

Revisiting the Question of Why Four Years

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Introduction

Over the years, there have been many programmatic models proposed and many voices calling for a degree program, at least five years in duration, as the minimum required for a professional degree. The proposals have generally recognized the need for dramatic changes in the way in which engineers are educated. The following introduction is excerpted from the author's paper "Why Four Years" that appeared in ASCE's Journal of Issues in Engineering, Education and Practice in 1991¹:

There's an old Bob Newhart routine about baseball. In it, an adult game manufacturer is talking on the phone to Abner Doubleday who is explaining the rules of his new game, baseball. Doubleday explains, "Three strikes and you're out, four balls" "Why four balls?" asks the manufacturer. Why, indeed?

The engineering curriculum, leading to a Bachelor of Science degree, has been a four-year program at most institutions for as long as they have offered degrees. Programs that required longer eventually found it difficult to compete for students. In the 1950's and early 1960's, most five year programs in existence were being phased out as the engineering programs, in general, were reducing credit requirements. The reduction was accomplished by elimination of many skill courses (such as drafting). Also, certain courses were pushed back to high school. When this transition was taking place, many engineering educators justified the reduction in credits by arguing that a Master's degree would become the minimum requirement for entrance into the profession. While some schools at the time adopted a professional program, they were few and far between.

In 1958, ASCE conducted a survey in which 66 percent of its membership favored extending the civil engineering curricula to five years². In 1960, the ASCE Conference on Civil Engineering Education addressed this subject extensively³. A group of 30 eminent civil engineering educators adopted the following resolution:

Resolved that "the growth in universities and colleges of a pre-engineering, undergraduate, degree-eligible program for all engineers —with at least 75%-- interchangeably among various engineering curricula, --be followed by a professional or graduate CE curriculum —leading to the first engineering

degree, with a CE degree awarded only at the completion of the professional or graduate curriculum." ^{3,4}.

Despite the overwhelming acceptance, implementation was sparse. Educational requirements and methods are cyclical. Those in education for any substantial time, at all levels, see curricula fluctuating between flexible and rigid ⁵, requirements (such as credits) increasing and decreasing, educational delivery systems preaching hi-tech and reverting to traditional, and etc. Several years ago, the author, noting the pressure of increasing credits on the four year program, posed the question "Why Four Years?" At the time, ABET requirements were essentially bean counting.

In a discussion to the "Why Four Years?" paper, Dan Pleta observed that ⁶:

As the author notes, schools then jettisoned skill courses and pushed beginning calculus back into high school to make room for advanced material. Unfortunately, colleges also reduced the 144 credit hour requirement to more nearly liberal arts standards as engineering enrollments decreased. The 5-year baccalaureate programs of the 1950s that he mentioned were, in the writer's opinion, an excellent idea except for one defect. They should have awarded the M.S. degree then. Had they, all schools today would be regarding it as the first designated degree for entry into the profession. The 1968 ASEE Goals Study did recommend that, but its suggestion was also ignored.

Curricula in accredited engineering programs is definitely influenced by ABET. It has been the author's experience, from the viewpoint of both a faculty member and an ABET visitor, that programs quickly reflect changes in ABET requirements. ABET's requirements for the new millennium are outcome based. This comes at a time when several programs have or will be actually cutting requirements (e.g., California's legislature limiting all undergraduate degree programs to 120 credits). It, therefore, seems appropriate to revisit the question of "Why Four Years?"

1980's Curricula

Throughout the country, four-year programs were becoming more and more rigid and were generally in excess of minimum ABET requirements for total credits. This was due; in part, to external pressures, primarily exerted by evolving ABET criteria. Many programs were so tight that additional requirements often extended the completion time. Although many programs still had elective courses, these electives were increasingly forced into satisfying certain ABET categories. For instance, many schools, under ABET scrutiny, were shown to be lacking in engineering design credits. Most institutions, so identified, changed their programs by eliminating free electives in favor of electives or required courses having design content. Many schools added a capstone design course.

