John H. Moore. *NSF deputy director insists that the best proposal won.*

ed no finding of "unfairness," and insisted that its negative assessment was directed at the management of one proposal and not at the NSF review process in general.

The GAO report recommends that NSF's director take action in three areas of management to ensure that similar problems "do not occur in the future." NSF should be sure that documentation on large awards clearly links reviewers comments with criteria stated in program announcements. Requirements for matching funds should be specified in detail. And conditional recommendations should be avoided.

GAO, the auditing arm of Congress, oversees administrative as well as financial aspects of federal government operations. The GAO report says that the focus of the review was to determine whether NSF followed its award procedures and to examine the credibility of that decision. "Our intent was not to recompete the proposals or to second guess the judgments of the panelists but rather to validate information that the panelists had provided to us."

What was not included in the report was an evaluation of NSF's broader intentions in establishing the center. The GAO did explore a complaint originating with the Berkeley group that NSF's program announcement did not make clear that NSF would look with favor on having a center with a national rather than a regional focus. Plans in the New York proposal to cast its net widely for earthquake engineering expertise and deal with a wide range of earthquake engineering problems were cited by the foundation as a strong factor in the choice of SUNY Buffalo. The GAO said the issue was one of those on which the documentation was weak and reported it could not find evidence that a national focus was a criterion added during the evaluation.

Those familiar with NSF's development of the center idea say that it was a product of discussions over several years involving federal agency officials and members of the earthquake research community in academia. A consensus is said to have evolved on the need for multidisciplinary research aimed at a broad range of scientific and engineering issues, the involvement of industry, and a broadening of attention beyond earthquake problems special to the West Coast, particularly to include the eastern portion of the United States. Discussion of these aims is reflected in such congressional documents as the recent House Science and Technology Committee report on the authorization measure for the Earthquake Hazards Reduction Act, but they were expressed only sketchily in the NSF program announcement.

In the view of Representative George E. Brown, Jr. (D–CA), who represents a seismically vulnerable southern California district and has been a strong proponent of earthquake research, the center award was "favorable to the health of earthquake research." Brown told *Science*, "I have repeatedly argued for the need to broaden the base of the research. We have to have a bigger constituency with an understanding of the need for such research. From that standpoint, the award of the center to Buffalo was constructive."

Brown notes that GAO was highly critical of some steps in the award process and of a lack of internal consistency, but says he is "not sure that it warrants opening it up, starting over." One thing he is emphatic about is that provision of funds for the center "should not be allowed to detract from resources for other high-quality research" in the field.

From the incident, Brown draws the lesson that "NSF needs to look at its procedures for awarding grants that have sensitive geopolitical aspects and be sure that its skirts are clean and it will not draw criticism."

A piquant footnote to the episode is that GAO recruited a panel of four experts from universities not involved in the competition to examine the performance of the NSF panel in evaluating technical aspects of the research plans put forward in the two competing proposals. The key finding in the report, therefore, hinged on a peer review of peer review. ■ JOHN WALSH

Space Station Price Climbs Higher

The U.S. space station will cost more than advertised—about $27.5 billion in 1984 dollars—but not more than expected by aerospace experts, according to a special report released on 6 July by the National Research Council (NRC).

The report is part of a bigger study commissioned by the Reagan Administration early this year when it decided to take a second look at the space station. The full study, to be written by a 13-member panel chaired by Robert C. Seamans, Jr.,* will come out in the fall. This interim paper discusses mainly "acquisition costs," not problems in assembly and operation, which will be examined later.

When the National Aeronautics and Space Administration (NASA) made its first cost estimate in 1984, the station's price tag was put at roughly $8 billion. That was the basis on which Congress and the White House originally endorsed the project.

Last year, NASA was then asked to make a more complete analysis to include ancillary costs at various NASA centers. The new total, announced in January, came to $14.5 billion for the entire station, or, if bought in segments as now planned, $12.2 billion for block I and $3.8 billion for block II. The station will not be fully operational until well into block II, sometime in the late 1990s.

The new Seamans report finds that if other essential items are included—the orbital maneuvering vehicle, the flight telerobotic servicer, and the crew emergency rescue vehicle—the full research and development cost comes to at least $18 billion. When deployment costs are added, the bill is $27.5 billion. (With inflation, this comes to more than $32 billion in 1988 dollars.)

Many of the deployment costs in the NRC's total do not represent new expenses but ones already covered in NASA's financial plan. They will be provided for by shifting priorities within budget levels al-

*In addition to Seamans, a Massachusetts Institute of Technology (MIT) professor of aeronautics, the group includes W. Bowman Cutter III of Coopers & Lybrand; Earl H. Dowell of Duke University; Brigadier General Robert A. Duffy, former president of the Charles Stark Draper Laboratory; Herbert Friedman, former presidential economic adviser; Owen Garriot, president of EFFORT, Inc.; Benjamin Huberman, vice president of Consultants International Group; John McLucas, chairman of Questech, Inc.; Eberhardt Rechtin, president of The Aerospace Corporation; Donald B. Rice, president of RAND Corporation; Ivan Sellin, chairman of American Management Systems, Inc.; Lieutenant General Thomas Stafford of Defense Technologies; and Laurence R. Young, director of MIT's Man-Vehicle Laboratory.

ready in the plan. In this sense, they will not require new money. But the figures have been included to show the extent to which NASA will devote its resources to this one project.

