twice," he said. "Once in court and once when the technology of oil extraction has evolved to the point where drillers will be able to suck oil from under the reservoirs." This type of extraction is normally done by slant drilling, but since the oil fields of Osage County are close to the surface, this method is not practical. For the moment at least.

And so it goes. The chief flies out to Washington to battle the Prairie Park, the dams, the bureaucrats. The litigation continues even at home in Oklahoma. On the basis of the appellate court decision, the tribe last year sued six cities in Osage County because their municipal lakes are said to impinge upon the Osage mineral rights. Such local activity is nothing new. Back in the 1960's, when the Osage were not quite so flush, a white resident of Osage County gave some 1500 tons of boulders to the city of Tulsa for use in a park. The Osage, however, claimed they owned the mineral rights to the stone. After some haggling, the donor ended up paying the Osage 10 cents per cubic yard for the boulders.

Is it worth the effort? To most Osage, the answer is a clear yes, a yes on basic economic grounds. For some, the exploitation of the past makes enlightened self-interest even more to the point. It was because of increasing white settlement that the Osage in 1872 were compelled to leave their lands in southeastern Kansas, going south to settle in what some whites laughingly called those barren hills, not fit for man or plow. And though the arrival of unexpected wealth brought its compensations, it also brought con artists and mass murderers. The Osage do not forget. Chief Tinker, for instance, takes along a small-caliber gun when he travels the back roads of Osage County. "The Osage got money," he says with a grin. "All them other Indians got is their ass and a hat."—WILLIAM J. BROAD

Is Science and Engineering Training Adequate?

President Carter, "increasingly concerned," directs NSF and the Department of Education to report on this question by 1 July

The National Science Foundation and the Department of Education are now engaged, at President Carter's direction, in a high-priority effort to assess the health of science and engineering education.

The study has been ordered partly because American industry is faced with a shortage of engineers, especially engineers trained in computer-augmented design and manufacturing techniques. Also, with most new engineering graduates finding attractive jobs in industry upon receiving their bachelor's degree, the engineering schools are discovering that to recruit enough graduate students and junior faculty they must look increasingly to foreign-born nationals.

President Carter gave Secretary of Education Shirley M. Hufstedler and NSF director Richard C. Atkinson their marching orders in a memorandum, dated 8 February, that said: "I am increasingly concerned whether our science and engineering education is adequate, both in quality and in numbers of graduates, for our long-term needs. Accordingly, I would like you to carry out a review of our science and engineering education policies at the secondary and university levels to ensure that we are taking measures which will preserve our national strength. Please submit a report to me, with your recommendations, by July 1, 1980."

Carter's directive to Hufstedler and Atkinson was sent on the advice of Frank Press, the White House science adviser, who in a memo to the President in early February had suggested that the study of science and engineering education be undertaken. Press, in turn, had acted partly on information received over a period of several months from engineering school deans and people in industry. He figured that, if the nation was already faced with a shortage of engineers, the additional demands generated by major new federal spending for synfuels R&D and defense research and engineering might make that shortage still worse. Also, in his memo to the President, Press is understood to have cited a report by two U.S. Census Bureau analysts, Louvan E. Nolting and Murray Feshback (*Science*, 1 February) that the number of scientists and engineers taking part in R&D in the Soviet Union may substantially exceed the number so engaged in the United States.

Press says he is not at this point asserting that there is a major problem in science and engineering education. Except for a few fields such as computer science and toxicology, there is no shortage of scientists today and many new Ph.D.'s in the sciences have been hard put to find jobs in the fields in which they have been trained. But Press says more information is needed as to whether a shortage of physical scientists may develop in the years ahead. (As one NSF staffer points out, the number of students receiving bachelor of science degrees in physics in 1978 was down by more than a third from the number who received such degrees in the peak year, 1970.)

At NSF, a task force headed by the agency's deputy director, George C. Pimentel, and two assistant directors, is in charge of the education study. A parallel effort is in progress at the Department of Education under the direction of Michael O'Keefe, deputy assistant secretary for planning. The major R&D funding agencies such as the departments of energy and defense and the National Institutes of Health are also being drawn into the study, as are private organizations such as the National Academy of Engineering, the AAAS, the American Chemical Society, and various education groups.

The present shortage of engineers in industry may have resulted from widespread reports in the early 1970's of massive layoffs in the aerospace industry and of some engineers being reduced to pumping gas or driving taxis. Misled into thinking that engineering in general faced hard times and bleak prospects, many students entering college in those years made their career choices accordingly. More recently, engineering enrollment has grown dramatically, but the supply of graduates still lags behind demand.

But catching up with the demand for bachelor's degree graduates is not the only problem facing engineering education. Engineering schools are having trouble recruiting enough American-born graduate students and junior faculty and in giving up-to-date training. The sit-

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uation at Ohio State University (OSU) may be fairly typical.

Today the OSU engineering school has more than 1000 students in the senior class, or more than twice as many as it had 5 years ago. But, whereas 20 percent or more of the graduating seniors continued into graduate training in the 1960's, less than 10 percent are doing so now. Instead, most go into industry where starting salaries are often running as much as $20,000 a year and the work may seem more interesting professionally than what a university might offer.