Simultaneously, internal pressure was often exerted from the rest of the university on the engineering curriculum. The national thinking in education, at all levels, was moving toward ever-increasing core requirements in response to, "why isn't Johnny learning _____ (fill in

the blank)?" At the university level, this often lead to more required courses for all students. For instance, over a period of a few years in the 1980's, the UConn University Senate mandated the following additional requirements:

- a minimum of two courses (beyond two freshman English courses) that require writing,
- a minimum number of courses involving computer usage and math,
- a course in western history,
- a course in non-western culture,
- a course in philosophical and/or ethical analysis,
- a course in social scientific and comparative analysis,
- one year of a single foreign language if three years were not taken in high school,
- two courses in literature, and
- two courses in science and technology.

Many of these requirements were easily absorbed into the existing programs at UConn, but others required the virtual elimination of free electives within the program. The pressure for additional requirements is still not complete.

Responses to the 1995 Position Paper

Every five years since the 1960's, ASCE has held an education conference. It is interesting to look at the content of the conferences. The same issues seem to continually surface, including the issue of the length of the program. Prior to the 1995 conference, there was a call for position papers. The author posed the question of "Why Four Years" in one of the position papers. This topic had the most written responses and was a prime issue at the conference. While this conference focused on civil engineering education, almost every discussion, observation and recommendation concerning the length of the program are applicable to all engineering programs.

Many responses to "Why Four Years?" presented at the 1995 conference were subsequently published in 1996 in a special forum section of ASCE's Journal of Issues in Engineering, Education and Practice⁷. For instance, Peter Hoadley wrote⁸:

The position paper "Why Four Years?" written for the ASCE 1995 Civil Engineering Education Conference, received more responses than any other position paper. This issue is very "hot" right now. ABET, ASCE, ASEE, NSPE, NCEES, and the state registration boards are again studying the question - probably more seriously than ever. The issue is broader than the title implies. Interrelated and intertwined are additional questions such as dual-level accreditation, first professional degree, practice-oriented MS/ME programs, 3/2 BS/MS programs, and degree requirements for P.E. licensure. To some extent, the question is no longer whether the first professional degree be four years or five, but rather the following:

- Should the B.S. engineering degree be a broadly based preprofessional degree?
- Should the first professional engineering degree be a Master's degree?

- Should the professional engineering Master's degree be practice-oriented and an advanced technology degree?
- Should the professional Master's degree be the M. Engr., and should the Master's degree be the M.S.?
- Should institutions be allowed to accredit programs at both the basic (B.S.) and advanced (M. Engr.) levels?

Professor Hoadley believes that the answer to all of the questions is yes and so does the author. He goes on to state that, in his experience, it is becoming more and more difficult to find one of the "movers and shakers" in the civil engineering profession (owners, presidents, partners, principals, division heads, project managers, etc.) without a Master's degree. So, the marketplace probably has already answered the questions posed and it is now up to the professional organizations and others to catch up.

Another response to the position paper reiterated the contention that the current degree is four years, in name only. Professor Donald Anderson of North Dakota State University wrote ⁹:

In his paper, Professor Epstein revisits an ongoing, however viable, issue regarding a 4-year versus 5-year engineering program. At best, many schools now have a nominal 4-year program. The program is shown on paper as four years, but in reality, most students take longer to complete the degree requirements. Experience with our students at North Dakota State University indicates that only three out of 65 students from combined 1990 and 1991 classes finish within exactly four years.

Professor Anderson's goes on to say that marketing of a longer program, the real costs and the potential of losing a larger percentage of potential engineers to other fields are all factors that work against lengthening the program. His experience, regarding the time to finish, parallels the author's at The University of Connecticut as well as many other institutions. At one UConn graduation, ten years back, only 1 of the 26 civil engineering graduates completed the program in only four years. This number was particularly low, but other years and other engineering programs at UConn show very few students finishing in four years, the average being approximately four and a half.

