Why Bigger Isn't Better in Earth Observation

How budgetary and technical realities—and the surprise entrance of a new rocket—brought EOS to heel

AN OUTSIDE REVIEW PANEL'S RECOMMENDATION that NASA scale back its ambitious plans for two huge instrumented satellites has shown how the space agency's penchant for massive projects is colliding with new realities. And in this case, at least, NASA seems to agree with its critics.

The twin 13-ton platforms, the centerpieces of NASA's widely touted Earth Observing System (EOS) program, would each have carried a dozen or more instruments for taking the pulse of the planet. They would have monitored physical, chemical, and biological processes at Earth's surface and in the atmosphere. But many researchers who favored the concept worried that NASA's program risked choking on its own mass. And now a team of experts NASA itself appointed has taken those worries one step further.

Called the EOS Engineering Review Panel,* the eight engineers and earth scientists issued a report last week urging that the sensors slated to fly on the two mammoth satellites be parceled out among a series of smaller platforms carrying two to nine instruments each. The panel also recommended that NASA rethink other parts of the program, including its vast but perhaps unwieldy data handling system. The object of the panel's recommendations, according to the report, was to make the program more "resilient and robust" in the face of future budgetary pressures and technical glitches. And NASA shows every sign of taking the report to heart. After being briefed by panel members but before the public release, Lennard Fisk, NASA associate administrator for space science and applications, was already speaking of the need to increase EOS's flexibility by breaking up its big platforms.

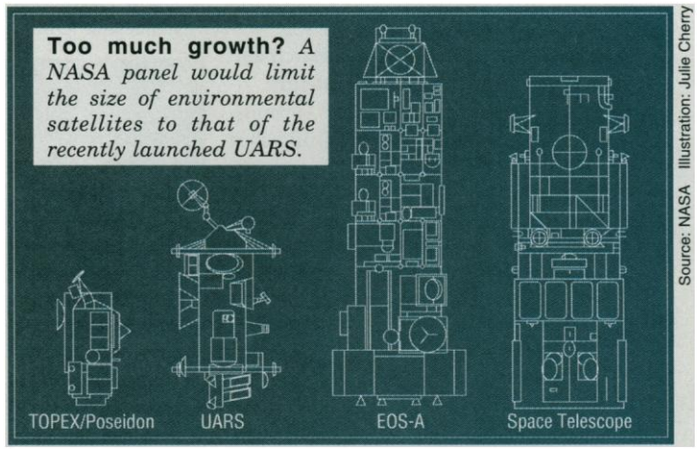
If NASA follows the recommendations, it will have made a 180-degree turn in strategy. At the time of its conception, EOS's grand scale was expected to secure it against budgetary vagaries, recalls climate modeler and panel member Warren Washington of the National Center for Atmospheric Research. There "was some concern [at NASA] that if EOS were broken up into smaller pieces, these pieces would be lopped off [by Congress]" as soon as money got tight, he told *Science*. As panel member Albert Wheelon, retired chairman and chief executive officer of Hughes Aircraft, phrases the theory: "A big ship rides out big seas better than a small one."

But that argument looks less compelling if the big ship is so overloaded that it's destined to sink at launch. Panelists and many observers could not help wondering where NASA would get the $30 billion needed for EOS over the next 20 years when it was also requesting funding for its $37-billion Space Station Freedom. The dangers of a high price tag were underscored this year when the Senate directed NASA to make do with $11 billion through the year 2000 for EOS rather than the $16 billion anticipated. That looked likely to push the first big platform past the turn of the century, whereas smaller, cheaper ones might go up sooner.

Meanwhile, another rationale often invoked by NASA—economies of scale—crumbled under the panel's scrutiny. It's cheaper, NASA had argued, to support many instruments on a single power supply and communications system and launch them all at once than to send them up in smaller packages. But Wheelon points out several flaws in what he calls the "bigger-is-cheaper argument." The savings gained by linking more and more instruments to a single life-support system diminish quickly when the instruments themselves are costly, as on EOS. And such calculations, he says, do not take into account the difficulty of deciding when to replace a big platform as a few of its instruments fail.

