News & Comment

Space Station Science: Up in the Air

In the past 3 months, NASA has revamped plans for the space station twice and in the process it has upset scientists, foreign partners, and some key members of Congress

THIS FALL, Congress signed off on $1.8 billion for the space station—a 1-year installment on a total bill that, with shipping included, could run to $30 billion. But nobody—including members of Congress who voted the money, National Aeronautics and Space Administration (NASA) engineers who are designing the hardware, and scientists who hope to hitch a ride for their experiments—knows exactly what all that money will buy. Even at this late stage, 5 years after it was given the go-ahead, the space station has yet to be fully defined and its schedule completely worked out.

Since being included in the federal budget in 1984, the program has run through four directors, four agency chiefs, and 11 planning reviews, spending more than $2 billion along the way. And that was in the slow days. In the past 3 months, NASA has dismantled plans for the station and put them together again—not once, but twice. In addition, NASA is now overhauling the management. All this churning has upset scientists, who have seen key scientific capabilities dropped, downgraded, or deferred, and it has worried NASA's international partners, who have feared they were getting shortchanged.

Even some of the space station's strongest supporters on Capitol Hill are getting concerned. Confusion about what the space station will do and when it will do it got Representative Robert Roe (D–NJ) angry. And when he gets angry he says so. As chairman of the House Science, Space, and Technology Committee, he called the program chiefs in for a dressing-down on 31 October, complaining that it is too late in the day to be changing the fundamental nature of the project, as NASA had done between August and October.

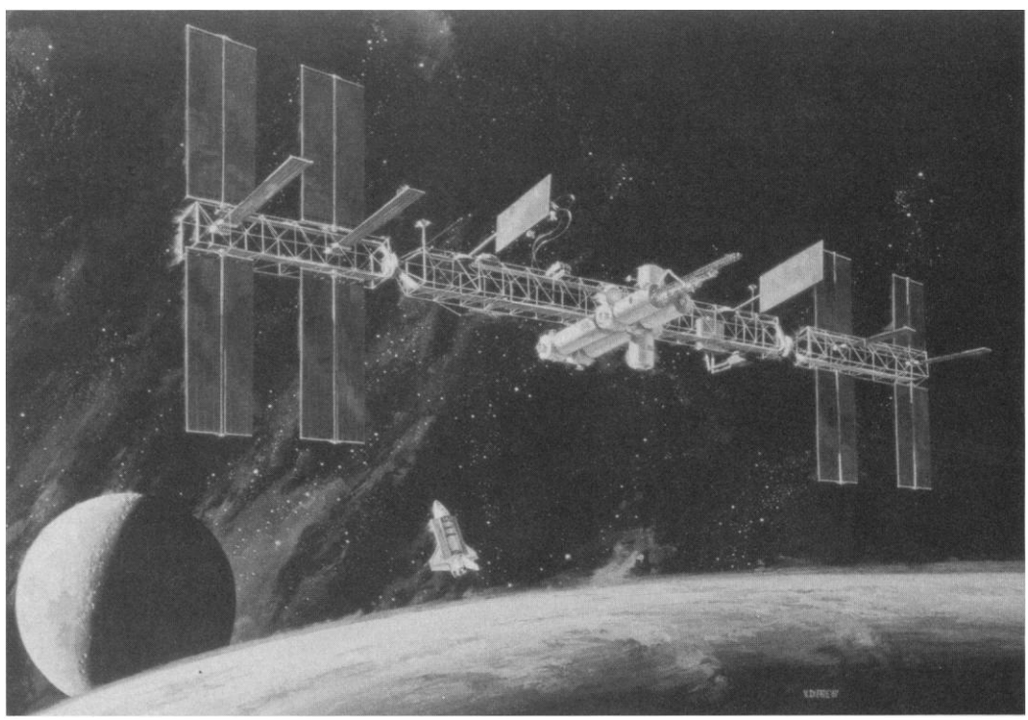
Roe warned that NASA will have to freeze the design and live with the consequences next year, for if the situation doesn't improve in 1990, he said, his committee has "the guts" to ask Congress to put it out of its misery. Representative F. James Sensenbrenner (R–NY) agreed.

"What annoyed the committee," Roe told *Science* later, "was that they went ahead and reshaped the station to meet levels of budget allocation," rather than holding firm and asking Congress to vote an honest yea or nay on the original plan. "I wanted to make it clear," Roe said, "that . . . if you're going to reshape and reform every time we turn around, then we don't really have a U.S. space station; we have a station that's driven by funding rather than technology."

