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Some Comments on the Crisis in Engineering and Engineering Technology Education

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ABSTRACT: The maintenance of a high-quality technological base in the United States is dependent upon adequately funded engineering programs in American colleges and universities. At the current time, many American engineering educators feel that their academic programs are in a state of crisis with respect to adequacy of resources.

A number of foundations associated with large American companies (Exxon, IBM, Amoco, and others) have provided funds designed to aid engineering education. Funded programs at the national level have been proposed in Congress.

At the present time, the current level of funding is still inadequate. It will take a national technological crisis to improve this situation.

KEY WORDS: engineering education, crisis, resources

The maintenance of American technological leadership has a distinguished history during the past century, particularly so during the post-World War II period. Much of the impetus in the movement has been based upon the inherent strengths of American scientific and engineering education in the colleges and universities.

Today, many concerned engineering and engineering technology educators feel that certain aspects of their academic programs are in a state of crisis that seriously threatens the quality of engineering-based education. Others, while not willing to use a word so strong as "crisis", readily admit their own serious concern about these same issues. A fairly extensive dialogue has built up over this situation within recent months, particularly in academically oriented periodicals such as *Engineering Times* and *Engineering Education News*. In ad-

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dition, some of the national weekly news magazines have devoted full issues, articles, or editorials to this topic; see, for example, the editorial in the 15 March 1982 issue of *U.S. News and World Report*.

The basic problem is concerned with an alleged serious mismatch between the task that engineering-based educators feel they are being called to carry out and the actual economic resources which American society has chosen to allocate to this task. Specifically, the list of problem areas most frequently cited by engineering academicians is as follows:

- A relatively low level of funding for university engineering department capital equipment and operating budgets, as compared to even modest assessments of reasonable need.
- Rapidly growing enrollments in engineering undergraduate programs.
- Underenrollment in certain areas of engineering graduate programs.
- A lack of funding for graduate assistantships.
- A relatively high percentage of nonnative engineering graduate students, who will eventually graduate and export their skills to their home countries.
- A serious shortage of qualified Ph.D.-level faculty to staff teaching and research positions in engineering programs.
- A low salary level for engineering faculty, as compared to their counterparts in industry.
- Inadequate classroom, office, and laboratory space and facilities on the campus.
- A general degree of estrangement from the mainstream of campus and academic life.

Opinion differs widely as to the relative importance of any individual item on the foregoing list. In addition, doubt has been expressed in some areas, particularly within the liberal arts sector of the university community, as to whether the problems of engineering are worse any than those of the American university system considered as a whole. However, the basic fact of the existence of these concerns as widespread perceptions in the minds of engineering educators is significant. It seems evident that preoccupation with such problems, either real or perceived, will tend to divert substantial energy away from the main academic efforts of teaching, research, publication, curriculum development, and public service.

On the national level, there are a number of reasons to be concerned about the crisis in engineering education. In fact, it can be argued reasonably that the dimensions of this problem cause it to be one which affects sensitive areas of the national interest. According to the aforementioned *U.S. News and World Report* editorial, the engineering crisis is important because "...in a high technology society racked by fierce international competition, engineers' performances can decide the survival or withering of an industry: prosperity

and paychecks *or* unemployment and hunger." Strangely enough, the editorial does not directly mention national security as an area of concern related to the crisis; nevertheless, it is. The basic weapons strategy that underlies Western military posture is built upon the technological superiority of American aerospace, nuclear, and defense electronics systems as a counterforce to Warsaw Pact superiority of numbers in weaponry.

For ASTM, the areas of concern are obvious. Without strong, high-quality academic programs to support the work of the Society, the input of human technological skills into the activities of the Society will diminish. Ultimately, ASTM and its programs will suffer.

Approaches Towards Remedying the Crisis

Currently, several high-level attempts are being made to deal with these issues. On 7 April 1982, the National Engineering Action Conference (NEAC) was convened in New York City. NEAC is a relatively small organization of about 250 members. However, it draws its membership from among top-level representatives of engineering education, industry, government, and professional societies. NEAC is chaired by Edward E. David, Jr., President of Exxon Research and Engineering Company. The conference was attended by Vice-President George Bush, representing the Reagan administration. Other attendees were John Slaughter, Director of the National Science Foundation; Scott Matheson, Governor of Utah and Chairman of the National Governor's Association; George Keyworth, Science Adviser to President Reagan; Jim Beggs, NASA Administrator; Frank Carlucci, Deputy Secretary of the Department of Defense; and R. Q. Marsten, President of the University of Florida.

Its stated goals are (1) "to fill, with qualified faculty, the engineering faculty vacancies," and (2) "to make engineering faculty careers more attractive by enhancing the academic environment." NEAC members intend to carry out these goals by enlisting the support of their colleagues throughout the country. The NEAC organization is apparently not intended to be an ongoing working organization. Its primary role is to serve as a highly visible group that has the ability to focus attention on specific aspects of the engineering crisis, thus giving credibility to the perceived needs of engineering education.

Early 1982 was a significant period for establishing the parameters of the engineering education crisis and drawing attention to it on a national level. For example, the Industry/Founder Society Forum held in mid-January in San Antonio, Texas, was also concerned with obtaining solutions to the problem. This forum, sponsored by the "founding societies" of the American Society of Engineering Education (ASCE, AIChE, ASME, and IEEE), called for direct financial assistance from industry to provide salary increases for faculty, improved equipment, and increased graduate student fellowship aid.

