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Presidential Address

AMERICAN SOCIETY OF CIVIL ENGINEERS

ENGINEERING EDUCATION — THE NEXT TEN YEARS

Presidential Address of Frank E. Perkins[1]

Introduction

It has been the recent practice of outgoing BSCE Section Presidents to use the occasion of this message as an opportunity to summarize the past year's accomplishments and to identify future challenges facing the Section. I would like to break with that practice and return to an earlier tradition in which the President uses this message to present a technical or professional paper of general interest to the Section. To that end, I would like to share with you some thoughts that derive from my personal experience and observations in the field of engineering education. I shall title these remarks, "Engineering Education — The Next Ten Years".

My remarks are based, in large part, on a talk entitled, "Trends in Engineering Education" that I delivered recently to the Fellows of the American Consulting Engineers Council. I apologize to those who may be hearing these remarks for the second time; however, I believe that they are relevant to all members of BSCES for at least two reasons:

1. Our members are dependent on the output of the engineering educational system for their future engineer colleagues and employees; therefore, they should have an interest in what they may expect to receive from future graduates of the educational system.

2. Several current trends in engineering education imply an even larger educational role for companies, professional societies, and individual practitioners than has existed in the past. We should be preparing for this role.

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[1]Presented at Part I of the Annual Meeting of the Boston Society of Civil Engineers Section, ASCE, April 21, 1981.

The Engineering Education System

The engineering education system is subjected to and responds to a variety of external and internal forces as it attempts to meet its several objectives. At any point in time, the nature of the system depends on the type of compromise that is established among these multiple forces and objectives, and the changing future of the system is driven by changes in the compromise that is reached. Thus, before describing some of the changes that may be expected in the next ten years, it is well to review some of the important objectives and forces around which a compromise system develops.

Our engineering education system has at least four major objectives:

1. *Training for Present Practice* - This is perhaps the most obvious objective and ensures that graduating engineers have some minimal level of training that permits them to be immediately useful in their initial employment.

2. *Preparation for Future Practice* - The System must ensure that its graduates are prepared for further development in the future. This is the objective that argues for an education based on underlying principles which will allow the practicing engineer to enter graduate study, participate in a program of self-education, and adapt to the changes in practice that inevitably occur during one's career.

3. *Education for Other Fields* - Significant numbers of students use their undergraduate engineering education as an entree into other professions such as law, medicine, business, etc. The presence of large numbers of such students, as occurred in the late 60's and early 70's, can drastically alter the type of engineering education that is sought.

4. *General Education* - Our engineering education system in the U.S. operates on the assumption that it is responsible for the broad liberal education of its students as well as for their technical education. In addition, the system should (although it has not always done so successfully) be responsible for the technical literacy of nonengineering students.

In attempting to strike a compromise among these somewhat conflicting objectives, the engineering education system responds to a multiplicity of forces. Among the most important sources of these are the following:

1. *Industry* - As a principal employeer of engineering graduates and a source of financial support, industry has a potentially major role to play in shaping the engineering education system. In some fields of engineering, e.g. chemical engineering, the provision of major financial support has led to an attendantly large influence on the educational system. In the field of civil engineering, such support and influence have been relatively smaller.

2. *Government* - The Federal government, through its support of sponsored research ever since World War II and more recently through its student loan and fellowship programs, has become a major force influencing the engineering education system. Government at all levels is also a major employer of civil engineers.

3. *Students* - Choices made by students, largely in response to societal pressures, are another major force acting on the system, as witnessed, for example, by the shift away from engineering in the late 60's and early 70's, and the more recent explosion of undergraduate enrollments in engineering. These, and other shifts in student interest, are translated rapidly into changes in the education system.

4. *University* - The university, in which much, but not all, of the engineering education system is based, provides its own internal forces. Principal among these are the internal reward system for faculty and students and the financial climate in which the system operates.

As noted earlier, the system changes in character with time in response to these forces. At the present time one may identify several changes which have occurred recently and are now firmly established. I would include among these the following:

1. A return to a more structured curriculum with more emphasis on fundamentals, greater concern for professional practice, and fewer individual options.

