

NSF Seeks Expanded Role in Engineering

National Science Board policy statement sets direction for another effort to achieve so-far elusive objectives

Critics in the engineering community and in Congress have complained for years that the National Science Foundation (NSF) does not understand the problems of engineering research and education and has neglected these activities. Lately, NSF has been enjoying a kind of grace period as the critics gave the foundation time to make good on pledges to do better with engineering.

The National Science Board (NSB), which makes policy for NSF, this summer produced a policy statement on the engineering mission of NSF for the next decade and foundation director Edward A. Knapp and his staff have followed up by fashioning an expanded engineering initiative designed to be incorporated in next year's budget. A new sort of pressure on NSF appears to be building up, however, as some interested outside organizations have become participants in the process of change.

In the past, two kinds of limitations have influenced NSF actions on engineering—financial and conceptual. The scientific community has been concerned that a major commitment to engineering by NSF beyond the relatively modest sums now devoted to it* would divert funds from basic research. In addition, NSF has had genuine difficulty in framing an engineering initiative that the Office of Management and Budget (OMB) would find persuasive. It is also fair to say that advocates of greater federal support for engineering have not been very successful in defining the issues clearly and laying out what should be done.

During the period of more than a year that the NSB worked to formulate a policy statement on the subject, the board consulted the engineering professional societies and got more active assistance from the National Academy of Engineering (NAE) than it had in the past. Having been invited to participate, these organizations now seem disposed to remain part of the process.

On the other hand, Representative George E. Brown, Jr. (D-Calif.), NSF's principal congressional critic on engineering matters, remains underwhelmed by NSF's actions and says he will reopen the matter in the coming session of Congress with hearings on his bill to estab-

lish a National Technology Foundation parallel to NSF.

Brown's legislation, first introduced at the end of the 1970's, was in a sense an expression of exasperation generated during that decade. NSF was given the responsibility of nurturing U.S. engineering as well as science when it was established in 1950, but through its first two decades it concentrated on the support of basic research, particularly in the physical sciences. From the early 1970's, demands that NSF pay more attention to engineering grew more insistent but won little serious backing outside the profession. Toward the end of the decade, however, the lag in innovation and productivity in U.S. industry kindled concern in Congress and the Executive. Engineering organizations pressed both for new programs in engineering and greater status, seeking to recast NSF's name to denote technology or engineering as well as science.

"The engineering leadership of [NSF] needs to be broadened."

Pressure on NSF for changes in its engineering program slackened after a 1980 reorganization that created a separate directorate for engineering in the foundation for the first time and attention was diverted by the accession of the Reagan Administration and an initial round of heavy budget cuts for NSF.

Brown says he was encouraged to revive his National Technology Foundation legislation this year by the Administration's proposal to convert the Department of Commerce into a Department of International Trade and Industry (DITI). A consequence would have been a hiving off of several technical agencies now under Commerce and one plan called for combining the National Bureau of Standards and other smaller agencies from Commerce with NSF. Brown saw an opportunity for establishment of a new agency combining the technology functions of NSF and Commerce in a new entity focused more sharply on technology. The DITI initiative appears to have foundered, but Brown says he still sees

the "need to organize our technological resources more effectively" and feels that some version of his technology foundation is the best way to do it.

There seems to be no great mystery about why NSF has found the problem of engineering so intractable. NSF is the only agency whose main mission is basic research. The formula has been to award research grants to individual scientists on the basis of the quality of their proposals as judged by their peers. Research manpower has been trained with funds from the grants. The problem is that this model does not work very well with engineering. NSF has done best at supporting engineering science, as it is categorized, that most resembles NSF's mainline science research, and rather poorly with the rest. And the rest is very important to engineering.

In comments to his fellow members at the June meeting of the NSB, Case Western Reserve president David Ragone made this key distinction. "During our many discussions of the NSF support of engineering," said Ragone, "I have observed that we as a Board fail to appreciate the difference between the practice of engineering and the aspects of engineering we support—engineering science." Ragone went on to say that "The objective of engineering practice is to solve problems. The objective of engineering science is to increase the knowledge base to support the practice, an objective shared, of course, with the sciences."

Ragone's own definition of engineering practice is that it "requires decision making under conditions of uncertainty and also involves constraints that are irrelevant to science, such as budgets, deadlines, etc."

NSF has always shied away from the support of work that would lead to the development of particular products or processes because such work was seen as the province of industry and NSF sponsorship would violate the letter and spirit of the foundation charter. The dilemma for NSF is that it is in this suspect area that engineering needs help to maintain U.S. competitiveness.

In its policy statement, NSB urges NSF to "expand and alter its traditional role in support of engineering science at academic institutions." In defining the recommended NSF role, the board says

*An estimated \$126 million is allocated to engineering programs at NSF this year, about 10 percent of the foundation's total research budget.

that "The Foundation should not support the 'clinical' practice of engineering; the development of specific products and solutions of commercial problems should be left to the private sector. However, the linkage between the applications of engineering principles in industry and the research and teaching of our engineering schools should be close and mutually supportive."