Results and Responses

In view of these high-level attempts to focus attention upon the needs of engineering programs in academia, an examination of visible results obtained in the past year is helpful. There have been a number of large-scale gifts and donations made by corporate donors. A pacesetter donation of $15 million was made by Exxon Education Foundation during late 1981 to 66 different engineering programs. The gift, which provided for teaching fellowships and junior faculty salaries, was designed to deal directly with the shortage of classroom engineering teachers.

Following this gift by the Exxon Foundation, in March 1982 the Atlantic Richfield Foundation announced a similar program in the amount of $5 million to be used in support of doctoral students and junior faculty in selected departments of engineering and science at 30 universities. The program consists of 40 grants of $125 000 each. About one third of the selected institutions will receive two grants. Also in March 1982, the Amoco Foundation announced that it was expanding its initial commitment for engineering and geoscience doctoral fellowships to $5 million.

According to the *Engineering Times* (May 1982), the Du Pont Company announced a program to provide fellowships in chemical engineering, which brought its 1982 educational grants program to a total of $6 million. The 1982 grants program included support to life sciences, computer technology, and young faculty members in university science and engineering departments. Du Pont's total 1982 commitment was up by $1.3 million, from $4.7 million in 1981.

In late 1982, IBM Corporation announced a major grant of $50 million to provide cash and equipment grants to help universities improve their manufacturing engineering courses. According to the *Engineering Education News* (November 1982), "five universities, to be selected by the spring of 1983, will share more than $10 million in cash grants over a four year period to implement new manufacturing systems curricula at the master's degree level." In addition, IBM has committed itself to providing up to 20 CAD/CAM systems for the support of the manufacturing systems education programs of the selected schools.

Response of the Public Sector

The commitment of large amounts of funds by major private industries has been a positive factor in attempting to resolve the crisis. However, the public sector, both at the state and national level, has been much slower to respond. Although the state legislatures of Kansas and Nebraska have passed special appropriations to provide for salary increases to engineering faculties in their respective state universities, other states have been slow to follow their example.

At the national level, Representatives Don Fuqua (D-Fla.) and Doug Walgren (D-Pa.) have introduced HR582 (formerly HR5254), a bill intended to create a national policy for engineering, technical, and scientific manpower. The bill would provide federal funds to match those applied to engineering programs by private, state, or municipal sources. This bill has been in committee for over one year; it is not considered to be a high-priority legislative item.

Other Approaches

Hans Churney of IBM, quoted in *Engineering Education News* (March 1982), has offered the following simple solution to engineering educators with regard to the staffing problem on engineering faculties: "If you can't get the faculty, don't admit the students. The only reason you have a faculty shortage is because you allow too many undergraduates into your programs. If industry and government would feel the crunch, perhaps salaries for engineering professors would go up."

Churney's point has a certain amount of validity. Part of the difficulty in focusing recognition on the problems of engineering education has been created by the very resourcefulness of the educators in continuing to create graduates while coping internally with their own resource problems. The output of baccalaureate engineering graduates is currently running at about 64 000 graduates per year. A decade ago, the output was roughly one half this rate. Although engineering educators are generally concerned about the "quality" of their graduates, they continue to be hired by industry at increasingly higher starting salaries each year. It can be speculated that industry's concern about the crisis on the campuses might be substantially higher if the output of baccalaureate degrees were to hold steady or even decline for a period of time.

Another suggested approach is to charge a "realistic" graduation fee to those students who are receiving their degrees. Today, the typical fee paid upon application for the degree ranges from $3.00 to $25.00. If the amount were raised to about $3000 to $5000, with all of it reverting back from the campus bursar's office to the engineering budget, this would have a significantly beneficial effect upon engineering programs. Many critics of this approach would quickly point out that this is an exorbitant, even outrageous, fee. On the other hand, it is not at all unusual for a newly graduated engineer to purchase a new automobile with a price tag of $10 000 for a basic sedan or $25 000 for a sports model. The value added to the graduate by the engineering degree is the economic lever that makes this purchase possible.

In a typical land grant institution with 300 graduates, a graduation fee of $3000 would generate almost $1 million of additional revenue to a typical engineering college annual budget of perhaps $5 million. This incremental revenue would be sufficient to resolve many of the faculty salary, capital equip-

ment, and other budgetary problems with which the engineering programs are currently faced. In addition, it would diffuse the cost burden to industry of supporting engineering programs, which presently appears to be falling disproportionately upon the larger (and more magnanimous) corporations. For example, the new graduate could negotiate with prospective employers on the basis of both starting salary and payment of the graduation fee. The employer might offer to pay either a percentage or all of the fee, depending upon the attractiveness of the new graduate's qualifications. This is not a new feature for corporations; many of them already willingly pay finder's fees to commercial employment agencies which range from 25 to 40% of the first year's salary for a new employee.

Summary

The crisis in engineering education is a quiet one. It is, after all, not in the nature of engineers and the engineering profession to be clamorous and strident in their approach to solving problems—even their own. Engineers appear to take their collective image as thoughtful, analytical, logical types more or less seriously. It is interesting to speculate how other academic disciplines, such as sociology, economics, or marketing, might respond to the same stimuli and perceptions.

Nevertheless, however quiet, the crisis in engineering education is real and its impact on the quality of engineering programs in this country, particularly at the graduate level, is adverse. No doubt, many engineering deans, in their few reflective moments entertain fantasies of "magic bullet" solutions: massive aid from industry, large-scale support from new federal legislation, or some combination of these. Unfortunately, neither approach appears to be in the offing. The "band-aid" rather than the "magic bullet" appears to be the tool of necessity for engineering educators until some great national need, some great counterpart to the space program and the energy crisis, emerges. In that case, in the words of Representative George Brown (D-California), "We'll lose years trying to rebuild."

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