2. A reduced interest in graduate study, especially at the doctoral level, among U.S. students.

3. A growing difficulty in attracting U.S. students into the teaching profession.

4. An increase in undergraduate engineering enrollments to all-time high levels.

With these thoughts as background, let me turn to the future. Forecasts about a system as complex as the engineering education system are difficult at best and potentially very much in error if the forces identified above evolve in unexpected ways. Nevertheless, current trends and events are sufficiently clear to permit me to make a number of predictions with some reasonable expectations concerning their accuracy.

The Next Ten Years

Those changes which I expect to be particularly important over the next decade are of two general types. The first are those topical areas in the curriculum which will receive increased emphasis in response to a variety of external and internal pressures which have been growing in importance for several years and which now appear to be on the verge of finally receiving major serious attention by the engineering academic community. The second group of changes are those which result from or are part of the changing environment in which engineering education will take place in the next few years. Both types of changes — viz., areas of increased emphasis and environmental changes — are, of course, strongly related to one another.

Those areas which I expect to receive increased emphasis within the formal curriculum are three in number:

1. *Design* - During the 1960's and 1970's, greater emphasis was placed on the teaching of underlying principles and theory, frequently at the expense of current applications and design. While the reasons for these changes were defensible and the teaching of design had atrophied in many schools, it is now generally recognized that the processes and concepts that make up "design" are fundamental to engineering and must play an integral part in engineering education. New approaches based on computer-aided design have long held out the promise of a revolution in the teaching of design; that revolution now appears to be on the verge of occurring.

2. *Management* - It is widely acknowledged that a large fraction of engineers in practice devote major parts of their time and energy to activities which are broadly classed as management. In recognition of this fact, many engineering students have selected elective subjects from management school offerings, and some curricula have introduced a token subject in engineering management. Now, however, there is a growing emphasis on the establishment of formal programs of study in engineering management. These are typically offered as joint ventures between a university's engineering and management schools. I expect the development and attractiveness of such programs to increase during the next decade.

3. *Writing* - Engineering schools (and universities in general) have been severely criticized by employers in recent years for producing graduates who are inadequately prepared in the art of writing. It is generally believed that the writing problem has its roots in the secondary schools and society's reliance in television, and that the university education should somehow correct these deficiencies. It is my belief that engineering schools are at long last beginning to take this challenge seriously. In particular, it is now recognized that in order to be successful, a concern for writing must be given high priority by engineering educators, and they must take the principal responsibility for implementation. Writing programs offered in English departments may be helpful adjuncts and can be highly successful when offered jointly with engineering subjects, but real success is most dependent on the existence of engineering faculty members who are able to address the problem directly. I sense that engineering faculty will pay much greater attention to this issue in the coming decade.

I noted earlier that the environment in which engineering education takes place is also changing. In the following subparagraphs I list several of these changes that I consider to be of special importance to developments in engineering education during the next decade.

1. *Computers* - The potential role of digital computers in engineering education has been recognized for at least 20 years. Much of that potential has been transformed into reality with significant impacts on the engineering education system. However, some of the most dramatic possibilities, particularly those in the areas of interactive learning and computer-aided design, have been seriously hampered by cost and accessibility constraints. It now appears that these constraints are likely to be greatly reduced during the past few years because of continuing dramatic developments in microprocessor and computer graphics technology. Engineering students should in the near future have greatly expanded access and much improved interaction with a variety of computing devices, including those equipped with appropriate graphics and word processing capabilities. A major challenge to the education system will be to make more effective use of these facilities that has been realized to date.

