News & Comment

Science and the Space Station

Although the space station recently won some important political endorsements, it continues to draw fire from scientists, for whom it is supposedly being built

An odd thing happened to the space station on its way to becoming a reality in May. Even as it cleared some final political hurdles, it ran into sharp criticism from the scientists for whom it is being built.

The barrage of skepticism does not seem to have diminished support for the project in Congress, where there is a feeling that the National Aeronautics and Space Administration (NASA) must have a success soon. But it undermines the argument that the space station is badly needed by the research community. It is clear that many of the users would prefer to have something less grandiose and more easily launched than the station NASA has proposed.

When first advanced in the early 1980s, the space station was sold as an aid to commercial "materials processing" in space. Since then, the hopes for business investment have dimmed. NASA shifted ground recently, saying the multibillion-dollar project is more suited to be a laboratory for basic research in microgravity (one millionth of the earth's gravity); a means to stay abreast of competitors such as Japan, West Germany, and the Soviet Union; and a program for developing an infrastructure or "manned presence" in space.

Andrew Stofan, NASA's new associate administrator for the space station, discussed the birth pangs of this, NASA's most ambitious, project on a muggy afternoon just before Memorial Day. "It's been a long road," he said, "a long time to get it through the political process here in Washington. But we did."

NASA's plan is as follows. It intends to loft a 135-meter, crane-like boom into space in 1994 and 1995. In a series of shuttle flights, it will hook up eight solar arrays, a cylindrical laboratory, a similar dormitory, spherical connector nodes, and a "telerobotic servicer." Canada, the European Space Agency, and Japan are being invited to hook up two more lab cylinders and a mobile servicing unit. From 1996 on, the task will be to keep the big structure floating 250 miles above the earth and occupy it with a crew of six to eight astronauts, "permanently."

Some people still see this as a daydream, but it became a reality for Stofan this spring when NASA won a hard-fought second endorsement from the President and key members of Congress.

The first approval came in 1984. Since then the cost of the station has grown, the federal budget has tightened, and NASA's transportation system has gone down.

After the shuttle accident, the White House wanted to take a second look. Stofan took over the program in July and directed a detailed cost review last summer. New accounting rules, inflation, and transportation expenses drove the price up from $8 billion to $14.6 billion. It will go higher as other elements such as scientific instruments are added. NASA persuaded the Administration in January that the project should go forward for reasons of national pride and economic survival.

NASA

Andrew Stofan. *Former chief of NASA's Lewis lab now (minus beard) heads the space station program.*

NASA huddled with the President's budget office, the National Security Council, and the White House science office, and came up with an agreement. The President would back the station provided (i) its impact on the budget in the next 3 years will be no greater than planned before, (ii) it will be built in segments known as Block I and Block II, and (iii) it will receive a final critical review this summer by the National Research Council. On this basis, the President gave his blessing in April.