However, this carefully worded report warns that some logistical problems have not been pinned down as yet, and their budget impact is not clear. A major one is the task of fitting all the parts of the station into shuttle-sized packages and coordinating this effort with precision among four geographically separate NASA centers. The challenge will be "unprecedented," greater than the one NASA faced in building the shuttle. "Technical problems with systems integration are unlikely to be discovered until relatively late in the development cycle when they are costly to rectify," the report notes. "Schedule slippages resulting from delays associated with these fixes can themselves be a source of additional cost." Because the task is so much more difficult than building the shuttle, experience is not likely to be a reliable guide to future problems and cost escalation. This is an area of great uncertainty, which the committee plans to discuss more fully in the next report.

Staffers in the House and Senate appropriations committees said they welcomed the report but found no surprises in it. "We are waiting for the other shoe to drop" before making a judgment, as one said. ■

ELIOT MARSHALL

The Boom in Service Industries Will Not Solve U.S. Trade Problems

Seventy percent of Americans now labor in service industries, the fastest growing part of the U.S. economy. Manufacturing has been on a long slide since the late 1960s. The recent boom in services—banking, construction, information processing, and transportation—has encouraged the hope that exports from this area might restore the balance of trade in goods, now running deeply in the red.

According to a report from the Office of Technology Assessment (OTA), *International Competition in Services*, the United States is more successful than any other nation in exporting services, also more successful than the government realizes.

By OTA's estimate, service exports in 1984 were nearly twice as large as the Commerce Department said, amounting to between $69 billion and $91 billion, not $44 billion. This means, OTA says, that the nation ran a surplus in this kind of trade amounting to about $14 billion, six times the official estimate of $2.3 billion. This is pleasant news because it helps offset the staggeringly poor U.S. performance in exporting goods. Here, the nation ran a deficit in 1984 of more than $120 billion. But OTA warns that there is small comfort in the new numbers, for several reasons.

Unlike goods, services cannot be stored. There is a limit to the "growth prospects for exports." OTA estimates that services will never amount to more than one quarter of the value of all exports.

Furthermore, nations are protective of domestic service industries. For example, 90% of the contracts for the Euro-Disneyland near Paris will go to French architects, engineers, and construction firms, according to OTA. Even when U.S. companies do win foreign contracts, most of the jobs go to local workers.

The main reason for muting optimism is that other nations are beginning to compete in service exports as they already have done in goods. Two illustrations from the report make the point.

U.S. engineering and construction firms won more foreign contracts than those of any other country in the 1970s, mainly for energy-related projects. However, with the stagnation of Third World economies and the collapse of the oil market, they began to lose ground. Big contracts are going more frequently now to newcomers such as Kumagai Gumi of Japan, Philipp Holzmann of West Germany, and Hyundai of Korea.

U.S. firms are sometimes at a disadvantage because they may not get subsidized financing of the kind provided by European governments. OTA is more concerned, however, about America's failure to invest in research and development to create proprietary technologies. "U.S. engineering and construction firms have seemed content to adopt construction technologies pioneered elsewhere," according to the report. As an example, OTA cites the "shotcrete" or sprayed concrete tunnel construction method developed for use in the Alps by an Austrian firm. It was used recently by the Austrian company Ilbau (which beat out U.S. competitors) to build a subway station in Washington, DC. This does not augur well for the future.

In another boom area—information services—the United States has gained a commanding lead in the 1980s. For example, in 1985 U.S. firms controlled about 70% of the $30 billion world market in software. But whether the lead can be maintained is debatable. OTA warns that this dominance is "bound to shrink in the years ahead as competition, mainly from Japan, catches up."

Japan cannot compete effectively in providing computer programs for the mass market right now. Yet "the Japanese recognize their deficiencies quite clearly," OTA says, and "have embarked on a massive effort to catch up." Hitachi has tripled its R&D spending on software. Toshiba has built a "software factory" employing 3000 programmers. And NEC spends $400 million a year on software development. In time, these investments will pay off, OTA says, and the Americans should be prepared for the challenge.

What are the implications for the United States? OTA concludes that there will be an increasing demand for broadly educated workers with special skills, particularly in the "knowledge-based service industries." But few jobs in the United States will be created by service exports, because services usually must be performed at the point of sale.

On the darker side, OTA predicts a growth of "involuntary part-time labor," because service companies tend to be run by small staffs augmented as needed by part-timers. OTA says underemployment will be a "persistent U.S. economic problem." The same office organization that creates the demand for part-time employees also causes stratification according to skill level, so that "many service companies have knocked the rungs out of internal promotion ladders." Rather than promote from within when expertise is needed, many companies now look outside.

Thus, OTA sees a need for educational programs that will replace the missing rungs in the ladder, providing training that companies seem unwilling to provide. This may lead to "a fundamental rethinking of the nation's educational and training system."

Finally, OTA has a warning for U.S. negotiators involved in the "Uruguay round" of trade negotiations this fall. Because services are America's strong point at present, there is an interest in gaining agreements from other countries to permit importation of services. However, OTA points out that gains in one area may require concessions in others. The United States should not sell out its substantial, long-term interest in free trade in goods to promote services, where it it has a big, but temporary, advantage. ■ ELIOT MARSHALL