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A Letter Report of the NAE Foreign Secretary to the Committee on International Science of the National Science Foundation

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OFFICE OF THE FOREIGN SECRETARY

November 14, 1984

Prof. William A. Nierenberg
Chairman
Committee on International Science
National Science Board
National Science Foundation
1800 G Street, N.W.
Washington, DC 20550

Dear Bill:

This letter is in response to your invitation to the National Academy of Engineering (NAE) to assist the Committee on International Science of the National Science Board (NSB) in defining issues in international engineering with regard to programs of the National Science Foundation (NSF). To accomplish this, a group of NAE members (see attached) was assembled at the Academy on 17 October. In addition, we benefited from the presence of Dorothy Zinberg, former Chairman of the Advisory Committee on International Programs of the NSF. Nam Suh and Carl Hall of the NSF Engineering Directorate and Rafe Ronkin of the Division of International Programs (INT) also joined for portions of the meeting to provide information on current programs and possible opportunities.

The 4 following issues summarize the results of our deliberations:

1) Are we adequately informed of areas of excellence in engineering abroad?

2) Do we have a healthy set of mechanisms for connecting to engineering progress abroad?

3) Do international data and information collection and networking for engineering operate effectively for the U.S. in both directions?

4) Can we have an improved set of major collaborative efforts in engineering research?

Before elaborating on these 4 issues, I would like to offer a few contextual comments.

First, we recognize that responding fully to these issues will require not only initiatives on the part of NSF but also enhanced cooperation and effort from several agencies of government. For example, while there are attaches of the State Department and other agencies stationed abroad who are highly

qualified in some engineering areas, like nuclear power, there is a general need for strengthening engineering and technology expertise in the overseas activities of the US government. From the point of view of engineering, federal government initiatives focused simply on 4 or 5 leading countries could make a substantial difference. We welcome the greater leadership role that the NSF has been developing in inter-institutional cooperation for international science and technology among US government agencies. It is also gratifying to see the seriousness in the State Department with which Secretary Shultz is treating science, engineering, and technology.

Second, we note that previously there has been little conscious development of international aspects of engineering within the NSF. This year may be the first time the topic has been raised in a serious way, and greater alertness within the Foundation to the importance of the area is likely to produce benefits in itself.

While no precise estimate of programs and resources currently involved was available for our discussions, it is clear that international engineering activities are located primarily in the engineering directorate. It appears that several million dollars may be spent internationally by the engineering directorate, for example, in earthquake programs. There are also some international engineering activities in INT, and probably some in the Divisions of Industrial Science and Technological Innovation and Policy Research and Analysis, as well as Polar Programs and others. INT, for example, supports some groups in the International Council of Scientific Unions (ICSU) that are important to engineers (e.g., the International Union of Pure and Applied Chemistry, the International Radio Union, and the International Union of Pure and Applied Mechanics) and also some travel by engineers involved in international projects. A better identification of international engineering activities within NSF would be helpful. The absence of a focal point for these activities is evident.

Third, there is a range of issues having to do with cooperation in engineering with developing countries that merit more detailed consideration than we were able to devote to it. Questions of efficient means of technology development and transfer and the social impact of technology are matters of considerable concern. Broadly speaking, these are matters that may be more the responsibility of AID and other agencies than NSF. However, we do wish to note them, and at a future time it may be that the Committee on International Science would wish to explore them more carefully from the point of view of NSF policies. The US preparations for the 1979 UN Conference on Science and Technology for Development still provide a reservoir of ideas in this area.*

A fourth general point with regard to international engineering is the tremendous increase of importance of exchange with the Orient, particularly Japan. Our US system of education does not prepare our engineers sufficiently for international dialogue, particularly to make the most of visits to Japan

*See, for example, National Research Council (1978), "U.S. Science and Technology for Development: A Contribution to the 1979 UN Conference."

and contacts with Japanese and other oriental colleagues. Few US engineers study East Asian languages and culture. And the overall system of exchange has not adjusted to provide as many contacts as are warranted with engineering in Japan and the Pacific Rim. The current initiatives with the People's Republic of China and India are desirable, but do not respond to the sort of engineering needs we identified.

The final general point is that the NSB at present has a rare opportunity to define a set of policies for which a good and desirable set of programs and exchanges could be developed. The international programs of many US federal agencies grow by a rather passive accretion of programs, often in response to political need. A more active program, based on deliberately established priorities, is required to grasp the many attractive opportunities available.