Even more worrisome to panelists was the risk of a single failure that would take the entire suite of instruments with it. With the Hubble Space Telescope's problems fresh in their minds, global change researchers had long been fretting at the prospect of losing a large chunk of the EOS program through a single launch accident or some mindlessly simple failure of the spacecraft.

But all those considerations might have been moot had it not been for the surprise entrance of a launcher suitable for downsized satellites. EOS planners had assumed that they had only one practical launch option: the Titan-4 rocket, the most powerful U.S. expendable launch vehicle. At the time, the Titan was the only sizable rocket with launch pads in place on the West Coast. A launch there was needed because EOS platforms must be polar-orbiting to cover the entire globe. That rules out Cape Kennedy, where a launch into polar orbit would carry the rocket over inhabited areas. With no apparent choice but to use the massive launcher, says EOS platform manager Christopher Scolese of NASA's Goddard Space Flight Center in Greenbelt, Maryland, NASA had made the most of the big launcher's lifting ability by designing satellites to match. But then came the summer surprise.



Too much growth? *A NASA panel would limit the size of environmental satellites to that of the recently launched UARS.*

Source: NASA Illustration: Julie Cherry

As Wheelon recalls it, the review panel was well into its considerations when "someone brought to its attention" the Air Force's plans to provide West Coast facilities for the modified Atlas Centaur, a smaller but still capable rocket that was just what was needed to orbit an intermediate-size satellite. Curiously enough, says Wheelon, the Air Force had signaled its plans in its budget request, but no one at NASA had taken much notice.

The panel didn't confine its broadside against bigness to the space-borne part of EOS: It went on to question the adequacy of the massive EOS Data and Information System (EOSDIS), intended to collect, archive, and distribute data from the instruments. "The panel is concerned about the fact that EOSDIS is the largest and most complex civil data system ever attempted by the federal government," the report says.

*Edward Frieman, Scripps Institution of Oceanography; James Baker, Joint Oceanographic Institutions Inc.; Peter Banks, University of Michigan; Greg Canavan, Los Alamos National Laboratories; Richard Goody, Jet Propulsion Laboratory (temporary); V. Ramanathan, UC San Diego; Warren Washington, NCAR; Albert Wheelon.

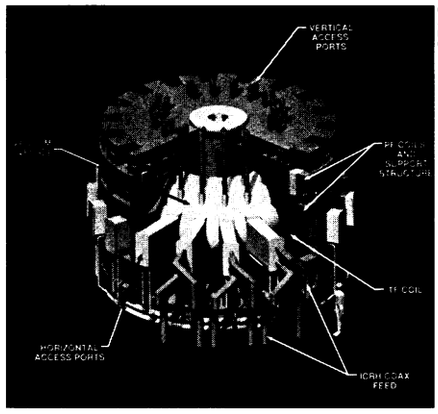
Noting a host of uncertainties, it recommends that NASA establish a review team of experts to see if the proposed system is technically and economically practicable.

The panel also turned a critical eye on NASA itself, suggesting that in EOS the agency has taken on more than it can handle. It strongly urged that NASA reach out to other federal agencies, pointing out that the Department of Defense, for example, has expertise in technologies such as optics that makes it a logical partner in EOS.

All of which has cheered many global change scientists. But Washington, among others, is concerned that even if NASA acts on all the panel's suggestions, EOS may still be too big for many researchers to stomach. "I think there is still going to be a problem" drumming up support for it in the scientific community, he says. "One thing we couldn't do was bring down the cost dramatically. A lot of investigators will think it's still too much. But the scientific community needs to understand that we have to have a comprehensive program to monitor this planet." Washington says the cost of such a program—$1 billion a year into the next millennium—is the sort of bigness that scientists studying global change will just have to get used to. ■ RICHARD A. KERR

Allocating the Pain in Energy Science

If you were looking for happy faces last week, room 1E-245 in the Department of Energy (DOE) wasn't the place to find them. A panel of physicists, assembled to help DOE's Office of Energy Research (OER) set its research priorities, looked increasingly dismayed as it realized there just isn't enough money to pay for the nine major facilities that DOE hopes to build in the next decade. Panel members issued dire warnings that the United States is underfunding basic research and imperiling its scientific infrastructure, lamented the "vast amount" of "promising" work that can't be funded, and shot jealous, sidelong glances at the huge budget of the Superconducting Super Collider (SSC). But in the end, they bit the bullet and told DOE to downsize plans for the next big fusion machine and put off two major high-energy physics projects.