Roe reports that new delays in the schedule could add $200 million to $300 million to the cost borne by the European partners alone. And another committee member, Representative Robert Torricelli (D–NJ), told the NASA chiefs that by trimming the station's capabilities, "You are [turning] what presented itself as possibly the world's most advanced scientific laboratory into a giant orbiting recreational vehicle."

NASA's propensity to keep going back to the drawing board began to worry the foreign partners in August, especially because they were excluded from a review (the "rephasing") at which major cutbacks were debated. They feared they were losing out on power supply, communications links, and priority of hookup. Even for NASA to consider such changes unilaterally, they protested, was a violation of international agreements.

The furor may have affected the funding debate this fall. The House, which had been considering a large, $400-million cut in NASA's request, relented in October and voted to take away only $250 million, leaving the station a total of $1.8 billion for 1990. In response to the protest, NASA also began restoring some of the items it had threatened to cut out, but not all of them. With more budget shuffling on the horizon (the Gramm-Rudman-Hollings process threatens to take back over $50 million of the money Congress just promised), even NASA people find it hard to see exactly what the station will include.



Late 20th century vision. *NASA's schedule calls for an 18-month delay in building Space Station Freedom, which will be fully staffed by 1999 if all deadlines in the next 10 years are met.*

The plan is a blur, changing almost every week, like "a train roaring through my office," says Robert Rhome, a NASA science official whose job is to ensure that researchers get a berth on the train as it flies past. For space science, there are some big unresolved issues. Rhome laid them out in a presentation to a NASA control board in Reston, Virginia, on 19 September. There is not enough power, he said. The data management system is scheduled to grow too slowly. Not enough crew members will be available to run experiments. In its initial configuration, Rhome said, the station did not seem to be much of an improvement over the shuttle's spacelab as a research center.

The Office of Space Science and Applications, for which Rhome works and which is headed by Lennard Fisk, will soon begin to negotiate with the space station program, headed by Richard Kohrs, on exactly who will pay for what. Within the next 8 months the fundamental issues must be settled. Starting in July, the program will undergo a "preliminary design review" when most of the fuzzy lines in today's concept must be made hard.

Already, the funding for some lab equipment has been postponed beyond 1991 and other items have been shoved beyond NASA's "budget horizon" of 1995. This approach "negatively impacts life sciences research," says Laurence Young, chief of the man-machine laboratory at the Massachusetts Institute of Technology and head of a NASA biomedical advisory group.

Young is disappointed that the new schedule has cut the crew size from eight to four through 1997, for this means crew members will be so busy with routine chores that they will have little time for science.

NASA thinks this concern may be overstated. Responding to questions from Representative Roe's committee in November, NASA reported that the station crew will spend 240 hours on scientific investigations in 1996, 2,600 hours in 1997, 5,000 hours in 1998, 11,000 hours in 1999, and 15,000 hours in 2000.

Young remains concerned, and, in fact, has another worry. NASA has not yet budgeted for $200 to $300 million worth of research hardware. One important item—a centrifuge for biomedical studies—is slated for early deployment, but other tools may not be.

For example, according to NASA's Rhome, the original design included racks of freezers and other equipment to hold specimens awaiting shipment back to Earth. Now they are gone. Young says, "The presumption is that [the cost of installing the freezers] will be picked up again" by

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"Annoyed." *Science committee head Robert Roe scolds NASA for changing its plans.*

NASA's science office. But Fisk has not yet offered to pay, and Kohrs said recently that he found the list of things Fisk's office wants him to do "not all that well thought out." But he insists that "NASA will pay," one way or another. The risk, according to Young, is that decisions will be put off until it is too late to shoehorn everything that's needed into the schedule.

It would be hard to do good research without freezers, for example, Young says. Experiments would have to be coordinated with shuttle visits so that specimens could be loaded quickly into the cargo bay just as the shuttle prepared to go back to Earth. Such rigid scheduling—in addition to the many other chores that must be done during shuttle stopovers—might be too demanding.

Equally important, according to Young and Rhome, is a system to carry live animals

Cutbacks could turn the station into "a giant orbiting recreational vehicle."