We now discuss each of the 4 major issues identified above.

1) Areas of excellence. It may be desirable for the NSF, through coordinated activities in several directorates and programs, to improve our ability to identify areas of excellence in engineering research and achievement abroad, especially areas that are not subject to export controls. The key is to identify a reasonable number of areas where the U.S., represented by the NSF, can cooperate and exchange information on a basis of reciprocity. The NSF has the unique responsibility in the federal government for looking across all fields and at the interstices between fields. Both emerging fields and ones that might be rejuvenated should be kept in mind. We can do a better job for the U.S. of encouraging inflow from foreign sources and showcasing here the best in foreign engineering. We can also do a better job of communicating to young engineers what we already know about foreign approaches to engineering.

For purposes of illustration, we mention a few subject areas. One is manufacturing. In various aspects of the understanding, modeling, optimization, automation, and integration of design and production, important work is being done in Japan, West Germany, Norway, Sweden, Hungary and Czechoslovakia. Such work can be a particularly fruitful area for both cooperation and exchange. One reason is that manufacturing science and engineering are essentially generic technologies, applicable across the entire world manufacturing industry, as contrasted with product-oriented technologies. As such, both cooperation and exchange in this field of technology are subject to far less industrial constraint than is the case in areas of technology which directly affect product capabilities and thus have strong proprietary and competitive overtones. A number of countries, most notably West Germany and Norway, already have fruitful programs of cooperation and exchange in manufacturing research underway.

Some other possible areas of excellence that might be mentioned include:

-- agricultural engineering
-- heavy electrical and power engineering
-- reengineering of the infrastructure (e.g., for transportation)
-- materials
-- telecommunications and information.

We should also mention that there are fields, like earthquake engineering, where international collaboration which involves NSF support is already highly successful. Such fields should be encouraged further and emulated.

These illustrations indicate that it might be desirable to establish some ad hoc advisory committees to identify more systematically areas for international collaboration in engineering in which a mutual exchange would be of clear benefit to the U.S. The Academy is prepared to assist, if this is desirable. Some of the studies the NAE has prepared on competitiveness of US industries for the NSF Division of Policy Research and Analysis may be useful background.

It is worth noting with regard to the question of how adequately informed US engineers are in respect to excellence in engineering abroad that there are substantial differences depending on which groups and areas one looks at. If one considers familiarity of US academics with European academics in engineering, the situation is probably not bad. Industry engineers in the U.S. in general may be less well-informed, and the work of industry engineers abroad may be less widely known. For Japan, neither US academics nor industrial engineers are well-informed. It is not that the Japanese hide information. Information is available, but it is in Japanese. Not enough Japanese work, especially patents, is translated swiftly from the Japanese literature into English.

There have been some efforts by the government and professional societies to increase availability of information in the U.S. about Japanese R&D, as there was in earlier decades with regard to the USSR. A problem is that both academic and industrial engineers in the U.S. tend not to read the foreign literature, even if translated. There is a strong, conservative impression of superiority. In other countries, it is much more ingrained to be alert to important developments abroad. Perhaps the NSB and NSF can take various practical and symbolic steps to improve US attitudes.

2) Mechanisms. The question of mechanisms of exchange includes many aspects: US students abroad; foreign students in the U.S.; exchanges involving faculty and practicing engineers; bilateral agreements; multilateral institutions; and means internal to the NSF for implementing programs.

a) It may be desirable to increase the exchange of information among those who lead graduate engineering education in the U.S., Japan, and Western Europe. There are several concerns in common. One is the flow of people. Not only the U.S., but the FRG, for example, also has considerable concern about the large number and skewed distribution of foreign student population. How to increase domestic student populations in engineering, how to achieve satisfactory flows among the advanced countries, how to define fair policies for engineering students from developing countries--all such issues warrant much deeper thought than they have been receiving. And it will be useful if we can develop some shared understanding and intentions with other countries on these issues.

A parallel topic of interest covers the content and methods of engineering education at the graduate level. The U.S. is experimenting with new mechanisms, for example, the Engineering Research Centers (ERCs), and as we seek to strengthen US engineering education and research in coming years, we should be especially alert to good models that are being used abroad.

