

ON THE PROFESSIONAL EDUCATION OF ENGINEERS

Dean M. L. Rudee

University of California, San Diego
La Jolla, California

There is no shortage of suggestions for what needs to be added to engineering curricula. I have received advice to include the following list of additions: more writing, oral communications, study of other cultures, TQM, more quantum mechanics, design for manufacturability, a first year design experience, foreign language, study abroad, economics, practice in teamwork, more humanities, etc.

In fact, our existing programs are overburdened and highly constrained, and the average time to degree exceeds four years. Yet, I hear few suggestions of what to eliminate.

Much of this dilemma is created by engineering education's continued use of the BS as the first professional degree.

A century ago engineering required one of the most extensive academic preparations of the professions; longer than medicine and dentistry. It now requires as short an academic preparation as any. For example, architecture requires at least a Bachelors of Architecture, a one year post baccalaureate degree. More commonly, the schools of architecture are moving to a longer Master of Architecture as the first professional degree.

Many engineers express concern for the apparent low status of the engineering profession. This perceived decline in the recognition for engineering may be related, in part, to engineering's own choice of the BS as an appropriate professional entry point.

Given its nature as a professional degree, it is not surprising that the maximum amount of technical material is crammed into the BS at the expense of flexibility and breadth.

ABET only requires a total of two and one-half years of science, mathematics and engineering. It is not immediately evident why the typical engineering program has expanded to fill almost the entire undergraduate program of study. It seems likely, but this is only conjecture, that the

recognition by faculty and ABET examiners that this is a professional degree has led to a situation of maximizing the requirements to require the student to achieve the highest level of professional preparation possible within the nominally four year curriculum. This tendency is intensified by the "weakest link" methodology required of ABET examiners in which a program is judged not by what most students actually take, but rather by the least rigorous path by which a student could thread through the requirements. This weakest link is measured by reviewing actual transcripts, as well as by analyzing the stated degree requirements and actual course outlines, reading lists, examinations, homework assignments, etc.

There appear to be three responses to this situation:

1. Do nothing. A defender of the *status quo* can make a good case that the present set of requirements is a reasonable trade-off between the competing demands on a four year *professional* program.
2. Make engineering a five year bachelor's degree. I recommend against this change. Such a change would cost students more time and money to achieve a degree that can be achieved in four years. Also, it is unlikely that employers or graduate schools would give such a degree any additional recognition. *A de jure* five year bachelor's in engineering has been tried at several major universities over the years (Cornell, Ohio State, and Rice among them) and abandoned when their enrollments declined. A five year bachelor's program would also ignore efforts by various state officials, university leaders, and parents, to reduce the actual time for a bachelor's degree to four years.
3. Make a master's degree the first professional degree in engineering. I recommend this option.

In this model, the BS would be a more flexible degree that would require somewhere around the minimum number of technical courses that ABET actually requires. The general education program could be enhanced, and the student could be allowed a meaningful number of free electives. It would not be accredited. These electives could be selected on the basis of the students aspirations. For example, the choices of electives would properly differ between those students expecting to take non-technical positions in business immediately after the BS, those students anticipating going to business or medical school, or those aiming for more education in engineering.

For this latter group, I suggest two tracks; the existing research oriented MS and Ph.D., and a truly new accredited professional Master of Engineering degree.

The Master of Engineering degree should include advanced course work and team design experience. This degree would emphasize the scholarship of integration. It would focus on issues now recognized to be important additions to engineering for enhancement of the nation's competitiveness.

The existing post-baccalaureate programs that emphasize the scholarship of discovery and lead to a Ph.D. are functioning well, in my opinion, and should not be significantly altered. They, too, are required for the nation's future.

The advantages of adding a Master of Engineering as the first professional degree are:

- It de-professionalizes the bachelor's degree. Thus, faculty and ABET examiners would be more willing to consider a flexible degree that approaches the ABET minimum loads than do the most current programs. Such programs could then approach the flexibility and breadth that are advocated by many thoughtful critics of the current undergraduate engineering programs.
- It places engineering on a par with virtually all other professions that require a post-baccalaureate degree to receive professional recognition, e.g., law, medicine, architecture, social work, urban planning, and psychology.
- It would lead to a degree that would be valued by employers, unlike a *de jure* five year bachelor's.
- It would increase the number of US citizens and permanent residents who begin graduate study.
- It would give engineering programs graduate enrollment credit for some of the intensive, professional classes and design experience that currently are only given undergraduate credit.
- It allows students not seeking a highly technical career to terminate with a bachelor's degree that is likely a better background than are current degrees for business school, medical school, sales, etc. These are career options selected by many engineering graduates.
- It would make the baccalaureate degree in engineering attractive to a wider range of students.