According to Donald Glower, OSU's dean of engineering and a member of the delegation of deans from the American Society of Engineering Education that called on Frank Press last year, OSU is having to look increasingly to foreigners for candidates for its Ph.D. programs in engineering and for the numerous new teaching jobs created by the boom in undergraduate enrollment. "You can get as many foreign nationals as you want [for the graduate programs]," Glower said.

These students—and Glower says they are "very, very good"—come mainly from Taiwan, India, the Arab nations, western Europe, and Japan; they usually have already earned the equivalent of a bachelor's degree in their home countries.

After receiving their Ph.D., many want to remain in this country, but find it easier to get a faculty position than a job in industry, where visa restrictions and restrictions having to do with access to classified and proprietary information may pose a problem. Glower says that, already, 15 percent of the OSU engineering faculty of about 300 is foreign-born and that the proportion of foreigners is rapidly increasing.

By next September, OSU must fill 40 vacancies in the engineering school, and, according to Glower, if the job candidates were screened strictly on the basis of their academic qualifications, 90 percent of those chosen would be foreigners. Glower feels that it is undesirable for foreign nationals, brought up under alien political and economic systems, to make up a large part of an American engineering school faculty.

According to Glower, OSU, like most other schools, has not had the money to equip its laboratories in keeping with the revolution in engineering brought on by the rapid introduction of modern computer technology, as in interactive graphics, robotics, and microprocessors. "Our graduates are going out into industry not knowing the technology of today," he said. "They have been trained in the technology of yesterday."

In Glower's view, this is particularly unfortunate when these graduates join companies which have themselves fallen behind in the engineering revolution. Many small- to medium-sized companies are known to be in this laggard state.

Along with many of his colleagues among the engineering school deans, Glower would like to see NSF—or, better yet, a new "national engineering foundation"—provide $20-to-30 million a year in matching funds to the engineering schools for 5 years—funds earmarked for bringing their laboratory equipment up to date. He believes that major companies such as General Motors and IBM would willingly match the NSF money.

At NSF and the Department of Education nobody is ready to speculate yet as to what the federal government should do to bolster science and engineering education. Currently, NSF is asking Congress to authorize $85.7 million for its science and engineering education programs in fiscal 1981, or $7.5 million more than was authorized for 1980. Department of Education programs directly related to science and engineering education are much smaller, because most programs in this field were retained by NSF when the new department was created.

Science and engineering education is, of course, very much affected by inflation and some of the other problems that afflict the rest of education. The leveling off and decline in college and university enrollments in many science courses during the 1970's after the earlier expansion (partly associated with the postwar baby boom) has made for an uninviting job market in some fields. If enough promising students are discouraged from pursuing careers in science, there will be shortages later on.

At the secondary-school level, NSF-sponsored surveys indicate that science is still not regarded as a part of the general education program for most students. Also, because of weaknesses in counseling at the junior and senior high levels, some able students are entering college without the mathematics and other prerequisites necessary for them to complete a major in science or engineering in 4 years.

Just what NSF and other federal agencies can do about all this in an era of tightening budgets and rampant inflation is anything but clear. Nonetheless, by calling for the science and engineering education study to be done, and done posthaste, President Carter is creating expectations which, in this political season, he presumably will take steps to try to satisfy.—LUTHER J. CARTER

High-Tech Sales to U.S.S.R. Further Reduced

The Administration has set down what it calls "tough new controls" on the export of high technology and industrial know-how to the Soviet Union. This represents formalization of a temporary new policy enunciated by President Carter in a 4 January speech following the Soviet invasion of Afghanistan.

Until now, this country has been exporting some $200 million worth of high-technology items annually to the Soviet Union. About 70 percent of this commerce has required obtaining exceptions to rules established by COCOM, the Coordinating Committee on Export Controls, which is comprised of NATO members and Japan. COCOM has agreed on a long list of high-technology goods whose export to the Soviet Union and its allies requires approval of all the members. Computers comprise the largest single category of items; there are hundreds of others such as oil drilling equipment, computer parts and software, lasers, and sophisticated machine tools. Under the new American policy, very few exceptions to the COCOM list will be allowed.

Since the Soviet invasion, some 700 export licenses and license applications have been suspended, the vast majority involving sales of computers. Officials at a background briefing could not assign any monetary value to the aborted transactions; however, before the invasion there were 494 license applications pending covering $155 million worth of goods. The total number of exceptions granted last year by COCOM was 1500; 25 percent of these involved exports to Russia, and the United States was the exporter in 40 percent of these cases.

In addition to curbing high-technology exports, officials said they would be taking "a very careful hard look" at policies governing the export of "process technology," meaning U.S. assistance in setting up manufacturing plants in "industrial sectors of military relevance" to the Soviets. Although it has consistently been American policy not to sell the Russians anything that could support their military activities, trucks built at the Kama River plant in the Soviet Union,

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