Envirosat 2000 itself will then be released as a policy document in August 1985. Some issues:

• The military/civilian relationship. Quite aside from the one-polar/two-polar debate, OMB has asked NOAA to look at ways to eliminate wasteful duplication between the two systems. NOAA and the Pentagon already use the same basic spacecraft, for example, and they are already planning a joint system of data analysis. What else might be done? So far as NOAA is concerned, this is an utterly sensible thing to think about.

• The NOAA/NASA relationship. NASA withdrew from advanced remote sensing research in 1981, when it was under budget pressures of its own. NOAA, of course, has had no funds to pick it up. The Land Remote Sensing Commercialization Act of 1984 requires NOAA and NASA to prepare a joint agenda for future research by July 1985.

• Expanded international cooperation. In June 1984, the Versailles Economic Summit identified satellite remote sensing as a potential area for scientific cooperation. One result has been the creation of the International Polar-Orbiting Meteorological Satellite group (IPOMS), which includes Japan, Australia, Canada, and six European nations. At their first meeting on 19–20 November in Washington, the members unanimously endorsed the need to maintain *two* polar platforms—with an expanded suite of instruments—and indicated a willingness to shoulder a good deal more of the financial responsibility. "The program we have outlined could save [the United States] a *lot* of money," says McElroy.

• NASA's space station. One way to implement an international remote sensing program would be to collect everyone's instruments onto a single polar-orbiting platform. NASA hopes to include such a platform in its space station initiative—in fact, the European Space Agency may very well be willing to build it—and McElroy, for one, hopes to be a big user. At the moment, he says, the failure of a single sensor or even a single light bulb means abandoning a satellite worth $50 to $100 million. With the instruments collected on a platform, however, visiting astronauts could do repair and maintenance on a regular basis. "I can imagine savings of one-third of the budget per year," says McElroy. "That's $30 or $40 million."

At the moment it is hard to say just what opinion OMB has of all this; officials there have consistently declined to talk to the press about the subject. However, it is clear that none of NOAA's efforts are going to mean much unless a consensus on these issues can be reached with OMB and Congress.

—M. MITCHELL WALDROP

NSF Readies New Education Program

Revamped science and engineering education directorate plans switch in emphasis for precollege activities

For the past year, the National Science Foundation's (NSF's) education directorate has been rebuilding its staff, reorganizing its shop and rethinking its policies. The revival is now at the point where the program is finally taking shape; the first big push will be to upgrade science and mathematics teaching at the elementary and junior high school levels.

The rebuilding effort was required because the Reagan Administration abolished the previous education directorate shortly after assuming office in 1981. As a result of pressure from Congress and some second thoughts by the Administration the directorate was reestablished a year ago, but major hiring and policy decisions were, in effect, put on hold and expenditures on programs kept at a low level while NSF searched for someone to head the revived office. The post went to Bassam Z. Shakhashiri, a chemistry professor at the University of Wisconsin with considerable experience in science education. Shakhashiri joined the foundation in late June and has spent the ensuing months working to develop a program while at the same time recruiting for the directorate staff. Things are now far enough along for Shakhashiri to have agreed to discuss developments in an interview with *Science*.

The education directorate has on the books some $82 million appropriated for use this year, plus another $31 million left over from the last fiscal year for a total of $113 million. Some $25 million of this will go to fund graduate fellowships and another $5 million to provide science instrumentation for colleges. Nearly $80 million, however, is earmarked by Congress for use in precollege programs.

In the precollege sector, what Shakhashiri describes as a major thrust will be in programs for elementary schools and middle and junior high schools. The intent is to use up to 50 percent of the precollege funds for projects in this area. Explaining the targeting of elementary and junior high school students Shakhashiri said, "We believe that attitudes develop in that age group, opinions harden. By the time students get to high school their minds are made up" that science is too hard, math is not for them. He said that discussions at the foundation produced agreement that this was an area where a "concentrated effort needed to be made." He added that research findings support this position. Shakhashiri emphasized, however, that NSF is asking for proposals for lower grades "not to the exclusion of programs at the high school level."

In a letter written to Representative Edward P. Boland (D–Mass.), chairman of the House Appropriations subcommittee with authority over the foundation, NSF director Erich Bloch said that the emphasis on elementary and junior high school education "is a major refocusing of the Foundation's efforts on science and mathematics education that was achieved after much discussion with staff, members of the Advisory Committee and others knowledgeable in the field."

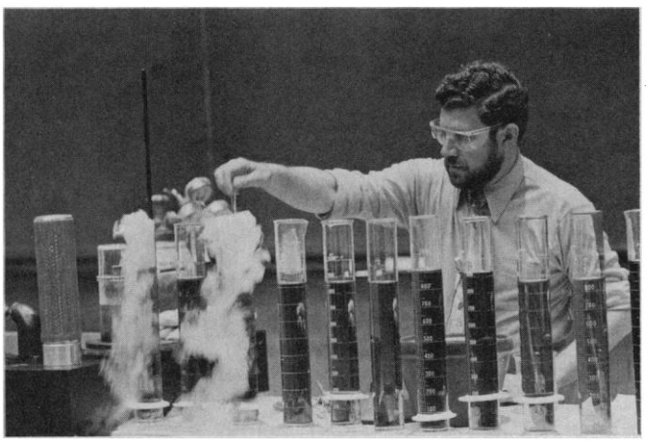
Within the education community, a major question brewing since the NSF education program was restored is whether the teacher retraining programs—most familiarly the NSF summer institutes—supported by the foundation in the 1960's and 1970's will be revived. The institutes were popular with teachers and school administrators but have both backers and critics in Congress. NSF expects to resume sponsorship of teacher training programs but not on the scale of former times.