Studies by the Science Resources Studies (SRS) Division and a symposium might be appropriate means of obtaining more information in the education area. More detailed comparative analyses might follow. The efforts should involve a balance of engineers and others who understand the economics, sociology, and politics of other countries, as well as the U.S.

b) With regard to improving the experience of US academic engineers abroad, we note one mechanism of particular interest. In the humanities, many universities have long had effective offices and other facilities abroad to provide a base for scholarly and educational activities. In engineering and science, there are few parallels. MIT recently established an office in Japan to facilitate the studies and research of its students and faculty who travel there. Other schools might want to consider establishing such a mechanism with strong capabilities in engineering and science, or several schools might want to consider establishment of a consortium to operate a joint office. Perhaps the NSF would want to consider supporting such an operation on an experimental basis. The role of the small NSF liaison office in Tokyo could also be enhanced.

c) Bilateral agreements in S&T (and NSF's Division of International Programs) developed in an era when the NSF was not strongly oriented toward engineering. It is timely to consider how to achieve a new center of gravity in the existing bilaterals and INT program that reflects both science and engineering interests.

d) We note that there are discussions underway about the establishment of a new east-west center for science and technology in Hawaii. If the NSF is a participant in this effort, we urge due attention to engineering.

e) The results of a Lipset-Ladd (1977) survey on travel patterns of academic scientists and engineers was brought to our attention. Engineers reportedly traveled abroad less than scientists. It might be desirable for NSF's SRS Division to confirm this finding and seek some explanations. It is uncertain whether such a finding would simply reflect different needs in the very diverse fields subsumed by engineering or whether travel support is inadequate. There is anecdotal evidence that support may be deficient in a few areas, for example, participation in international congresses on materials.

In the US, travel abroad still tends to be regarded as a privilege rather than as necessary to be part of engineering progress. In contrast, several of our industrial competitors who are always looking for ideas recognize that travel is one of the cheapest ways to obtain information. As suggested above, there are also ways to increase the value of travel. For example, North Carolina State has set up a Japanese Center, where scholars can "train" to be better able to benefit from their time abroad. This pattern is already employed by some other countries for sending their best people to the U.S.

f) With regard to multilateral institutions, we do not see a need to build a general, centralized international institutional infrastructure for engineering, an ICSU-like equivalent for engineering. The needs and subdisciplines are too diverse to be handled effectively by a comprehensive agency. A variety of specific structures in existing and emerging specialties is preferable. What may be needed is a greater flexibility domestically to form ad hoc mechanisms when needed to address international engineering opportunities and rapidly evolving problems. The strengthening of our national institutions will also help with regard to such functions as host representation. The emerging coalition of national engineering academies can be an increasingly useful mechanism for facilitating certain kinds of exchanges.

g) Professional engineering talent is more concentrated in industry than universities. The NSF may wish to explore means of involving more young engineers from industry in international conferences and exchanges. While senior engineers in industry can typically finance their own participation, younger engineers, for whom exposure may be especially valuable, often cannot. Clearly, NSF must think carefully about the wisdom of support for "industrial" travel; in the context of industry-university cooperative programs, it could be appropriate.

h) The NSF may also wish to consider funding of specific fixed-term international exchanges in engineering operated by professional societies, the Academy complex, and other groups. These would involve engineers from both academia and industry, and might extend for, say, 2-5 years. Such fixed-term exchanges may be an attractive alternative to government bilaterals that take a long time to launch or terminate for protocol reasons. Engineering faculties at US universities should also be encouraged to enter into regular faculty exchanges with outstanding counterpart institutions abroad.

i) Active means for stimulating exchange in specific engineering fields might be employed. It might be desirable to select a few areas where there is substantial foreign expertise where a solicitation of proposals would send appropriate signals to the community. The customary system of unsolicited proposals is unlikely to bring changes as rapidly as national needs warrant. We also note that Unesco does have engineering programs, and imminent US withdrawal might lead to the availability of some funds domestically for new US initiatives in international engineering.*

3) Data and information. The central question is whether the system of data and information collection and distribution operates both ways. Often the U.S. appears to be contributing appreciably more than it receives in exchange, and in truth we may not gain as much advantage in this country from international data collection as we might, or perhaps as others do. Such a conclusion should not stand as a basis for withdrawing from international data collection and dissemination programs. Much of the problem of asymmetry may

*Unesco's program VI.1 "Research, Training, and International Cooperation in Technology and Engineering Sciences" has a current annual budget of $11.6 million.

lie in our cultural attitudes. We simply do not realize how much value we might derive from information generated beyond our borders, and outsiders who are simply more hungry take better advantage of information in the public domain. We should respond to the noted asymmetries by working harder to extract value from the data. If we respond by backing away from the few international programs in which we are engaged, it would probably be unfortunate.

