

NSPE Position Statement No. 1752—Engineering Education Outcomes

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NSPE CONTACT: Licensure and Qualifications for Practice Committee

It is the position of the National Society of Professional Engineers that engineering students of all disciplines who become licensed professional engineers should attain education outcomes in addition to those already included in the ABET baccalaureate level general criteria. The additional outcomes include the ability to:

- Apply principles of leadership;
- Account for risk and uncertainty in the solution of engineering problems;
- Apply principles of project management;
- Explain where and how public policy is developed and how it influences engineering practice;
- Explain business concepts applicable to engineering practice; and
- Apply principles of sustainability to the design and evaluation of engineering systems.

Outcomes

Undergraduate engineering education in accredited programs in the United States is required to include attainment of a set of outcomes developed by ABET in the 1990s. These outcomes include the ability to:

- Apply knowledge of mathematics, science, and engineering;
- Design and conduct experiments;
- Design a system, component, or process to meet desired needs within a broad set of constraints such as economic, environmental, social, political ethical, health and safety, manufacturability, and sustainability;
- Function on multidisciplinary teams;
- Identify, formulate, and solve engineering problems;
- Understand professional and ethical responsibility;
- Communicate effectively;
- Understand the impact of engineering solutions in global, economic, environmental, and societal contexts;
- Recognize the need for life-long learning;
- Understand contemporary issues; and
- Use the techniques, skills, and modern engineering tools necessary for engineering practice.

Reports on the body of knowledge required for professional engineering practice have recently been prepared on behalf of some engineering disciplines. Other similar reports are being prepared by other disciplines. The reports completed thus far advocate that additional outcomes beyond those included in ABET's current criteria are necessary for professional engineering practice. The National Society of Professional Engineers (NSPE) has reviewed these bodies of knowledge, considered the applicability of various outcomes to the professional practice needs of all engineering disciplines, and concluded that the following additional outcomes are necessary to properly prepare individuals for professional practice.

- **Leadership:** In an engineering context, leadership incorporates a number of capabilities that are critical to function at a professional level. These capabilities include the ability to assess risk and take initiative, the willingness to make decisions in the face of uncertainty, a sense of urgency and the will to deliver on time in the face of constraints or obstacles, resourcefulness and flexibility, trust and loyalty in a team setting, and the ability to relate to others. In a broader context, engineers need leadership skills so that later in their careers they can develop the ability to help create and communicate a vision for the future and the ability to help shape public policy. These leadership capabilities are essential for the professional practice of engineering and for the protection of public health, safety, and welfare.