Commenting on the retraining issue, Shakhashiri said that NSF is concerned with "teachers in the field and in training," and that "we need to help teachers maintain their competence. But we can't support the retraining or education of

every teacher out in the country." The foundation could, for example, support "leadership workshops." A group of good teachers would attend and then be expected to be involved in the local dissemination of the workshop material.

As he did several times in the interview, Shakhashiri noted the limited resources available to NSF compared to the total expenditures on U.S. education. He said that NSF can spend about $100 million a year on education while the total education undertaking in the country is a trillion-dollar-a-year enterprise. NSF funds have to be used for "catalytic purposes."

Because NSF "doesn't have the funds to repair all the inadequacies" of American education, Shakhashiri says it is essential that the private sector be more deeply involved in efforts to improve science and math education. He says he wants NSF to promote collaboration among the private sector and universities and schools.



NSF's new assistant director for science and engineering education, Bassam Z. Shakhashiri, in former role at Wisconsin.

Shakhashiri says he would "like to see the private sector more involved in dissemination" activities with state and local education authorities; that could mean industry sponsorship of teacher retraining programs. A fair number of companies participated in such programs in the 1960's and early 1970's, but such involvement diminished and has only recently begun to revive significantly.

A concept of "partnerships" aimed at having NSF promote collaboration on innovative programs among industry, universities, and state and local school authorities was an element of a hybrid education measure enacted in the closing days of the last Congress (*Science*, 28 September, p. 1453). The provisions caused misgivings among some NSF partisans who argued that the program would saddle NSF with toilsome administrative responsibilities.

Shakhashiri appears comfortable with the partnership concept and his own experience at Wisconsin would seem to account for the attitude. He was a founder and first director of the Institute for Chemical Education at Wisconsin. The aim of that institute, which began operating in 1983, is to enhance chemical education at all levels by enabling academic chemists, school chemistry teachers, and industrial chemists to work together on educational innovations. The institute operates with funding from industry as well as from state and federal government sources. In discussions at NSF of collaborative programs, says Shakhashiri, "many aspects of what we talked about were in total harmony with the bill."

The education directorate's relations with Congress have always been somewhat delicate. Conservatives have regarded NSF as a potential federal trespasser on state and local authority over education. In the 1970's, some of the new courses in the social and behavioral sciences developed with NSF support attracted criticism in Congress that contributed heavily to the abolition of the directorate by the Reagan Administration.

Against this background, some observers surmised that the revived directorate would simply rely on the peer review process to choose among proposals submitted, as is generally done in NSF's disciplinary directorates. According to Edward A. Knapp, who was NSF director when Shakhashiri was appointed, an early decision was made that in education, "You can't just respond to proposals. Congress said there should be a programmatic effort, and Jay Keyworth (Office of Science and Technology Policy director George A. Keyworth, II) shares the view." The initiative on elementary and junior high school teaching fits into this programmatic scheme.

On the issue of developing new teaching materials, it appears that NSF will not follow its previous pattern of developing revised curricula on a broad scale that extended to backing publication of a series of textbooks. The new style will be to support such things as the development of instructional materials of use to students and teachers, the application of advanced technologies to instruction, and the development of model programs for teacher training. But the more comprehensive projects of curriculum reform that inspired conservatives to accuse NSF of seeking to impose a national curriculum are not in prospect.

At this point, however, only the outlines of the proposed education program are visible. A clearer picture will emerge when guidelines for proposals are made public. The directorate staff was working on revised guidelines and plans to have them out around the first of the year.

The preliminary assessments of the new dispensation on education at NSF by its patrons on Capitol Hill seem to be favorable. Shakhashiri is given credit for making progress in building a staff—about 50 of the 70 slots have been filled—and his effort to attract able people with a range of relevant expertise is regarded a fresh start for NSF. For example, he has brought in an experienced high school science and math teacher as an associate program director and has recruited a professional with an industry background to act as liaison with the private sector. He appointed an advisory committee, chaired by MIT mathematics professor Kenneth H. Hoffman, whose members are well-known representatives of the constituencies NSF wants to involve in science and math education. Shakhashiri's reorganization of the directorate is viewed as providing a sensible base for future development and his policies so far seem to be acceptable to both the traditional friends and traditional critics of NSF's education program.

Despite his rookie status as a Washington official, Shakhashiri appears to have gotten off on the right foot in respect to both policies and politics. And at this point, has an evident zest for the task. His message is, "We're back in business in science and math at NSF, but not in business in the same way as before."

The make or break factor for the program, he says, is the extent to which scientists, mathematicians, and engineers out there are willing to involve themselves in the effort. "If it doesn't work out, it's our own damn fault. Not OMB's or Congress's, but the science and engineering community's."

—JOHN WALSH