ORNL

Candidate for downsizing. *The BPX.*

For nearly a year, the handwriting has been on the wall for the OER budget, which is being squeezed between expensive commitments to long-term projects such as the SSC and other DOE priorities, such as cleanup of the nuclear weapons complex. To cope with this onrushing disaster, newly sworn-in OER director William Happer, Jr. followed a time-honored precedent and convened a 15-member panel of eminent academic, industrial, and federal scientists from the research fields supported by DOE. This panel, chaired by Nobel Prize–winner Charles Townes, was told to set priorities under the assumption that budgets in the four programs funded by OER—high-energy physics, nuclear physics, magnetic fusion, and basic energy sciences—would remain essentially flat. Energy Secretary James Watkins insulated the SSC from this process and told the panel only to set priorities, not to suggest project modifications or stretched-out construction schedules.

Forced to look elsewhere for savings, the panel set its sights on the Burning Plasma Experiment (BPX), the first major U.S. fusion facility proposed since Princeton's Tokamak Fusion Test Reactor was completed in 1982. Touted last year as a $1-billion reactor capable of producing at least five times as much energy as it consumes, BPX is the "major issue" for the U.S. magnetic fusion program, said Anne Davies, OER's associate director for fusion energy. But the major issue for the advisory committee was the fact that BPX construction—now estimated at $1.9 billion—would double the magnetic fusion energy budget by 1996. To prevent that from happening, the committee accepted a plan proposed by panel member Marshall Rosenbluth, a fusion researcher from the University of California at San Diego, to cancel funding for BPX and consider a smaller, yet-to-be-specified burning plasma experiment instead. The panel also endorsed full funding of U.S. participation in the International Thermonuclear Experimental Reactor (ITER), now a $1-billion, four-nation program to design a working fusion reactor.

Turning next to the high-energy physics program, the committee agreed to recommend "deferring" funding for two new initiatives: a $181-million main injector for Fermilab's Tevatron accelerator, and a $200-million "B factory" proposed by the Stanford Linear Accelerator Laboratory. The idea, says panel member Herman Feshbach, an MIT physicist, is to withhold funding for these projects until DOE's High Energy Physics Advisory Panel (HEPAP) ranks them against the base program. Fermilab may not fare well in that competition. A DOE official who asked not to be named says only: "Certain people were talking about ranking the main injector against the B factory, and they're not certain the main injector would go forward."

The nuclear physics and basic energy sciences program fared somewhat better in the panel's deliberations. Neither program would lose a major facility, although the panel recommended a "go-slow" approach to the Advanced Neutron Source, a $1.15-billion nuclear structure laboratory still under design. Two other big machines—the Continuous Electron Beam Accelerator Facility (CEBAF) and the Advanced Photon Source—got votes of confidence from the panel. The only potential loser was the $397-million Relativistic Heavy Ion Collider now under construction at Brookhaven National Laboratory. Without making a clear recommendation, the panel suggested kicking the issue back down to the Nuclear Science Advisory Committee (NSAC), which could weigh full funding of the machine against the severe cuts in the nuclear physics base program that would be necessary to accommodate it.

Although most panel members complained about the difficulty of setting a 5-year course for DOE science programs in a 2-day session, none disputed the need for the exercise. "Before, people in various groups would propose facilities, and the political process would determine which ones got funded," says panel member William Brinkman, an executive research director at Bell Labs. "We have tended to start too many things and then not deliver on them." Happer has already shown that he might be thinking along similar lines: He has asked the panel to remain intact for further consultation. ■ DAVID P. HAMILTON