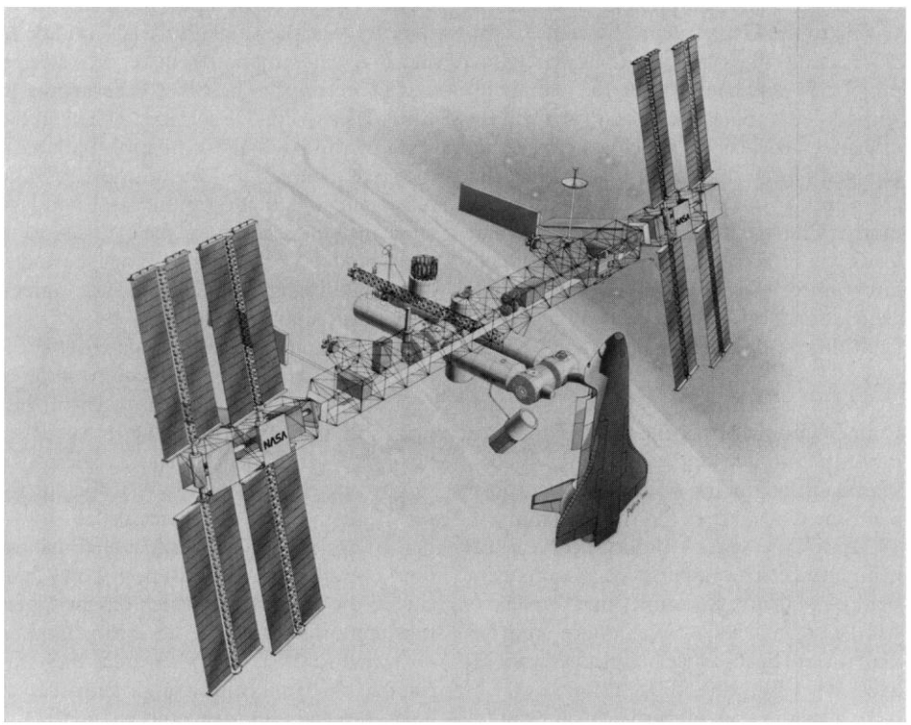
"Congress wanted to make sure the White House was still committed," Stofan says. In May, the House and Senate authorizing committees agreed to give NASA $767 million, the full amount it wants to begin detailed engineering work in 1988. If it stands, this amounts to a pledge to take the entire $14-billion to $20-billion plunge. The Congressional Budget Office estimates the total cost may run to $30 billion by the year 2000.

The action went unnoticed in the fuss over the Iran-Contra hearings and the adventures of Senator Gary Hart. But it may be important in the future. "The horse is out of the barn," says congressional budget analyst David Moore.

NASA is eager to put the aerospace firms to work. But the political ordeal is not yet over. The appropriations committees and Congress must act as a whole. There are some who would like to send the space station back to the drawing board, even though $600 million has been spent already in this mode. Stofan doubts this will happen, and he is probably right. Momentum serves as strong logic in Congress.

NASA's political triumph is eerie, however. It is being played out against a background of sharp criticism and disappointment among the very scientists who are supposed to benefit. Some criticism comes from those long opposed to tying scientific research to human space travel. The spokesman par excellence of this view is James Van Allen of the University of Iowa. On 1 May he spoke to the Senate appropriations subcommittee about the "outrageous optimism" of NASA officials who sold the shuttle with promises that it would fly cargo to orbit at $100 a pound, at a rate of nearly once a week. Similar outrageous promises are being made to sell the space station, Van Allen contends, and they will lead to a similar disaster for science.

Because NASA put all its eggs in the shuttle basket, no civilian project can be sent to space while the system is being repaired. It makes no sense to hold scientific instruments hostage to manned vehicles, Van Allen says, particularly since unmanned vehicles have been more productive. Tying science to another huge manned project will create more inane burdens, he thinks. Van Allen, discoverer of the radiation belt bear-



The cut-rate space station. *By reducing the size of the skeleton and postponing full occupancy, NASA hopes to get this structure on orbit in 1995 for $14 billion.*

ing his name, focuses on a distinctly nonhuman realm. For this reason and, one suspects, because he has spoken so lucidly for so long, observers seem to take his opposition for granted.

Carl Sagan of Cornell delivered an equally harsh assessment on behalf of the Planetary Society, which calls itself "the largest space-interest group in the world." Sagan asked, "What's the rush?" The space program is in a shambles; the shuttle must be rebuilt; the purpose of the space station is ill-defined. Why not rethink NASA's goals? The Planetary Society argues that the goal of manned flight should be to prepare for exploring the solar system, aiming at a Mars landing in the next century. The recent report of the President's National Commission on Space also endorsed this goal. The station is designed not with this in mind, Sagan argues, but with an eye to industrial potential, mainly quiet materials research, which he considers to be incompatible with the jarring hustle and bustle of a center for space travel.