2. *Continuing Education* - Students graduating today from engineering schools are choosing less frequently to enter directly into graduate study. This is occurring at a time when the increased sophistication of engineering practice is creating a demand for more advanced levels of engineering education. During his or her career, engineers are increasingly likely also to move into new areas where additional technical and managerial training is essential. Even the prospect of

relicensing engineers at various points in their career has received serious consideration. These, and other factors, point to a potentially large increase in the role of continuing education in the engineering education system. Although many successful continuing education efforts are already in existence, I anticipate that the demand for such programs will grow to the point that they constitute a major component of our engineering education system. At the same time I expect that new forms of joint efforts involving academic institutions and industry will be required if these efforts are to be maximally effective.

3. *Industry-University Interaction* - Many universities are currently heavily dependent on Federal government money for their support of students, laboratories, and research programs. That government-university relationship has been responsible for many changes in the engineering education system, many of which are viewed as positive and desirable. However, two aspects of this relationship appear to be changing simultaneously. First, many segments of industry complain that their interests and points of view are not heard by educators because of the preponderant weight of government support. The response from some industries appears at last to be a recognition that industrial support of engineering education can take many forms and is essential if the private sector point of view is to be heard. Second, the threat of large reductions in Federal support to educational institutions looms ever larger. These anticipated reductions make the importance of industry support even more crucial. I anticipate a decade ahead in which the need for and possibility of industry-university interactions is greatly increased. I personally welcome this as a desirable change in the environment.

4. *Secondary School Issues* - One of the greatest concerns to the engineering education system are recent studies of deficiencies in secondary school education in the United States. These studies seem to imply that the meeting of future demands for engineers in our technological society may be most seriously constrained by the failure of secondary schools to produce sufficient numbers of graduates adequately trained in mathematics and science. Should these forecasts prove to be correct, it is clear that the production of new engineers by our engineering education system would be constrained in terms of quantity and/or quality. The subsequent implications for U.S. industry and for possible new forms of continuing education are self-evident. I have great confidence that market forces thus generated would eventually work to rectify the situation but not without serious impacts on industry and the educational system.

Concluding Remarks

Before closing, I cannot pass up this opportunity to say a few words about the 1980-81 year for the BSCE Section. You may recall that I set five specific goals for the year. Major progress has been made toward four of these.

1. *Membership* - The Membership Committee has been aggressive in its attempts to attract new members and has met with considerable success. An important new effort to attract affiliate members was launched and has begun to produce noticeable results.

2. *Journal* - The Publications Committee reaffirmed the desirability of continuing the BSCE Section *Journal* and put forward a series of recommendations for improving the quality and financial viability of this publication. These recommendations were adopted and have already given the *Journal* a new vitality.

3. *Western Massachusetts Branch* - An effort was made to acknowledge increased enthusiasm among Western Massachusetts Branch members and to provide more tangible support for their activities. The Branch responded with an expanded program and increased participation in the Board of Government.

4. *Energy* - The ad hoc Energy Committee increased its programming efforts during the last year by cosponsoring three meetings with technical groups and one luncheon meeting. The Committee also prepared and published a draft Energy Policy Statement.

The fifth goal, that of establishing a new activity in the area of engineering management, was not successfully initiated. However, a small cadre of interested persons was identified. I remain optimistic about the prospects for future activity in this area of growing importance.

An anticipated, but unwelcome, added concern was generated by the continued impact of inflation on the Section's financial operations. The failure of investment income to keep pace with inflation and the long-term failure of the Section to add significantly to its endowment are serious problems that have not been resolved. Fortunately, the impacts of these problems have been somewhat alleviated by the magnificent efforts of our technical groups in sponsoring lecture series in recent years. In the past year the Hydraulics and Geotechnical Groups sponsored lecture series that were tremendously successful from both an educational and financial point of view.

Finally, I wish to thank the many dedicated members who have contributed in numerous ways to the successful operation of the Section during the past year. Time does not permit me to name and thank each of you personally, but please know that your efforts are important and are appreciated.

I must, however, acknowledge the special debt that I owe to our Vice-President, Dr. Edward Kinner, who shouldered such a major part of the load, and to our Executive Director, Ms. Susan Albert, who kept me on target throughout the past year.

It has been a pleasure to serve as your President. I look forward to continued participation within the BSCE Section in new roles in the future.