- **Risk and Uncertainty:** The assessment of risk and uncertainty is a fundamental component of engineering practice. On a daily basis, professional engineers are faced with determining how much data is enough to define a problem or to characterize existing conditions. Factors of safety are assessed analytically in some disciplines, and subjectively in all areas of practice. In some engineering programs, engineering students are currently taught rudimentary probability and statistics, yet an academic background in the assessment of risk and uncertainty as it applies to engineering decision making and design is typically not provided. We as a society have learned from several notable disasters, such as the loss of the Challenger spacecraft and the Minneapolis I-35 bridge collapse, that engineers need to be in responsible charge of decision making on technical matters when public health and safety are at risk. In view of these examples and others, all engineers need sufficient background such that they can identify and assess risk and uncertainty and take the initiative in the decision-making process when necessary. The adequate protection of public health, safety, and welfare demands that the assessment of risk and uncertainty be incorporated in the engineering thought process throughout engineering curricula, beginning with undergraduate engineering education.
- **Project Management:** Project management is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. Such abilities are essential for all disciplines and at all levels of engineering practice to successfully meet the objectives of all engineering projects. To ensure that engineering projects have a positive effect on the public, effective project management is essential. The ability to apply project management principles should be an outcome attained by all engineering graduates.
- **Public Policy:** Public policy affects all aspects of our society and can significantly impact the practice of all engineers whether in the private or public sector. Many engineering projects implement public policy and the rest are certainly influenced by it. Public policies, including laws, regulations, institutions, codes, and standards, impact engineering disciplines in different ways; thus, engineering graduates need to know how public policy is established and who sets it at the various levels of government relative to their discipline.
- **Business Concepts:** Engineers in all disciplines function in the private and public sectors, and their effectiveness will, to a significant extent, depend on their ability to function within the organizational context applicable to their practice. Imparting fundamental knowledge of both sectors will produce graduates equipped to function in a society that involves interaction between the two. In business, being knowledgeable of subjects such as contracts, risk management, quality assurance, marketing and sales, direct and indirect labor, overhead, profit, and pricing as well as the balance between business demands and professional ethics are critical for effective practice, and effective practice best serves the public interest. In public service, being knowledgeable of subjects such as laws, regulations, governmental structures, and funding mechanisms as well as the professional responsibilities of an engineer in public service are also critical to the public interest.
- **Sustainability:** Sustainability is defined here as the ability to meet human needs for natural resources, products, energy, food, transportation, shelter, and effective waste management while conserving and protecting environmental quality and the natural resource base that is essential for the future. In engineering design, sustainability might also incorporate concepts of economic viability and long-term operability. The public increasingly demands that sustainability concepts be applied to engineering projects in practice, and it is necessary to incorporate these concepts in the engineering thought process, beginning with undergraduate engineering education, if these concepts are to be thoroughly integrated into the design process in the future. Sustainability is currently one of eight factors to consider in engineering design as presented in ABET Criterion 3(c). NSPE contends that sustainability is fundamental to all aspects of engineering and merits emphasis in the public interest through establishment of a specific sustainability outcome.

Humanities and Social Sciences

NSPE has chosen not to advocate that “humanities and social sciences” be added as a specific outcome for engineering programs, because these topics are typically the purview of university general requirements in the United States. NSPE does advocate, however, that the “general education” accreditation criterion for engineering programs should include specific reference to “humanities and social sciences.”

The humanities include topics such as literature, philosophy, art, and religion. The social sciences include economics, sociology, psychology, history, and political science. Both the humanities and the social sciences are of critical importance to engineers of all disciplines, both as learned professionals and as practitioners. All of the learned professions recognize the importance of these educational areas and consider them a fundamental part of the foundational education needed by professionals. Such education is also critical for engineers because it imparts an understanding of the cultural and economic framework in which they will practice. A lack of humanities courses has been a shortcoming of some foreign universities in the past, and this lack of humanities courses may become more critical as engineers become more globally mobile, and as ABET’s international accreditation activities continue to increase.

Harmonization

In recent years, ABET has made significant progress in “harmonizing” the general criteria among the four ABET commissions: engineering, applied science, computing, and technology. Consideration has been given to using the same outcomes and terminology in each set of criteria, whenever doing so is appropriate. This is not an absolute rule, and the commissions are allowed some flexibility to maintain differences where appropriate. NSPE anticipates that some or all of its proposed new outcomes will be applicable to the harmonized criteria for all four commissions. However, as an organization that is principally concerned with engineering, NSPE claims no expertise in applied science, computing, or technology education. As such, NSPE leaves to these commissions the task of determining which of the proposed outcomes are appropriate for programs within their respective areas of interest.

Summary

NSPE represents the interests of licensed professional engineers of all disciplines and those who aspire to become licensed professional engineers. NSPE has as a core value of protecting the public welfare. The outcomes described herein are fundamental to the continued protection of public health, safety, and welfare regardless of engineering discipline. NSPE also represents professional engineers of all engineering disciplines, all of which impact public health, safety, and welfare. The applicability of the outcomes described herein to all engineering disciplines is clear.

Although NSPE advocates the inclusion of the outcomes and other recommendations described above for engineers of all disciplines, there is concern that under current circumstances, these outcomes could not be added to undergraduate engineering curricula without deleting other curriculum components that are equally essential to engineering practice. NSPE is also mindful of the current economic conditions affecting university engineering programs and understands that immediate implementation would be difficult. Therefore, it is recommended that the process of considering these additions to the criteria be initiated at this time so that implementation can occur within one decade.