Back in the author's undergraduate days (the 1960's), finishing the 4-year program in four years was the norm. There are many reasons why this is no longer so, including:

- Many programs have increased credit requirements
- Rigid programs have made it difficult for transfer or brancher students to have all credits counted
- Failing grades, missing prerequisites and any pre-college deficiencies make 4-year completion problematic
- Many students work during the school year (increasingly evident with student loan cutbacks)
- Many students prefer not to take full loads (averaging 16 or more credits per semester at many schools)
- Many students now opt for co-op experiences and then stay on to work part-time

One of the responses to the position paper reported polling 17 engineers working in a particular firm. They "voted" 6 for a 5-year program and 11 for a 4-year program¹⁰. Their written comments to the question included:

- * A five-year program would not greatly benefit the student, but might deter students from pursuing a civil engineering degree because of the extended length of time.

- * I believe the best alternative is not more than what is learned in a 4-year engineering program, but the practical exposure of engineering students to actual field experience. This will lengthen the curriculum to five or more years and lead directly to a professional degree, with some preprofessional degree awarded along the way as suggested.

- * I favor extension of the program to five years. The 5-year graduate should be better educated in the technical aspects than the 4-year graduate, thus making them a more valuable asset in the industry.

- * The curriculum should be, or maybe, needs to be reevaluated and restructured. In these hard economic times, the universities should help students finish learning well as quickly as possible to help them begin to earn. I am in favor of a 4-year program when it is well taught.

- * I would support the fifth year only if at least 50% of the additional credit hours were committed to courses in the humanities and/or business.

- * Leave the course requirements possible to do in four years if a person has the smarts. Most people now take five. Extending to five years means most will then take six years. Most smart students go on to grad school anyway, so that leaves the 2-2.8 GPA students who require five years. Therefore, leave it as it is.

- * I would personally vote for improvement in curriculum, real-world exposure of the student, and greater emphasis on quality by colleges and industry, rather than adding course work. The author's point is well made, and improvement in quality in the profession is a must.

- * I would support a 5-year CE program, but I would prefer a different approach. It would be more practical. (I would) require the Master's degree for registration and push for ABET accredited Master's programs.

- * If the program is lengthened to five years, it will take up classroom space and prevent incoming high school graduates from entering the program.

This last comment is probably the only one that the author hasn't heard, in some form, before. The point is well taken. If engineering programs are currently operating near capacity (few are) than there could be a real strain on resources. However, programs that currently offer a Master's degree should see little effect, except for fuller classes in the fifth year. However, there certainly will be increased costs to both the student and the universities. Speaking of costs, one response to the position paper asked¹¹:

And who is going to pay for that fifth year? There are only two choices, the

student and the taxpayer. How many bright students will choose another major because of the cost of a 5-year program? Is this additional financial burden on our public colleges and universities justified?

For those engineering students whose career paths are firmly fixed in their minds, advanced degree programs are available, if they wish to avail themselves of these opportunities. But as a foundation for a productive and rewarding career in civil engineering, it is unclear to me that a 5-year undergraduate curriculum is either necessary or desirable. To me, it seems that the Society, the profession, and the educational community could better utilize their scarce resources by addressing other needs.

What Now?

Engineering continues to be the only profession where only four years of college preparation are required for practice. With professional societies now becoming more vocal in their support of some sort of five-year program, the professional school is an idea whose time has come, again. If the existing program isn't truly a four-year program anyway, the extension to a five-year program should be relatively painless. This is especially true if the program requirements are made reasonable.

It is proposed here that a five-year program leading directly to a Master's degree should be the minimum professional degree. The program should contain approximately 140-152 semester credits. This averages out, over ten semesters, to a credit load that gives a greater possibility of completion on time. More flexibility should automatically follow such a program once ABET evaluates the caliber of the graduates. It is further suggested that some credits be assigned to any significant cooperative education experience. For instance, if eight credits were obtained for a significant six-month experience, the remaining semesters would only need to average fifteen or sixteen credits, and graduation could still be on time.

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