AC 2012-3972: TO RAISE THE BAR OR NOT: ADDRESSING THE OPPOSITION

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Background

Consistent with its *Vision for Civil Engineering in 2025*, the American Society of Civil Engineers (ASCE) has been engaged in an ambitious effort to better prepare civil engineering professionals to meet the technological, environmental, economic, social, and political challenges of the future.¹ This “Raise the Bar” initiative attained an important milestone in October 1998, when the ASCE Board of Direction formally adopted Policy Statement 465. The most recent version of this policy is as follows:

The ASCE supports the attainment of a body of knowledge for entry into the practice of civil engineering at the professional level. This would be accomplished through the adoption of appropriate engineering education and experience requirements as a prerequisite for licensure.²

In conjunction with the implementation of Policy 465, ASCE initiated a comprehensive effort to formally define the profession’s body of knowledge (BOK).³ As the BOK has been developed and refined, a concurrent analysis has demonstrated that the prescribed BOK outcomes cannot be adequately achieved through the traditional four-year baccalaureate degree.⁴ Consequently, Policy 465 specifies that the prerequisites for licensure should be (1) a baccalaureate degree in civil engineering, (2) a master’s degree or approximately 30 graduate or upper-level undergraduate credits, and (3) appropriate progressive, structured engineering experience.

ASCE is currently attempting to influence state laws to reflect the increased educational requirement for licensure. In 2006, with ASCE’s strong support, the National Council of Examiners for Engineering and Surveying (NCEES) modified its Model Law and Model Rules pertaining to engineering licensure.⁵ The revised Model Law and Rules state that admission to the engineering licensing exam will require an accredited bachelor’s degree in engineering, a master’s degree or an additional 30 credits of acceptable upper-level undergraduate or graduate-level coursework, and four years of progressive engineering experience. In 2008, the effective date for the new Model Law was set at January 2020.

While the implementation of Policy 465 has made substantial progress since 1998, the process has often been contentious. Today, various aspects of the initiative are opposed by the Engineering Deans Council, the American Council of Engineering Companies, and professional societies affiliated with several other engineering disciplines. In April 2008, the American Society of Mechanical Engineers (ASME) Board of Governors approved a position paper opposing additional education as a prerequisite for licensure. This position paper, “Mandatory Educational Requirements for Engineering Licensure,” was subsequently endorsed by eight other professional societies and the Executive Board of the Engineering Deans Council, and then published on a specially developed website.⁶ The position paper is included as Appendix A of this paper.

Purpose

The purpose of this paper is to assess the key points of opposition presented in the ASME position paper, “Mandatory Educational Requirements for Engineering Licensure,” from two complementary perspectives:

- Validity of each specific point of opposition, based on objective evidence, logic, and recent multi-disciplinary visions of the engineering profession’s future.
- Consistency with the theoretical framework of professionalism, as described in the Sociology of Professions.

Addressing the Key Points of Opposition

The following paragraphs address the ten key points of opposition to the NCEES Model Law changes, as presented in the ASME position paper “Mandatory Educational Requirements for Engineering Licensure.” Each point, enclosed within a border, is a direct quotation from the position paper. The numbers assigned to each point are my own; they are used strictly for ease of reference in this paper and do not reflect any particular priority.

1. “The low number of engineering students in four-year colleges has been going in the wrong direction nationally, as cited in the statistics below.”

In support of this point, the position paper provides the following statistics:

- In 1981, 6.7 percent of degrees awarded were in engineering. In 1984, the figure rose to a high of 7.7 percent. Today it has dropped to 5 percent.
- During the past two decades, part of an era that has been described as science and engineering’s greatest period of accomplishment, the numbers of engineers, mathematicians, physical scientists, and geoscientists graduating with bachelor’s degrees in the United States have declined by 18%. The proportion of university students achieving bachelor’s degrees in these fields has declined by almost 40% during that time.
- The number of engineering doctorates awarded by U.S. universities to U.S. citizens dropped by 23% in the past decade.*

The first of these statistics fails to support the point that engineering enrollments are “going in the wrong direction,” because it describes only the *proportion* of degrees awarded. A decline in the proportion of degrees awarded does not necessarily indicate a decline in the *number* of degrees awarded. The second item obfuscates the point by aggregating engineering with mathematics, physical sciences, and geosciences. The third is simply irrelevant, as the number of doctorates awarded has little relationship to the number of engineering students in four-year colleges and has no impact on engineering licensure.

Figure 1, produced by the Engineering Workforce Commission of the American Association of Engineering Societies, illustrates undergraduate engineering enrollments over the period from 1970 to the present.⁸ These data demonstrate unequivocally that undergraduate engineering

* These statistics were taken from a report by Norman R. Augustine, one of the profession’s most prominent supporters of the master’s degree as a prerequisite for the practice of engineering at the professional level.⁷

enrollments (1) are currently at an all-time high, (2) have been rising sharply since 1996, and (3) have been trending upward for the past decade. The position paper's claims that engineering enrollments are low and "going in the wrong direction nationally" are demonstrably false.