George Field of the Harvard-Smithsonian Center for Astrophysics urged Congress to establish long-range objectives for the space program and ask NASA to fit the station to them. Like Sagan, he sees no reason to pump up industrial research at this early stage.

Riccardo Giacconi, director of the Space Telescope Science Institute at Johns Hopkins, politely undermined one of the key "infrastructure" arguments for the station, the notion that it is needed to service satellites. His criticism is remarkable in that NASA's Hubble space telescope, for which he runs the science program, was designed to be serviced by humans in space and to fly on the shuttle. But Giacconi claims it would be just as efficient to avoid servicing altogether by using long-lasting machinery that could be abandoned after 5 to 10 years. He also thinks NASA should let the researchers decide how and where to launch spacecraft and provide them with the necessary funds.

Giacconi would happily disengage from the space station. Astronomers prefer to get away from human activity because the vibration, the low orbit, and other disturbances impede observation. It is time, Giacconi said, "to recognize that science and manned flight programs each have worthwhile goals and objectives, but to refrain from making one subservient to the other." Quoting from the 1983 statement of the Space Science Board of the National Academy of Sciences, he said there was "no scientific need for the space station in the next 20 years."

In private, some speak more bluntly. The space station is a "mishmash," says one, a "monster," the product of "incredible confusion." Another agrees with the critics in principle, but takes the "realistic" view that manned flight pays the bills for space science.

NASA officials have heard all this before. Stofan chuckles about Giacconi's "very generous offer" to relieve NASA of the problems (and the funds) connected with launching scientific spacecraft. "Riccardo has been consistent; when I worked with him in science, he would always say, 'NASA, give all the money to me and I could do much more with it.' " Stofan doubts there are great savings to be had: "A resistor costs the same amount, no matter who buys it."

David Black, chief scientist for the space station, says "there's been no raping of the science budget to pay for the space station." He and Stofan have reviewed NASA budget data over the last two decades and found that science consistently takes about 20 to 22%. While a few people think the shuttle and space station are hurting the research budget, Stofan argues that "historically, the opposite is true." The more NASA spends in total, the more it spends on science.

NASA is accustomed to criticism from the sky-watchers, but it was taken aback this spring by some harsh comments from its advisory Task Force on Scientific Uses of the Space Station (TFSUSS). Chaired until April by Peter Banks, an electrical engineering professor at Stanford, TFSUSS represents a new generation that has grown up with the shuttle and looks forward to a time when scientists from all disciplines will do research in space.

The loss of the shuttle has deeply affected this "user community." They see their own projects being delayed, and, more alarming, they foresee the loss of the next generation of scientists. "The user community will become a waiting community," says Banks. Bright students will not beat down the door when the agenda is to sit out the decade.

If the station is approved in its present form, Banks thinks NASA will have to find an additional $3 billion to $5 billion to design, build, test, and operate "the scientific instruments and other facilities which, after all, are the purpose of building the facility." The plans now call for a stripped-down version to be ready for occupancy around 1996. Even this is an optimistic schedule, which one businessman believes is understated by 2 years. The "Block I" configuration, according to a congressional aide, is "a mansion in Beverly Hills with no furniture." This suggests that to use the station, NASA will have to get funds it has not yet mentioned.

NASA may think that when it issues the summons 10 or 15 years from now, plenty of researchers will come running, Banks says. But stagnation will take a toll, and the field may be moribund.

To maintain interest, Banks would like something to be done to bring the station into use sooner, either by increasing the rate of spending or by scaling back the design. Banks says NASA has never been made to

say what it could buy for $8 billion. He thinks it could come up with something useful. For example, he suggests developing an extended-flight shuttle orbiter, previously opposed by NASA as unnecessary. Meanwhile, TFSUSS has asked NASA to schedule more spacelab flights as soon as possible and to back the Industrial Space Facility, a large private lab designed to fit in the shuttle by Maxime Faget's Space Industries corporation. Faget has nailed down a reservation to fly on the shuttle in 1992, and claims that with NASA's support, the lab could go up in late 1990.