Fair game for NSF support, says the statement are such topics as engineering design, materials processing, risk analysis, manufacturing engineering, testing, and quality control. Most of those involved in the discussion of NSF engineering say it is appropriate for the foundation to support research on engineering "methodologies" or "generic technology." The difficult task of framing effective programs that stay on the right side of the fine line is now up to NSF.

Knapp is frank in saying that "we are still trying to understand what the foundation ought to do in engineering." And he suggests that the engineering community has to do a better job of specifying what it wants. But Knapp says he thinks that the engineering initiative proposed for the next budget is a good one. How it will fly with OMB he says is not clear.

How well NSF will adapt to the new role is questioned by some. The first ambitious initiative in engineering broached by NSF was never implemented. Through most the 1970's, engineering activities were lumped with applied research and both were organizationally isolated. Pressure from the partisans of engineering in the late 1970's prodded NSF director Richard Atkinson, who was about to depart NSF, to draw up a new blueprint for engineering, leaving his successor John B. Slaughter to carry out the changes. In November 1980 Slaughter announced his own reorganization plan which created a separate engineering directorate and spread responsibility for applied research through the foundation. Slaughter had experience in industry and academia and was regarded as having a professional understanding of the problems of engineering and being sympathetic to its needs. He took over just as the new Reagan Administration was elected, however. The big funding increases anticipated for engineering did not materialize and, in fact, Slaughter had to preside over the deep cuts in the fiscal year 1982 budget mandated by the new Administration. Observers say that Slaughter, a Carter appointee, was uncomfortable at NSF. He resigned to become chancellor at the University of Maryland's main campus after less than 2 years at NSF.

Despite the reversal, the NSB continued to work on engineering issues. The board's current chairman, Lewis M. Branscomb, IBM vice president and chief scientist, kept engineering high on the board's agenda. Knapp assumed the directorship last November, in time to participate in the board's formulation of the policy statement on engineering.

During its deliberations, the board solicited the opinions of professional engineering societies and also of the NAE. The NAE had not been conspicuous in the campaign of the late 1970's but evidently intends to make its mark now. In May NAE convened a blue-ribbon panel of engineers, and in July NAE's new president, Robert M. White, conveyed his own and the panel's view in an NAE



Representative George E. Brown, Jr.
Proponent of a technology foundation.

document on strengthening engineering in NSF subtitled "Views of the President of the National Academy of Engineering." In addition to comments on what the foundation could do in respect to engineering research, the paper emphasized the problem of engineering education and urged that NSF increase its involvement. The predicament was sketched as follows.

It is not news that the number of undergraduates enrolling for engineering degrees in universities has increased by 80 percent in the past decade, while the faculty in engineering schools has increased only 10 percent. There are still nearly 2000 unfilled faculty positions in U.S. engineering schools. The net result has been an instructional overload for faculty members to a point where the quality of engineering education has been impaired and its future endangered.

Effective action will require both new money and staff since engineering education was closed out at NSF when the Reagan Administration disbanded the education directorate.

The NAE paper also observed that internal changes are necessary if engineering at NSF is to be upgraded.

Quite simply, the engineering leadership of the National Science Foundation needs to be broadened. A greater number of engineers or scientists with strong engineering backgrounds are required at the policy and program levels of the NSF. Engineering education and engineering research cannot receive the attention now required unless there is deep understanding and sympathy within the NSF leadership.

Academy interest has not ended with White's paper. Engineering research was the subject of a workshop on 19 and 20 November sponsored by NAE. Key figures in fomenting activity were Rensselaer Polytechnic Institute president George Low, who is chairman of the academies' Committee on Science and Engineering Policy; President Reagan's science adviser George A. Keyworth, II, White; and Roland A. Schmitt, GE senior vice president for corporate research and development. Schmitt, who is a member of both NSB and the NAE governing council, chaired the workshop.

Under examination was whether the National Research Council (NRC), the research arm of the academies, should undertake a major, in-depth study of engineering research. Such assessments in disciplines such as physics, chemistry, and astronomy were in vogue in the 1960's and early 1970's and served both as scientific surveys of the disciplines and bids for support. The consensus at the workshop was that a study of engineering research was called for. A proposal is expected to emerge from NRC by the end of the year.

A jarring note could be struck by Brown's bid for a technology foundation. Potentially more significant politically, as Brown himself notes, is the question of whether the sputtering debate over industrial policy will ignite in next year's presidential campaign. If it does, engineering will be seen in a new and brighter light.

The more immediate issue is how NSF's engineering initiative will fare with OMB in the contest for budget funds. The partisans of engineering have so far maintained a united front on the point that engineering activities should not get major increases at the expense of basic science. The rationale expressed in White's paper is that "Engineering is fundamentally dependent upon a vigorous basic science activity, and it is of vital importance to engineering that this base not be eroded." This enlightened approach should forestall a head-on clash with science over federal funding, but, in the tough budget year in prospect, it is likely also to mean that engineering's new phalanx of friends will have to exercise further patience. —JOHN WALSH