spokesperson Cynthia Michener says the decision "would seriously impair the ability of researchers to make copies." Texaco has requested a rehearing of the case before a larger audience of appellate judges. AGU is pleased with the decision, says Judy Holoviak, director of the organization's publications division, adding that it upholds longstanding organizational practice. "We have always had a strong sense of abiding by copyrights, since we are both a user and producer of materials." Although AGU does not prohibit its staff from making copies of copyrighted materials, she says, "we try to be very careful and set a good example" for others. AGU also has a license from the Copyright Clearance Center that covers photocopying of copyrighted material, Holoviak said.

AGU's lawyer in the case, Jon Baumgarten of Proskauer, Rose, Goetz & Mendelsohn in Washington, believes the case is too narrowly drawn to clarify definitively what constitutes fair use. Although the fair-use doctrine makes greater allowances for the actions of researchers and teachers in making photocopies of published material, he says, "this doesn't mean all educational use is fair use." And Baumgarten has a warning for academic researchers: "Consult with your university counsel before making copies."

Berman says common sense and the Golden Rule are good guides when navigating the complex waters surrounding copyright laws. His advice: "Treat other people's intellectual property as you would have them treat yours."

–Andrew Lawler