Banks also stresses the need for additional transportation and has urged NASA to develop a new heavy cargo vehicle that could speed construction and relieve the stress on the "fragile" shuttle. Finally, he thinks other facilities should be promoted, including an early launch of the "polar orbiting platform," an unattached package of scientific instruments considered to be part of the station.

Many of these suggestions reflect naïveté about NASA's predicament, according to Stofan. The pace of construction is determined by funding, and the White House has drawn the line on the budget. There is no changing it. As for scaling back the design, Stofan says: "It's down now to the photovoltaic power and the modules; there isn't much less than that" worth doing.

Nor is there anything to be done immediately about transportation. "I'm sorry about that; I know they're hurting" for access to space, says Stofan. "I can't fix that now, but we will solve the problem for the long term" with the labs on the space station.

The Administration has given primary responsibility for developing a heavy lift vehicle to the Department of Defense, firmly rejecting pleas for a duplicate civilian project. Meanwhile, NASA has adopted a "mixed fleet" policy, meaning that it will use unmanned rockets to launch some payloads bumped off the shuttle. At this writing, five are planned, but it is not clear how much money will be available or how many payloads will be accommodated. For the indefinite future, the shuttle will be the only vehicle for large civilian payloads. "I can't launch the station with a Vu-Graph," Stofan says.

NASA accepts the National Research Council's estimate that the shuttle cannot be expected to fly more than 11 to 13 times a year. Putting up the station and the polar platform will take 16 flights beginning in 1994, and at least 4 flights per year for maintenance. This maintenance requirement is a low estimate; it assumes that astronauts will be staying aboard for longer stretches than the astronaut office has pledged: not 60 to 90 days, but 120, 150, or 180 days.

To allay the fears of the TFSUSS committee, NASA's science office is pressing for additional spacelab flights, for use of the Industrial Space Facility, and other research opportunities between now and 1994. Banks says this amounts to "a workable scenario if it comes through." Whether the Administration will go along is not known. Congress seems interested in backing the Industrial Space Facility, if only to sample the "furniture" that will go into the space station.

At present, only partial information on the "furniture" is available. Congress, preoccupied with "industrial competitiveness," stresses the need for materials processing. NASA's report to Congress in April dutifully notes that the single U.S. lab module in Block I will "emphasize materials research and processing." The other experiments in Block I, involving life sciences, will be in the same module only if "compatible with such materials research . . . within the lab." The report suggests that the Europeans and Japanese may make room for the life sciences in their modules. The international partners, now negotiating with NASA, have agreed to no such arrangement.

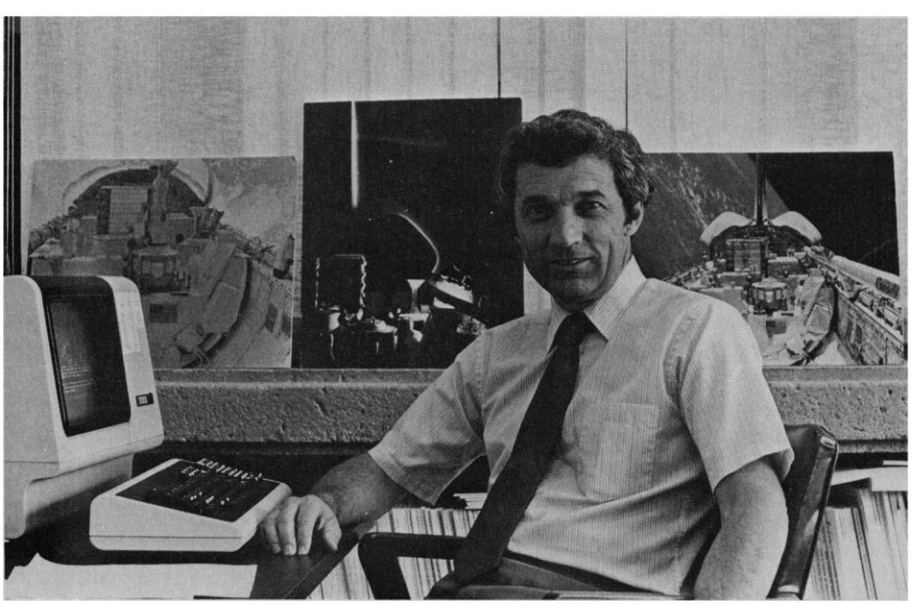
The difficulty is that crystal growth experiments, among others, require a quiet environment undisturbed by centrifuges, rats, and their human keepers. Similarly, biological researchers do not want to be plagued by chemical vapors that they imagine will come from the materials lab.