It may be worthwhile for NSF to consider funding some studies externally to survey the various facets of the data and information question--geographic access, access based on technology, the literature base, adequacy of translation and dissemination, etc.--to explore whether there is a need to adjust protocols, cost sharing, domestic focal points, and so forth. There are several examples of successful international data and information exchange and networking for engineering. Positive examples include fusion engineering and the international program located in the U.K. for collection and distribution of data on natural seismic occurrences.

A second aspect of this issue area is that new information technologies are affecting the conduct of research globally. This is no less true in engineering than in other disciplines. More forethought might be given to how the evolving international engineering research system can best be structured from the point of view of the U.S. This would probably need to be done on the basis of individual engineering subdisciplines.

4) Collaborative efforts. Joint projects probably provide the best mechanism for interaction, although these only develop well when there exists a pre-established pattern of contact through conference participation and other more limited exchange. With regard to major collaborative efforts, we wish to bring to your attention both those that are directly related to engineering and those that are related primarily to scientific research. In the latter category are such facilities as scientific drilling ships. In the former category an example is earthquake engineering facilities.

Such facilities can yield not only knowledge through research, but economic and commercial benefits as well. For example, while US investigators work cooperatively on earthquake facilities in Japan, Japanese industry uses the presence of these unique research facilities in Japan to promote its own reputation for leadership in the field. Major new facilities in engineering are under consideration, including ones for study of earthquake engineering and for high-gravity testing (the geotechnical centrifuge). Issues of cost-sharing and siting for such proposed facilities should receive very careful consideration.

With regard to major collaborative efforts we would also like to mention the increasing restraint we have observed over the last 10 years or so on large-scale, imaginative engineering thinking. We think it might be healthy for the NSF again to encourage investigators to ask the question: "What are the major problems that societies face, and to what extent might engineering provide solutions to them?" In areas such as water quality and quantity,

waste disposal, and energy supply, it may be timely to explore again some major technology projects, their international nature, and the barriers, benefits, and risks associated with carrying them out. While this would be a very small portion of the studies supported by the engineering directorate, proposals along these lines should be entertained. In addition to the above, the unique opportunity for major cooperation in the generic field of manufacturing science and engineering described earlier should not be overlooked.

I hope you find this preliminary identification of issues useful. It is a welcome task to participate in the enhancement of the international aspects of NSF's engineering programs.

Sincerely yours,

H. Guyford Stever
Foreign Secretary

Attachment

NAE Office of the Foreign Secretary
Ad Hoc Advisory Meeting
17 October 1984

Daniel J. Fink
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Trumbull, Connecticut

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Bechtel Civil & Minerals, Inc.
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M. Eugene Merchant
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William R. Schowalter
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August 20, 1984

Dr. H. Guyford Stever
President
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Dear Guy:

I am writing to you in your capacity as Foreign Secretary of the National Academy of Engineering to seek your advice and the assistance of the Academy in defining international issues in engineering for the National Science Foundation.

As you know, for the past year and a half I have been chairing the Committee on International Science of the National Science Board. Our First report (enclosed) focused on actions NSF might take in the international area that would contribute directly to the health of American science. We have recently completed a mini-study for internal use (also enclosed).

At its August meetings, the Committee decided to direct a substantial portion of its energies in coming months towards strengthening international aspects of NSF's programs in engineering. To this end, we would appreciate your help in developing an issues paper which might serve as a basis for deliberations of our Committee and eventually recommendations for action by the NSB/NSF.

In our initial discussions, several possible issue areas have been suggested. These include:

a) Exposure of U.S. students and professionals to outstanding engineering abroad;
b) Engineering education and research and export controls;
c) Representation of engineering in U.S. S&T bilaterals; and
d) Foreign students in U.S. engineering programs.

We would hope to receive a brief discussion of such issues and identification of others of importance. Please keep in mind that we are looking at all these questions through a specific lens,

that of current and potential NSF programs. And, again, at this stage we are not seeking recommendations but identification and discussion of issues.

Ideally, we would like to take up this area in depth at our 15 November meeting. I realize this is a very near deadline for an Academy activity. Please call me to discuss how best to proceed. We would greatly appreciate any contribution you might make and would look forward to working with you.

Sincerely,

William A. Nierenberg

Enclosures

cc: R. M. White
R. W. Schmitt
E. Bloch
M. L. Windus
W. A. Blanpied
J. Ausubel

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