—Representative Torricelli

from Earth to the station and move them quickly from the shuttle to the orbiting lab. At the moment there is no provision for the $24-million "animal specimen transport system." But, as Fisk wisecracked recently: "The station won't be of much use if we have to use freeze-dried animals." Fisk has offered to begin paying for a system in 1992, not before. If funding is allowed to slip too long, Young warns, "the whole space biology program will disappear."

Materials scientists have a list of problems of their own, reflected in comments submitted to an advisory group by Robert Bayuzick, a materials scientist at Vanderbilt University, and Simon Ostrach of Case Western Reserve. Their greatest concern is that the station be equipped with gadgets to monitor and control forces of acceleration throughout the structure, specifically to ensure that experiments requiring microgravity (one-millionth of Earth's gravity) can be sustained over a 30-day period. This is "an absolute necessity," according to Bayuzick, one of several that NASA has not yet agreed to provide.

NASA administrator Richard Truly told the Roe committee that the space station will be "virtually the same functionally as that envisioned in the [original] program," except for an 18-month delay in its completion. The first parts are slated to be launched in 1995 and the crew is to begin living aboard in 1997. Truly's reassurances had a calming effect, but the foreign partners remain uneasy.

Takehiko Kato, Japan's liaison officer to the space station program, says the decision to cut the station crew back from eight to four will create many problems. He also dislikes a recent decision to substitute the toxic chemical, hydrazine, as a thruster jet fuel on the station rather than using hydrogen and oxygen. By adopting an already developed hydrazine technology, the United States lowers its development cost, Kato says, but increases the operational cost over the long term. Hydrazine supplies will have to be shipped to space on a regular basis (whereas hydrogen and oxygen could have been generated by equipment on board). This will require extra shuttle flights, the cost of which must be borne by all the partners, as must all increases in the operating budget. The Japanese Diet may see that as an unbargained-for new expense.

Kato also sees a safety risk: the astronauts' space suits could get contaminated with hydrazine while they are working outside the station. He wonders if it will be necessary to add a special suit scrubbing facility.

But Kato has a deeper concern. He sees "instability" in the program's management and harbors doubts about Congress's commitment to future funding. While "the main issues" that caused upset earlier this fall "are resolved," he says, "we will have to wait and see how the new management does."

Kato's counterpart at the European Space Agency, Derek Deil, says his "concerns are exactly the same" as they were earlier this year, but "we are pleased to see that NASA is trying to work things out now." One awkward proposal was scrapped. NASA wanted to attach the European laboratory

module a year before turning on full power for research. "It would be very difficult to explain to our politicians that we are taking up a billion-dollar lab but will not be able to operate it until a year later." Now the plan is to get the power on first. "The mood has certainly improved" since last August, Deil says.

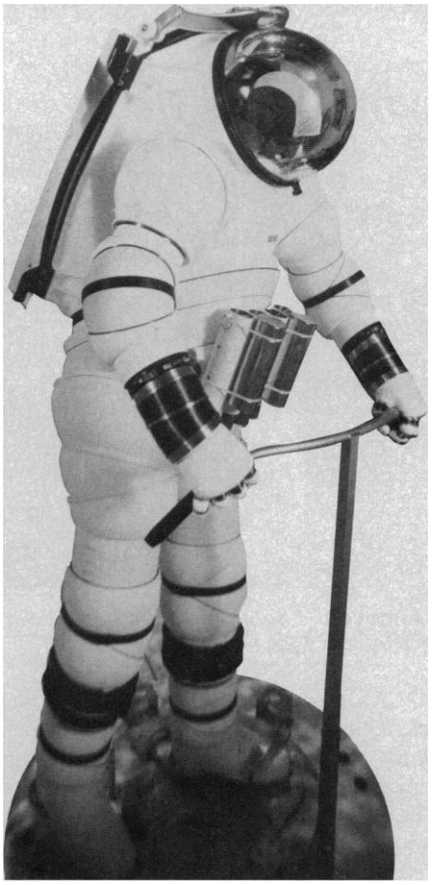
Karl Doetsch, director of Canada's space station program, says the allocation of power is an unresolved issue "of great concern." So is the availability of data processing, communications links, and robot systems that can be used to relieve labor demands on the crew. Canada is supplying the Mobile Servicing Center, a huge ($1.2-billion) mechanical arm that will be critical in assembling the station. Doetsch warns that NASA's plan to reduce the crew from eight to four may require a bigger investment in automated machinery, which the agency does not now plan to make.

