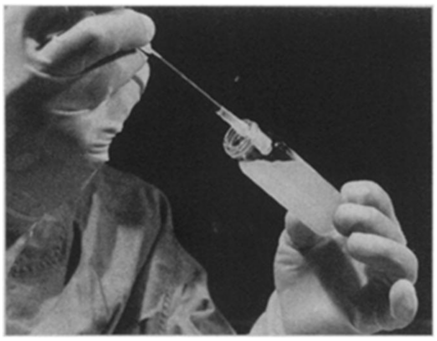
More active engineering role for NSF

For years there has been a growing movement within the engineering community to push for development of a technological analog to the National Science Foundation (NSF) — largely owing to a suspicion that engineering was never likely to rise above its stepchild status in an agency whose primary responsibility was a fostering of basic research in the pure sciences. Acknowledging that it might not always have been as nurturing of applied research as it could be, NSF has just embarked on a total revamping, expansion and rejuvenation of its engineering responsibilities. With its Jan. 28 reorganization of its engineering directorate, NSF aims to assume an active — even trend-setting — role in the support of both academic engineering research and industrial engineering excellence.


NIH
Biotechnology is a new area where special core-research programs will be sponsored.

Many of its changes reflect the ideas of Nam Suh, who has been in charge of the directorate since last October. Says Suh, "We are in some ways acting as an investment banker, generating new knowledge and manpower." Since any investment made today cannot be expected to pay off in benefits for a long time — perhaps before the year 2000 — he says, "our policies at NSF cannot be based on what the university community needs today." Rather, says Suh, NSF's investments must be directed toward future needs and engineering weaknesses.

Toward that end he has established a new interdisciplinary division for fundamental research in emerging and critical engineering systems. Some of the "emerging" areas — defined as offering promise for enhancing the nation's economy and security — include biotechnology, bioengineering and light-wave technology. "Critical" systems are those deemed essential to the nation's safety and health, including earthquake engineering, environmental engineering, toxic waste hazards mitigation and the systems engineering for large structures such as bridges.

Suh says universities have had trouble getting into these critical and emerging areas in the past for a number of reasons that NSF has only recently begun to appreciate. For example, solutions to these problems tend to be multidisciplinary. Yet university professors usually collaborate little, and when they do, only within departments. That's why, Suh says, NSF won't wait for biotechnology proposals for interdisciplinary research collaboration; the wait would be too long. Instead, his agency will actively solicit interest in developing university centers for biotechnology, offering to help create the infrastructure that will encourage such collaboration. He suggests that NSF's aiding in development of program curricula might even spur creation of a new breed of engineer, the biotechnologist.

Moreover, Suh points out that solutions to many of these problems require teamwork on a scale not usually encountered in universities. To prepare students for the scale of collaboration representative of the real world, NSF will encourage creation of university-industry centers to focus on critical large-scale problems, such as innovation in the design of bridges or a restructuring of the nation's highway arteries. This is an important area for NSF, Suh believes. Because it is the public that pays for developments in these areas, there has been little incentive for the commercial civil engineering sector to fund research or adopt cost- or resource-saving innovations, he says. The centers themselves may be funded out of his new Office of Cross Disciplinary Research.

Suh believes he was chosen for his new post in part because of his experience with such industry-university collaboration. The Massachusetts Institute of Technology's Laboratory for Manufacturing and Productivity, which he directed before coming to NSF, was such a center. "When I started our lab we had only a few students; it's become an organization of 150 people spending over $3 million of industrial money," he told Science News.

Another Suh strategem was the creation of an NSF division to develop a science base in design, manufacturing and computer engineering. Unlike pure science, which is based largely on knowledge systematized into collections of generally applicable principles, much of engineering is based on empirical knowledge — what one learns by experience. Each programmer, for example, develops his or her own approach to software design by trial and error, Suh notes. The same is true for welding and product design. However, attempts can be made to distill the experience base in many areas to scientific paradigms. In fact, Suh believes that's one of NSF's primary missions. This science of engineering, he explains, is essential research seldom tackled by industry.

Three other divisions complete Suh's organization: Chemical, Biochemical and Thermal Engineering, which deals with the transformation and transport of energy and matter; Mechanics, Structures and Materials Engineering, including geotechnology and building systems; and Electrical, Communications and Systems Engineering, related to basic electrical phenomena and the synthesis and analysis of devices.

Suh considers the $150 million engineering budget he has for this fiscal year "totally inadequate" — perhaps by a factor of 3 or 4. However, he says his reorganization may help him plead for more "where it matters, namely in the Congress and Office of Management and Budget." Explaining that it's hard to argue that mechanical engineering, per se, needs more money, he says he has no trouble justifying more for the priority programs he has given greater visibility through his reorganization.

—*J. Raloff*

Cereus bacteria go for the gold

For centuries prospectors have relied on plants, dogs and even bees to home in on mineral deposits. Now a group of researchers at the U.S. Geological Survey (USGS) in Denver reports that a spore-forming bacterium, *Bacillus cereus,* has a particular liking for topsoils overlying deposits of gold, copper and other ores that may be buried several hundreds of feet deep. While microorganisms have been used in oil exploration, this is the first indication that a bacterium might be a useful guidepost for mining, say the scientists.

Geomicrobiologists John Watterson and Nancy Parduhn presented their findings in Denver last week at the USGS-sponsored McKelvey Forum on Mineral Resources. Watterson outlined research done over the last two and a half years at a big copper deposit in Montana in which the count of *B. cereus* can run up to 100,000 times that of surrounding soils. Parduhn, following up on these studies, described recent soil surveys near gold deposits in California, Colorado and Nevada. She too discovered that *B. cereus* bacteria living over mineralized bedrock outnumbered their counterparts in unmineralized terrain.

Except for a few brazen plants and microorganisms, *B. cereus* is uniquely adapted to these kinds of deposit areas. Most other bacteria wouldn't dare enter Watterson's copper deposit, for example, because they would be killed either by the copper or by the penicillin and other antibiotics produced by metal-tolerant fungi that live in the soil. But *B. cereus,* the researchers believe, has learned to survive by stealing a water molecule from each penicillin molecule, leaving a gap in the penicillin that traps a copper molecule before either can hurt the bacterium. In this way, the bacteria continually detoxify the copper molecules migrating away from the ore site. (Penicillin is commonly used to treat copper toxicity in humans.) Watterson has found that the penicillin resist-