Figure 1. Full-time Undergraduate Engineering Enrollment, 1970-2010.⁷

Nonetheless, it is very likely that increased educational requirements for licensure *in a single engineering discipline* would significantly impact enrollments in that discipline. For this reason, ASCE's Raise the Bar initiative has been directed at the engineering profession as a whole, rather than on civil engineering alone.

2. "The engineering degree is one of the most challenging programs of study that one may undertake at the university and requiring an additional 30+^{*} will make it even more difficult to attract the highly capable students we need to ensure our technological growth."

Here the ASME paper suggests that *we must preserve low standards for entry into the profession* to ensure that we have an adequate supply of engineers to ensure our technological growth. Yet there is compelling evidence that our future global competitiveness demands not *more engineers*, but *better educated engineers*.

Consider the report produced by a National Science Foundation (NSF)-sponsored project called "The 5XME Workshop: Transforming Mechanical Engineering Education and Research in the USA."⁹ The 5XME project report describes the ongoing global commoditization of engineering

^{*} The ASME position paper uses the terms "BS+30" and "30+" in reference to the NCEES Model Law requirement for 30 credits of acceptable upper-level undergraduate or graduate-level coursework.

education, resulting in the ready availability of low-cost engineering talent in various foreign countries. Observing that these off-shore engineers are typically able to provide routine engineering services at 20% of the cost of U.S. engineers, the report concludes that “The challenge for engineering schools in the USA is how to educate a mechanical engineer that provides five times the value added when compared to the global competition, i.e., the 5XME.” According to the 5XME authors, U.S. mechanical engineers will only be able to provide five times more value than their foreign counterparts if they are able to develop greater breadth of intellectual capacity, an ability to innovate, and leadership in addressing major societal challenges. The authors of the 5XME Report are all mechanical engineers; however, they suggest that their findings are “broadly applicable to all fields of engineering.”

Off-shoring may also be an underlying reason for the surprising results of a recent study by the RAND Corporation.¹⁰ This study concludes that “there is no evidence of a current shortage of science and engineering workers” in the U.S. The 2008 report (which predates the current economic downturn) notes that a bona fide shortage of scientists and engineers would result in significant wage increases and declines in unemployment, neither of which is happening.

A more recent report by Georgetown University’s Center on Education and the Workforce finds that the unemployment rate for recent graduates of undergraduate engineering programs is 7.5% percent—significantly lower than recent graduates with humanities and arts degrees (9.4% and 11.1%, respectively), but *higher* than recent graduates with agriculture, journalism, education, health, psychology, social work, and business degrees.¹¹

These data clearly do not suggest a shortage of U.S. engineers with baccalaureate degrees. Demand for more highly educated engineers is significantly stronger, however. According to the Georgetown report, the current unemployment rate for U.S. engineers with graduate degrees is only 3.4%.

Taken together, these three sources suggest that ensuring a large supply of engineers by maintaining low educational standards makes no sense. In the context of intense global competition and the availability of low-cost engineering services overseas, turning out larger numbers of minimally qualified engineers will do little to enhance U.S. economic competitiveness and will do a grave disservice to the engineers themselves. Equipped only to do routine work, these U.S. engineers will be unable to compete with their lower-cost overseas counterparts, who can deliver the same services at a fraction of the cost. U.S. global competitiveness demands not more engineers but better-prepared engineers—those with the intellectual breadth, innovativeness, and leadership skills called for in the 5XME Report.

3. “Increasing the professional licensing requirements has the potential to reduce the supply of licensed engineers who are able to practice and therefore reduce our Nation’s technological competitiveness.”

In choosing the words “potential to reduce,” the ASME position paper appropriately acknowledges that it is impossible to predict the future with certainty. Nonetheless, we can get some indication of how increased educational requirements for licensure are likely to affect the

engineering profession by examining how it affected the certified public accountants (CPA) over the past two decades.

In 1989, the American Institute of Certified Public Accountants (AICPA) recommended that states require candidates to complete 150 credit hours of study before sitting for the CPA exam. At that time, a 120-hour requirement was the norm. The states responded slowly, but by 2009, 48 of 54 jurisdictions had adopted the 150-hour requirement. Subsequently, some states adopted a hybrid standard, allowing candidates to take the CPA exam after 120 hours of study but only attaining licensure after 150 hours.

The ASME “Licensing that Works” website briefly discusses the CPAs’ adoption of additional educational requirements, citing a 2006 analysis by Carpenter and Stephenson.¹² This study examined states that had implemented the 150-hour rule, and discovered that the number of candidates sitting for the CPA exam in these states had been reduced by 60 percent.¹³

Although the Carpenter and Stephenson study was the only evidence cited by ASME, it tells only part of a much larger story. Several subsequent analyses provide a more comprehensive perspective of the very complex effects of the changing standards for CPA licensure. Carpenter and Hock analyzed longitudinal data from three states—Florida, which instituted a 150-hour requirement in 1983 (in advance of the AICPA vote); Texas, which adopted the requirement in 1998; and New York, which had not yet adopted the requirement at the time of the study.¹⁴ Their results are summarized in Figures 2, 3, and 4 below.