The reduction in crew came about through a cascading series of cutbacks, according to one NASA official. When the planners decided to delay installation of a complex and heavy oxygen regeneration system, they realized that the task of supplying eight people in space with bottled oxygen would be horrific, turning the station into a "hungry beast," devouring many shuttle flights simply in the task of feeding its inhabitants. The best solution, it seemed, was to reduce the crew to half the number until the construction phase was near an end.

At present, NASA plans to reach the point of "assembly complete" in late 1999. By that time, the crew is scheduled to grow to eight and other items that have been dropped temporarily will be put back. However, Doetsch, like several others, remains troubled by "the complete lack of definition of when we reach the 'assembly complete' configuration."

Another ill-defined point that concerns the Europeans is the vague plan to convert the station into a "transportation node" for U.S. trips to the moon and beyond. President Bush has said that Americans will build a lunar base early in the next century. Some worry that if this goal becomes a reality, researchers will enjoy a relatively brief "quiet period" on the station before the construction of the lunar base begins. However, a NASA official involved in planning for the future, Frank Martin, dismisses these worries, saying, "We're not going to send people with jackhammers up there."

The moon mission and some other items on the agenda remain fuzzy, which has been a problem for NASA's planners in the past. For example, Fisk, as he met with his outside advisers (the Space Science Applications Advisory Committee) on 9 November, reflected that trying to agree on items to be included in the station "has been a very frustrating experience" because the responses to requests were often vague. "If someone says, 'No,' then you can appeal it," Fisk explained. "But if they say, 'We're working on it,' what do you do?" He told the group that the outlook is getting better because the new managers don't like to leave things unresolved.



Not included: *To trim costs, NASA eliminated new suits from the space station package. This hard-shell outfit developed at the Ames Research Center could eliminate the 4-hour pre-breathing sessions required by today's suits and enable more outdoor activity.*

Some of this agitation—such as the demand for first-class passage for lab rats—may sound trivial to NASA engineers who are trying to put the structure in orbit and keep its crew alive. "Scientists are traditionally guilty of special pleading," says Radford Byerly, Jr., an expert on space policy who once headed the staff of the House space science and applications subcommittee and is now director of space policy studies at the University of Colorado at Boulder. "On the other hand," Byerly says, "NASA has advertised the space station as a research laboratory" and invites judgment on that basis.

Byerly and his colleague at Boulder, Ronald Brunner, dissected the space station in a sharply critical paper* last month, finding that the root cause of its problems is a lack of "resilience." They argue that the program was conceived with a bureaucratic aim—increasing the size of the space program—and cast in a form that is huge, complex, indivisible, and very difficult to steer. As a result, Byerly and Brunner say, the program keeps crashing into fiscal barriers and being forced to redefine itself. With each redefinition, some of the earlier promises are postponed. This gives the impression that money is being wasted, leading Congress to impose tighter fiscal controls, triggering self-review exercises like the one this fall, and more deferrals. The only way for NASA to escape the cycle, according to Byerly and Brunner, is to "decouple" the elements of the space station and redesign it as a series of smaller, independently viable projects. These projects should be ranked by priority, the critics say, and built as funds become available.

This is not the way NASA would solve the problem. At the hearing on 31 October, Richard Truly reiterated NASA's long-held view that Congress could improve the program by passing a multiyear funding bill. The assumption is that if NASA could go about its business without annual interruptions from Capitol Hill, it would do the job more efficiently.

There are some leaders outside NASA who think multiyear funding is a good idea—including the chairman and ranking member of the House science committee, Representatives Roe and Robert Walker (R–PA). But the idea probably won't get much support elsewhere in Congress, particularly not in the appropriations committees where it would count. Support for the space station is already tenuous. Given the prospect of continued tight budgets through the early 1990s, committee members are not likely to give up any of the power of the purse they still hold. For this reason, NASA is not likely to get the multiyear appropriation that it seeks, and the space station could face a series of annual reviews as harsh as this year's.

Optimists think differently, and there are many optimists among the space station's planners. They are convinced that 1990 will be the year in which the program straightens out. "When you're in the space business, you have to be optimistic," says Kato, Japan's liaison officer who seems to have absorbed the NASA esprit de corps while working in Reston, Virginia. "We have to live today before we can worry about tomorrow." ■ **ELIOT MARSHALL**

*"The Space Station Program: Defining the Problem," by Ronald D. Brunner and Radford Byerly, Jr. (Center for Space and Geosciences Policy, University of Colorado, Boulder, November 1989).