L. Dennis Smith of Purdue, chairman of the Committee on Space Biology and Medicine at the National Research Council, says it is important to have an entire module dedicated to life sciences research. It is crucial that the lab include a large centrifuge at least 4 meters in diameter to provide a controlled amount of gravity for animal experiments. The credibility of the data depends on it. It would be "irresponsible," Smith says, to put humans in a weightless environment for an extended period without answering some basic questions first. But where will the biologists work?

"We don't have a well-defined home on the space station," says Richard Young, a member of the TFSUSS committee and an expert in low-gravity biological research at RCA's government services division. The two disciplines of biology and materials science are not incompatible, he thinks, but will require some clever engineering to put them together. That task lies ahead.

The interest in materials research, inspired partly by the Soviets' pursuit of the subject aboard the Mir space lab, seems to have helped the space station through its political ordeal. The West Germans also are eager to expand their work in microgravity, supported by government subsidy for more than a decade. Senator Jake Garn (R–UT), ranking minority member of the Senate appropriations subcommittee that deals with NASA and a one-time passenger on the shuttle, vigorously promotes the space station as a boon to commerce and science. He speaks, for example, of his expectation that research in space will lead to a cure for cancer.

But aside from a handful of very big, high-technology corporations, private businesses seem less enthusiastic than government officials. When the Office of Technology Assessment (OTA) looked into the subject in 1985 it expressed some doubts in its report, "International Cooperation and



Stanford University

Peter Banks *of Stanford says that NASA's space station focuses on hardware and neglects the needs of researchers who are supposed to use it.*

Competition in Civilian Space Activities." OTA dismissed some giddy predictions about the future of space manufacturing and noted with sobriety that "neither the scientific nor the commercial value of materials research in microgravity is fully understood."

OTA calculated that the two most promising areas for commercialization were purifying pharmaceuticals and growing crystals for use in electronics.

The research situation is fluid, illustrated by the fact that companies in these two areas recently said they find earthbound research more promising. Louis Lanzerotti, a vice president of AT&T Bell Laboratories, told the Senate appropriations subcommittee on 20 May that "the space environment offers no advantages for the manufacturing of electronic materials. Certain important basic research opportunities in materials science may exist [by] using the microgravity environment available on a space station," he said. But " 'scientific projects' should not be carried out just because the space station may exist."

Glenn Kiplinger, vice president of the Johnson & Johnson's subsidiary, Ortho Pharmaceuticals, wrote in a letter to the subcommittee that his company dropped out of space-based research on erythropoietin in 1985. "The decision to stop work . . . was purely an economic decision based on advances in other technology [gene-splicing] which had occurred in intervening years."

NASA's Marshall Space Center in Huntsville, Alabama, lists ten companies that have signed up with the agency to conduct microgravity research on the shuttle. The Minnesota Mining and Manufacturing Company is the oft-cited model, with plans for 60 shuttle experiments over 10 years and a staff of 14 to handle the data. A company spokesman makes clear that this is basic research, and that no commercial prospects are in sight. NASA officials, too, now take care to avoid describing the space station as a potential center of commercial investment. It is, Stofan says, strictly a research laboratory in space.

