# Space station: More study = more money

Less than three months ago, a study by a National Research Council (NRC) committee indicated that NASA's planned U.S. space-station program would cost about 60 percent more than the estimate cited by the space agency. The difference was not a case of unexpected cost growth, the panel noted; instead, it was due to such factors as the existence of many significant costs — launchings and personnel salaries, for example — that are listed under budget categories other than that of the station's actual research and development. The overall result, the NRC analysis suggested, was to make the "full resource commitment" likely to be required by the program appear nearly $10 billion smaller than NASA's own figures in fact demonstrate (SN: 7/18/87, p. 37).

But the matter has continued to smolder. This week the panel released its final report, stating that even with such differences in approach taken into account, subsequent analyses have "decreased the committee's confidence in [NASA's] cost estimates."

For example, the report notes, the program is still "in flux," with a number of potential changes occurring even "during the short course of this study." These range from the possibility that astronauts might be sent into space for six months at a time, instead of three, while constructing the station (doubling existing U.S. manned spaceflight records) to reconsiderations about what kinds of vehicles — shuttles or "expendables" — will best be able to handle the many required launchings.

"Other changes are almost certainly under way," the report states, "and they are likely to continue for some time, with net tendencies to increase costs (or alternatively to reduce performance)."

Another economic issue raised by the report is NASA's plan for testing the station's components as they are developed. The committee commends the agency for its intention to produce most of the hardware in duplicate — one set for ground-testing and one for flight — but expresses concern that the cost of such an approach is not covered by the present plan.

The committee also "remains strongly convinced" that plans for the station's information-handling system, as well as for the use of automation and robotics, are not well defined. All are potentially expensive, and the present uncertainty, warns the report, raises questions about the reliability of judging the costs of either their development or their subsequent operation.

The committee further notes that deploying the station with the space shuttle in its current version (including the present round of "post-Challenger" modifications) "while not infeasible, will be difficult and risky." The group recommends that NASA develop advanced solid-propellant rocket boosters for the shuttle to give it greater lifting capacity, and that doubling the "stay time in orbit" of one or more shuttles from the present level of about a week would cut costs and make the shuttle available to the space station crew for a longer period of time. In addition, the group declares that there is "a mandatory requirement" for a crew emergency rescue vehicle, possibly even one that can ride on a "man-rated" expendable rocket, independent of the shuttle. "As the Challenger accident has shown, shuttle downtimes can be very long," notes the report, urging that there thus needs to be another way of getting crews to — or away from — the station.

But the concerns expressed by the committee extend beyond such specific details. According to the report, "Developing the space staton, deploying and assembling it in space, and operating it as a multipurpose international research, development and operational facility must surely rank as the most ambitious and lengthy task NASA has ever undertaken." As a project that will "absorb much of NASA's energies for the next two to three decades," the committee maintains, it "cannot be considered a 'one-administration' program nor can it be developed 'on the cheap' " — a striking caveat to apply to a plan measured in the tens of billions of dollars and which has already more than tripled its projected cost (even without the NRC committee's latest recalculations) since it was inaugurated by President Reagan barely three and a half years ago. *— J. Eberhart*

# Asian languages aid mathematics skills

U.S. schoolchildren compare dismally to their counterparts in Japan, China and other Asian countries on tests of mathematics achievement. Researchers attempting to explain this difference are, for the most part, focusing on home and school experiences (SN: 1/31/87, p.72).

But, according to a study presented at the recent annual meeting of the American Psychological Association in New York City, the advantage in understanding and manipulating numbers may be traced to Asian languages with roots in ancient Chinese, including Chinese, Korean and Japanese.

"In Asian languages, number names follow a base-10 number system," says psychologist Irene T. Miura of San Jose (Calif.) State University. "Place value is inherent in the number language."

For example, the number 11 is read as ten-one, 12 as ten-two and 22 as two-tens-two. The numbers 13 and 30, which when spoken sound similar in English, are entirely different in the Asian tongues; 13 is spoken as ten-three and 30 as three-tens.

To compare the conceptualization of numbers across languages, Miura and her colleagues studied three groups of first-grade children: 24 from the United States, 25 from mainland China and 40 from Korea. The children came from what is considered an upper-middle-class background in their respective countries and attended academically rigorous schools.

Each child was shown how to use a set of base-10 blocks to represent numbers. The set consisted of white unit-blocks and purple 10-blocks equivalent to 10 unit-blocks stuck together. In their native language, children were asked to read a number on a card and show that number using the blocks. The numbers 11, 13, 28, 30 and 42 were presented in random order. Initial trials were videotaped, and in a second trial, children were shown their first constructions and asked if they could show the same numbers in a different way using the blocks.

All of the Korean children and three-quarters of the Chinese youngsters were able to show all five numbers in two ways. Only one of the U.S. first-graders was able to do so. Similarly, more than three-quarters of the Korean and Chinese children used a "canonical" base-10 representation to construct all five numbers, whereas only two U.S. children did so. Canonical represention place no more than 9 unit-blocks in the ones position, such as using 2 ten-blocks and 8 unit-blocks for 28. Noncanonical base-10 responses, such as using 1 ten-block and 18 unit-blocks for 28, were also far more common among the Asian children. In almost all cases, U.S. students used only collections of unit-blocks to represent numbers.

Asian-language speakers tended to start with a canonical base-10 construction and then use either a noncanonical approach or a unit-block collection in the second trial. "Their ability to think of more than one way to show each number suggests greater flexibility for mental number manipulation," says Miura.

Miura has uncovered similar results in a study of Japanese- and English-speaking first-graders. Among those children, she says, the ability to use canonical represention in the first grade is associated with higher math achievement in the third grade.

"Socialization accounts for some of the differences in math achievement between Asian countries and the United States," notes Miura, "but there also appear to be differences in the basic mental representation of numbers affected by language characteristics." *— B. Bower*