ABET Engineering Criteria 2000: How We Got There and Why

John W. Prados
National Science Foundation

Accreditation of educational programs in the United States is a voluntary, non-governmental, peer review process, which reflects a professional judgment that certain standards of educational quality are met. It signifies to prospective students and the public that graduates have achieved an expected level of competence in their fields of study and, thus, acts as a form of consumer protection. Two forms of accreditation exist: *institutional accreditation*, which seeks to assess the overall operation of a college or university from a broad perspective, and *specialized accreditation*, which focuses in detail on specific programs that educate students for professions (law, medicine, engineering, etc.).

Engineering programs in the U.S. are accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology, Inc. (ABET). ABET is the only organization recognized by the U.S. Office of Education to accredit Engineering and Engineering Technology programs in the United States. ABET was established in 1932 as the Engineers' Council for Professional Development (ECPD), a federation of seven professional societies: AIChE, AIEE (now IEEE), AIME, ASCE, ASME, NCEE (now NCEES), and SPEE (now ASEE). Today ABET is a Federation of 28 Engineering Societies that accredits approximately 1500 engineering programs at 300 institutions; 750 engineering technology programs at 250 institutions (two-year and four-year); and 40 engineering-related programs at 30 institutions.

The ABET organization consists of a Board of Directors, which establishes accreditation criteria and policies and hears appeals of denial of accreditation; an Engineering Accreditation Commission (EAC), which conducts visits and votes accreditation actions for engineering programs; a Technology Accreditation Commission (TAC), which conducts visits and votes accreditation actions for engineering technology programs; and a Related Accreditation Commission (RAC), which conducts visits and votes accreditation actions for a few program areas related to engineering, but which do not fit the definitions of engineering or engineering technology (e.g., industrial hygiene, safety, etc.).

ABET's policy is to accredit programs, not departments or schools, and to require that the program name include the word engineering if it is to be accredited as an engineering program. Accreditation information is provided through a self-study by the institution and a report of an on-site review team; accreditation is granted if it is judged that a program satisfies published accreditation criteria. These include general criteria applicable to all engineering programs and program criteria, which apply to specific engineering disciplines.

The present criteria address six major aspects of an engineering program: the *faculty* must be well qualified and sufficient in number to cover essential curricular areas; the *students* must be prepared to enter engineering study, and graduates must show acceptable performance; the *administration* must lead and support the engineering program; *facilities*, including classrooms,

laboratories, library, computer, etc., must adequately support the engineering program; *institutional commitment* must be evident through adequate financial support for the engineering program; and the *curriculum* must show certain quantitative and qualitative features.

The quantitative criteria require that an engineering curriculum include the equivalent of 1.0 year of mathematics and basic science; 0.5 year of humanities and social sciences, not counting communication skills courses; and 1.5 years of engineering topics including a strong engineering design stem that begins early in the curriculum and culminates in a major, integrative (capstone) design experience. The qualitative criteria require that the students' educational experiences include development of appropriate computer skills; development of written and oral communication skills; understanding of the ethical, social, economic, and safety considerations in engineering decisions; application of probability and statistics to engineering problems; and hands-on laboratory experiences in both basic science and engineering courses.

As originally conceived, these criteria were intended to be applied with flexibility and professional judgment to encourage experimentation and innovation in engineering education. An early statement of the ECPD Council was,

> "(ECPD) has no authority to impose restrictions or standardizations upon engineering colleges, nor does it desire to do so."

and a current ABET Accreditation Policy is,

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

But far too often, practice has failed to follow this intent. In the years following World War II ABET accreditation did become more rigid and rule-bound as new engineering programs and the accreditation workload proliferated, engineering education drifted away from its roots in practice, and litigation gained popularity as a way to settle disputes. The accreditation criteria grew from a few paragraphs (drafted by early ECPD leaders like Beckmann, Grinter, Pettit, and Stelson) to thirty-plus pages of fine print containing detailed prescriptions for required courses, credit hour distributions, numbers of faculty, and laboratory improvement plans. The specification-oriented criteria attracted specification-oriented engineers as program evaluators, discouraging those with more flexible views favoring innovation and experimentation. As an EAC member in the 1970's and 80's, I was an active part of the problem!

Today, the environment for engineering practice is changing dramatically and irreversibly, impelled by the shift from defense to commercial competition as a major driver for engineering employment, the impact of exploding information technology, corporate downsizing and the outsourcing of engineering services, and the globalization of both manufacturing and service delivery. Employers consistently emphasize that success as an engineer increasingly requires, in addition to strong technical capability, skills in communication and persuasion, ability to lead and work effectively as a member of a team, and understanding of the non-technical forces that profoundly affect engineering decisions. Acquiring such characteristics in a four, five, or even

six year program is unlikely with traditional, lecture-based instruction. A totally new engineering education paradigm is needed, built around active, project based learning; horizontal and vertical integration of subject matter; introduction of mathematical and scientific concepts in the context of application; close interaction with industry; broad use of information technology; and a faculty devoted to developing emerging professionals as mentors and coaches, rather than all-knowing dispensers of information.

The old criteria fail to address critical issues for an engineering education that will fulfill these needs. The newly-approved ABET Criteria 2000 have been developed, with strong industry input, to force attention to the goals of engineering education as expressed in the characteristics and abilities expected of graduates. The schools, not ABET, must then define the specific measurable learning objectives required to achieve these goals, the educational experiences that will produce these objectives, the multiple ways in which attainment of the objectives will be measured, and how the measurement results will be used for the continuous improvement of the educational process. ABET's principal role will be to assure that the program's goals and objectives are consistent with the characteristics of graduates described in Criteria 2000, and that the continuous improvement process is functioning effectively.

No one suggests that the new accreditation process will be easy or trouble-free. Establishing measurable objectives for engineering education and valid methods of measurement are poorly understood, especially by engineering faculty. (It may well be that our best models are in the armed services.) ABET, with support from industry and the National Science Foundation, is embarking on a major educational effort to develop a cadre of program evaluators and team chairs, along with engineering deans, department heads, and key faculty, who can participate effectively in the new accreditation process. Workshops and pilot tests of the new criteria are already underway, but a major, ongoing effort will be required. And therein, perhaps, lies the greatest change in ABET's approach to accreditation. We now recognize that new, more effective models of engineering education require a new relationship between ABET and the engineering programs seeking accreditation or reaccreditation. ABET is in a unique position to help these programs evaluate and continuously improve their educational effectiveness, but this will require a cooperative, not adversarial, relationship. Acceptance by the ABET Board and commissions of this philosophy has been critical in bringing us this far.

The most difficult part of the task has just begun. The concept of self-evaluation and continuous improvement is foreign to the academic culture, and engineering faculty, department heads, and deans must learn and grow if they are to apply these concepts successfully to their programs. ABET must set a high standard for the effectiveness of institutional processes, and not all programs will be able to meet them. However, in the final analysis, ABET's role is no different than that of a truly dedicated faculty member -- to set high standards for achievement and then do everything in his or her power to help students achieve them!

JOHN W. PRADOS, Ph.D., P.E., is serving in a three-year assignment as Senior Education Associate in the Engineering Directorate of the National Science Foundation. He is Vice President Emeritus and University Professor of Chemical Engineering at The University of Tennessee. He has been Chair of the EAC and President of ABET; was President of Sigma Xi; is Treasurer of AIChE; and is Editor of the *Journal of Engineering Education*.