ACREDITATION

Changes Are Needed

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The primary purpose of accreditation of undergraduate engineering programs is to protect students by assuring a set of minimum academic standards. A secondary purpose is to protect the public, companies, governments, and professional engineers themselves from employment of ill-qualified individuals, which is to say anyone who graduates from a program that is not accredited. This purpose will always be secondary, for no program can guarantee the qualifications of every graduate. That is the purpose of licensing, whereas accreditation is simply the academic equivalent of the Good Housekeeping Seal of Approval.

There is a price to be paid for accreditation, and it is therefore appropriate to ask if we gain as much as we lose by the accreditation process and to examine what can be done to overcome some of the negative aspects of accreditation. The four principal benefits of accreditation to a department are:

1. It is an asset to enrollment. Students seek to enroll in accredited programs. (In some states one must be a graduate of an accredited program in order to take the E. I. T. exam.)

2. Accreditation suppresses competition. Accreditation is usually necessary for survival of the program, but developing the resources necessary for accreditation is expensive and, therefore, not easily undertaken.

3. Accreditation protects its graduates from quacks, charlatans, and graduates of non-accredited programs who seek the same jobs. That is important. Most companies that hire BS chemical engineers do not hire them from non-accredited programs. On the other hand, most companies do not need accreditation to tell them what programs are of high quality, so this consideration is of little importance.

4. Accreditation affects the administration's view of the department and, therefore, its budget. That is, of course, important, but should be regarded as a necessary evil in the sense that Program A needs accreditation only because it might otherwise be regarded, sometimes even by the Dean, as inferior to accredited programs B, C, and D. This argument cuts both ways; in some cases an accreditation report that faults a department might result in decreased support, while in other cases threatened loss of accreditation might result in increased support to remedy deficiencies.

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The sacrifices a department makes for accreditation are these:

1. It is a modest direct expense. The current minimum cost of accreditation is $1025, plus $1025 for each pro-
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gram, plus $50-150 per year, plus other miscellaneous charges.

2. It is a large indirect expense and a gigantic headache for the department. Extensive documentation of every aspect of the department as well as supporting facilities and departments is required. Hundreds of hours of faculty and staff time go into the preparation of the required reports.

3. Many faculty members spend much time on ABET committee work or act as program evaluators. Through a sense of obligation to the profession, they sacrifice valuable time to undertake these tasks (and they deserve more credit and thanks than they usually get).

4. The fourth cost, and by far the most important, is that accreditation requirements place constraints on curricula that unduly limit creative experimentation in curriculum design and that severely limit the capacity of departments to respond to changes in the profession. Moreover, present requirements leave almost no time for electives. This cost is borne not only by departments but by their students and the profession as well.

The remainder of this paper concerns certain negative effects of accreditation on chemical engineering curricula and what might be done to make improvements.

We all know that chemical engineering is a dynamic profession. It is constantly changing, but the rate of change, like that of evolution, is uneven. Periods of slow change are punctuated by periods of sudden change, such as the one we have gone through in the past five years. Chemical engineering education must change too or it will become irrelevant and die. Indeed, signs of change in curricula are apparent. Many departments have made, or are about to make, changes in curricula in response to recent changes in the profession, and the “Amundson Report” will certainly stimulate more.

The central theme in most of these revisions is increased flexibility—more options for the students. A thoughtful and provocative article on this theme appeared in the spring 1987 issue of Chemical Engineering Education by Richard Felder and entitled, "The Future Chemical Engineering Curriculum—Must One Size Fit All?" Professor Felder argues persuasively for flexibility in the curriculum. He asks why not “abandon the pretense that all of our students have the same needs and can therefore be served by the same curriculum, give or take a few electives?” He then proposes some steps towards restructuring a chemical engineering curriculum. Neither he nor apparently anyone else, however, is proposing radical changes. The basic chemical engineering material will still be there, but there is obsolete material in our curricula that should be removed. In fact, in the same issue Phil Wankat has some suggestions as to what should be removed to make room for new material.

