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# Engineering and the National Science Foundation

In the scientific and technical communities of both the federal and private sectors, it is widely recognized that an effort to strengthen engineering at the National Science Foundation is desirable and timely. The engineering professional societies and engineering schools have been dissatisfied with NSF programs for many years. The engineering academic community has not found NSF to be an effective source of assistance as undergraduate enrollments have expanded while out-of-date laboratory facilities and inadequate research funding have decreased the ability of the schools to attract an adequate number of faculty members or full-time graduate students.

The organizational position of engineering within the NSF administration has been improving. Engineering has emerged from a division status, to part of a Directorate of Engineering and Applied Science, to its present position as a separate directorate. Presumably engineering is no longer considered as one of the sciences or simply the application of science but rather an enterprise with distinctive characteristics of its own.

One of these characteristics is the concentration of activities in industry. More than three-quarters of the engineers in the United States are employed in industry; industrial laboratories have done the outstanding research in many fields. Since much engineering research is best carried out by teams of specialists and is frequently heavily dependent on equipment, an industrial site may often be better adapted for effective engineering research than the usual academic environment.

Although in-depth skills in scientific and mathematical analysis are needed by both scientists and engineers, an engineer must also be able to synthesize knowledge into products and systems. Their designs must satisfy scientific as well as nonscientific criteria such as manufacturability, maintainability, risk-minimization, and cost-effectiveness.

There are also distinctions in the academic world. Most engineers complete their formal education in 4-year undergraduate programs; such programs cannot be directed simply to preparation for graduate work. Postdoctoral fellowships, which are so important in the training of research scientists, are almost nonexistent among engineers.

Such differences between engineering and the sciences might lead one to the conclusion that engineering should be the responsibility of a federal agency other than NSF. Some countries have developed separate university systems for engineering and scientific education, but in the United States nearly all research universities have strong scientific and mathematical programs as well as schools of engineering. Thus the U.S. academic structure provides a rationale for expanding NSF activities in engineering rather than assigning the general support of engineering research and education to other agencies.

However, of even greater importance is the fact that the scientific and engineering enterprises operate most effectively when their borders are kept indistinct. Increases of scientific knowledge and understanding have given great impetus to engineering and technological advances. In turn, engineering and technological advances have frequently led to expansion of scientific knowledge. The interplay of science and technology, which is crucial to the rapid advance of both science and engineering, should not be hampered by institutional barriers.

If engineering in NSF is strengthened, three objectives can be simultaneously served. First, badly needed assistance to the academic engineering community can be more efficiently provided; second, the synergism between science and engineering can be reinforced; and third, the nation's technological capability can be strengthened. A dynamic engineering program at NSF is one of the most highly leveraged investments in the nation's technological future that the federal government can make.—F. KARL WILLENBROCK, *Cecil H. Green Professor of Engineering, Southern Methodist University, Dallas, Texas 75275*