It will be an expensive research lab, and the benefits to come from it elude description. However, the rule of unpredictability applies to every new field of research. The venture may be, as skeptic Senator William Proxmire (D–WI) insists, a "blind leap of faith." It may also be, as David Black of NASA argues, a means to empowering Nobel-quality research.

One thing the project surely will provide is information on how to build and inhabit a space station, which at bottom is all that NASA can guarantee. ■ **ELIOT MARSHALL**

Mixed Views on Biotech

Despite warnings raised by activists about the safety of field experiments involving genetically altered organisms, a recently completed survey suggests that 82% of the American public supports such tests. The poll, conducted for the Office of Technology Assessment, indicates that a majority of Americans believe that the benefits to be derived from biotechnology—whether it be in agriculture or human health care—outweigh the risks.

Conducted by Louis Harris and Associates between 30 October and 17 November 1986, the survey indicates that 55% of Americans are willing to chance isolated ecological damage, such as the extinction of individual plant or fish species, at risk levels of 1 in 1000 so long as the potential risks are known. In contrast, where the risks are not well characterized, but thought to be "very remote" public approval drops to 45%.

*Public Perceptions of Biotechnology** is the second of a series of reports entitled *New Developments in Biotechnology*. This latest study is based on interviews with 1273 American adults and has a margin of error of 2 to 3%. Participants were queried on their attitudes toward science and the environment, as well as on matters directly related to biotechnology. Whereas public interest in science has eroded slightly, there is increased optimism about the benefits to be derived from science. Some 62% of the sample thought the benefits will outweigh the risks, whereas in 1980 a Harris survey indicated that only 58% of the country held this view.

The basis for Americans' confidence in science is called into question, however, by other survey results. For example, public understanding of the term "genetic engineering" is poor. Some 63% of the participants said they knew relatively little or almost nothing about it. This lack of understanding is most prevalent in those 50 and older, and in people without college degrees.

Only 26% of the respondents expressed any concern about the use of genetically altered microbes in agriculture, but OTA cautions that this may change. The survey showed that 70% of those polled were unfamiliar with the practice. As public awareness rises, however, OTA says concern may increase.

A majority of the country (68%) is not opposed to using recombinant DNA methods to produce hybrid plants and animals. A large portion of people who are against the idea oppose it on moral grounds. The OTA survey indicates that these opponents also tend to be less educated, religious, or both. Not everyone who is religious opposes recombinant DNA technology. In fact, a majority of people claiming to be "religious" or "very religious" are not troubled by DNA manipulations in plants and animals.

The survey also reveals inconsistencies in the way the American public views biotechnology and its application. Some 42% of the sample said the concept of altering human genes to combat disease is morally wrong, while 52% favored it. But Robyn Y. Nishimi, an OTA analyst who helped interpret the Harris data, says the survey indicates that people's views on the application of human gene therapy are governed in part by self-interest.

When asked about specific applications, such as preventing a child from inheriting a birth defect, 77% said they found it acceptable. The switch may be explained by the fact that 37% of the participants indicated there were genetic problems in their respective families.

Although the public is generally supportive of biotechnology, it continues to see a need for regulation by state and federal goverment agencies and external scientific bodies. Only 13% of those polled were willing to allow a company to decide on the suitability of large-scale applications of genetically engineered organisms.

With respect to evaluating risks, the report notes that university scientists are trusted most, followed by public health officials, and then federal government agencies. Where federal officials and environmental groups clash over safety matters, OTA says that a majority of Americans are more likely to believe environmentalists. ■

MARK CRAWFORD

*Copies of *New Developments in Biotechnology: Public Perceptions of Biotechnology* (OTA-BP-BA-45; GPO stock number 052-003-01068-2) may be obtained from the U.S. Government Printing Office, Washington, D.C. 20402–9325.