No two chemical engineering faculties are alike, and so if the curricula of many departments are restructured, there will inevitably be less uniformity among departments than there is now, and therein lies the rub with accreditation. Can accreditation requirements accommodate the range of changes discussed in the Amundson report now being considered by many departments? The answer is no. What will happen instead is that no department will wish to endanger its accreditation, and the rigidity of the ABET requirements will severely restrict the scope and implementation of those changes.

For many departments the principal accreditation problem centers on the ABET engineering science requirement, which is one year or thirty-two semester credits of a narrowly restrictive definition of engineering science. There are two subsets of problems here: the distinction between engineering science and basic science on one hand and between engineering science and engineering design on the other. We will look at each. First, the engineering science/basic science problem.

One of the great strengths of chemical engineering curricula is that their graduates are adaptable to a wide range of technologies and, moreover, are able relatively easily to change career directions in midstream. They are able to do so because they are well-grounded in basic science and fundamentals. Compared with other engineering disciplines, chemical engineering students take about the same amount of math and physics but a vastly larger amount of chemistry (typically twenty-six semester credits versus about four for other disciplines). But the heavy dose of basic science takes a big chunk out of the curriculum. In fact, basic science and engineering science together take up almost exactly two years, or one-half of the curriculum.

The reason that engineering science is a problem
lies in its ABET definition and the interpretation of that definition by evaluators. The relevant words are:

The objective of the studies in basic science is to acquire fundamental knowledge about nature and its phenomena, including quantitative expression. The engineering sciences have their roots in mathematics and basic science, but carry knowledge further toward creative applications. These studies provide a bridge between mathematics/basic sciences and engineering practice. While it is recognized that some subject areas may be taught from the standpoint of either basic science or engineering science, the ultimate determination of engineering science content is based on the extent to which there is extension of knowledge toward creative application."

Clearly, the foregoing definition requires judgment, and opinions will differ. However, the guidelines of the Engineering and Accreditation (E&A) Committee of the AIChE state that: “Instruction in this category (engineering science) will ordinarily be given both by the chemical engineering faculty and the faculty of other engineering departments.” Therefore, although the disclaimer “ordinarily” is in place, the practice of some accrediting evaluators has been to define basic science as science taught in basic science departments and engineering science as science taught in engineering departments, and in practice it is rare that a course taught outside of an engineering department is allowed to count as engineering science.

The E&A Committee is, of course, aware of this basic science/engineering science problem and has taken four steps to alleviate it. The first and most important step was taken some years ago when 1/5 year of advanced chemistry was allowed to count toward the engineering science requirement, i.e., it could be double counted as engineering science and advanced chemistry. That simple idea was a great help to curriculum planning and flexibility.

The next step was in December 1984 when Bryce Andersen, then chair of the E&A Committee, wrote a memo to all chemical engineering department chairs on the subject, “A Possible Change in the Chemical Engineering Program Criteria.” The memo said that the committee was considering a change in requirements and asked for comment. The proposed change was to allow 1/4 year of advanced science, instead of 1/5 year of advanced chemistry, to count as engineering science.

The proposed change was a step in the right direction but was too small to be significant. It meant that and additional 1-1/2 semester credits, i.e., about 1/2 of a course, could be counted as engineering science. A better choice would be to permit 1/3 to 1/2 year of advanced science to count as engineering science. There are two reasons for this suggestion. First, basic science and engineering science are sometimes difficult to distinguish. There are, of course, extremes of science and applied or engineering science, but there is also a huge range of grey in between that often makes the distinction irrelevant. Today, many courses in such disciplines as chemistry, physics, biochemistry, and even genetics, microbiology, and applied mathematics, are more applied, more engineering-oriented, than are other courses in those departments, i.e., these courses contain a substantial element of engineering science. Second, chemical engineers pride themselves on their flexibility and their ability to change the direction of their careers in response to the vagaries of the job market. This flexibility can only be provided if the chemical engineer has a strong background in fundamentals. As new technologies develop, this flexibility becomes ever more important.

The change of 1/5 to 1/4 year proposed by the committee was put into practice except that only advanced chemistry, not advanced science, was allowed to count. Strong letters of support from several department chairmen urging a change to 1/3 year did not affect the committee decision.

The final two changes to increase flexibility occurred just last year. One was to combine the math and basic science requirement. Instead of 1/2 year of each, the requirement is now one year of both, provided the math includes differential equations. That is an ABET requirement applicable to all engineering disciplines. But since chemical engineering has so much basic science, the new requirement amounts to allowing a decrease in mathematics. That provides a little flexibility, but not much. Most chemical engineering departments probably will not reduce their math requirement.

Finally, the latest change in requirements allows certain courses to qualify as advanced chemistry. The wording is: “If a course deals with changes in composition, structure, and properties of matter at an advanced level, then it may qualify as an advanced chemistry course, regardless of the department in which it is taught” (emphasis added).

Again, that is a step in the right direction, but only a tiny one. What is needed is to replace the previously quoted and misleading sentence, “Instruction in this category. . . ,” by a statement that would explicitly allow a course to count toward the engineering science requirement even if taught outside of engineering. That would really help. E&A Committee guidelines might go something like this: “Instruction in engineer-
ing science will ordinarily be given by the faculty of an engineering department, but up to six semester credits of courses in other departments that extend basic science toward creative application may also count toward the engineering science requirement.”

Now let us look at the engineering science/engineering design problem. Like the distinction between basic and engineering science, the distinction between engineering science and design is not always clear. In fact, the ABET definition of design is quite broad; some topics straddle the line and whether pigeonholed in one slot or the other might depend on where or how they are taught or on the judgment or prejudice of the teacher. Moreover, a new topic has appeared, design science. Which pigeonhole will that fit in? At present, every engineering course must be assigned x credits of engineering science and y credits of design. Then the credits for all courses are totaled and the hope is that it sums to 1.0 year for engineering science and 0.5 for design. If it does not, then the figures are juggled a little, or course substitutions are made, or a course is actually restructured until the count comes out exactly right, 1.00 and 0.50. Those minimum figures are seldom exceeded.

The E&A Committee is concerned about this problem also. In fact, there has been some discussion and writing about discarding the rigid requirement of a half a year of design and one year of engineering science and replacing it with one and a half years of both with certain restrictions, the principal one being a requirement for “a meaningful design experience.” I think that appropriate wording could be found for such a change which would be a considerable help in obtaining the sort of flexibility in our curricula that will be required to meet the challenge of new technologies. It is my understanding that this change is now under consideration by the committee.

WHAT CAN BE DONE?

Quality control of chemical engineering education, accreditation, is in the hands of the profession itself. It is a voluntary, peer-review process involving both academic and industrial engineers who must develop criteria that do not stifle innovation, yet provide reasonable assurance of competent graduates. If we do not do the job well, the government will do it for us, and that threat ought to provoke at least some readers to make their views known to the E&A Committee.

The members of the ABET and of the E&A Committee represent all of us. Many of their members, however, apparently think that accreditation requirements are already flexible enough. ABET Curriculum Policy #8 is:

To avoid rigid standards as a basis for accreditation in order to prevent standardization or ossification of engineering education, and to encourage well-planned experimentation.

The E&A Committee has a similar statement. The job for those of us in the trenches is to convince ABET and the E&A Committee that in order to abide faithfully by this policy statement, they must further liberalize the curriculum requirements.

The wheels of ABET and the E&A Committee grind so slowly that any changes made might be both too little and too late. The profession will suffer as a result. Therefore, the effort should be made to influence them now. As experience has shown, letters from half a dozen chairmen have little effect. We need much more support than that. What we must do is to express our concerns vocally, in writing, and often to members of the Committee and to the AIChE Council itself. Letters can be addressed to committee members at their addresses or to them through AIChE at 345 East 47 Street, New York, 10017.


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