- Figure 2 shows the number of CPA exam-takers (in blue) and their corresponding average pass rates (in red) in the state of Texas during the period 1991 to 2003. Here the effect of implementing the 150-hour rule in 1998 is quite pronounced. The law effecting the change included a “grandfather” provision allowing candidates who failed the exam prior to 1998 to re-take it in subsequent years, even if they did not meet the 150-hour standard. Thus, there was a surge in exam-takers in 1997, as candidates took advantage of this provision. Between 1996 and 2000, the drop in exam-takers was approximately 60%, just as Carpenter and Stephenson noted in their earlier study. Note, however, that a steady annual decline in exam-takers was already evident in the three years prior to the 1997 surge. Note also that the CPA exam pass rate increased significantly (over 70%) in the years following implementation of the new standard. Thus the decline in exam-takers after 1998 did not cause a commensurate decline in the number of registered CPAs.
- Figure 3 shows the corresponding graph for the state of Florida. In this case, the change to the 150-hour rule had occurred in 1983, nearly a decade prior to the earliest data acquired in the study. Here we see a steady decline in exam-takers from 1991 to 1998, followed by a distinct, if inconsistent upward trend. Throughout the period, pass rates vary between 21% and 33%—entirely consistent with the high pass rates achieved in Texas after the 150-hour rule was implemented in 1998.
- Figure 4 shows the number of exam-takers and pass rates in New York. Although the 150-hour rule was not implemented in New York during the period of the study, we still see a steady decline in both exam-takers and pass rates. These pass rates are significantly lower than those in Florida (where the 150-hour rule was in effect throughout the period) and in Texas after the 150-hour rule was implemented in 1998.

Figure 2. Number of CPA exam-takers and pass rates in Texas.

Figure 3. Number of CPA exam-takers and pass rates in Florida.

Figure 4. Number of CPA exam-takers and pass rates in New York.

Although Carpenter and Stephenson considered only three states, their results strongly suggest that (1) implementation of the 150-hour rule significantly improved exam pass rates, mitigating the associated reduction in the number of exam-takers; and (2) there was a general decline in the number of exam-takers occurring largely independent of the 150-hour rule.

The first conclusion was strongly validated by Raghunandan et al., who conducted a rigorous analysis of exam performance in *all* CPA jurisdictions.¹⁵ After controlling for SAT scores, accounting credit hours, and enrollment in CPA prep courses, the authors concluded that implementation of the 150-hour rule caused a substantial improvement in exam performance.

A particularly comprehensive study of the CPA case was performed by Metinko and Gray, who did a careful statistical analysis of all transitions of educational requirements in all jurisdictions between 1998 and 2008—from 120 hours to 150 hours and, in some cases, from 150 hours to the 120/150-hour hybrid model.¹⁶ This analysis showed conclusively that the observed decrease in the number of CPA exam-takers was *not due to the 150-hour requirement*. Specifically, there was no statistically significant correlation between the 150-hour requirement and the number of CPA exam candidates. To cite just one of many examples of data from the study: 8 jurisdictions never enacted the 150-hour requirement during the period 1998 to 2008. These constitute 15% of all jurisdictions; and, *despite no change in the exam requirements*, they experienced about 20% of the total decline in exam-takers—a clear indicator that the decline was independent of the requirement. In seeking alternative explanations for this decline, Schroeder and Franz suggested “ignorance about a career in accounting, faulty information about the profession; ... negative perceptions of the role of accountants in society; ... decreased salary levels, and the availability of more-attractive career alternatives.”¹⁷

In sum, the case of evolving CPA licensure standards over the past two decades is quite complex. The case has been the subject of numerous studies, and some of their conclusions disagree. Certainly, the CPA case cannot be adequately characterized by citing a single study, as the ASME website has done. Furthermore, the preponderance of evidence suggests that increased educational requirements did not cause a significant decline in CPA licensure but did cause a significant improvement in CPAs’ technical preparation for professional service.

4. “The added cost would be a hardship. Committing an additional year to obtain an extra thirty credit hours would be a very significant deterrent for anyone who might otherwise pursue an engineering degree.”

Education is generally (and appropriately) considered to be an investment in the future and a primary source of human capital.¹⁸ To the extent that the cost of education constitutes a hardship for any individual, that hardship is typically temporary. A recent study by Georgetown University’s Center on Education and the Workforce determined that the median salary of an engineer with a graduate’s degree is over 30% higher than that of an engineer with only a baccalaureate degree (\$99,000 vs. \$75,000).¹⁹ At this salary differential, the cost of one year of graduate study would be offset rather quickly, while the intangible benefits associated with performing a higher level of professional work could be substantial.

5. “Increasing the prestige or status of the profession by raising the bar to access does not contribute to the profession nor serve the public.”

After dismissing the relevance of professional prestige, the ASME position paper goes on to say that “Engineers rank high in national polls compared to lawyers and other professionals and therefore there is no need to increase educational requirements to achieve additional prestige.” This latter claim contradicts the first, suggesting that *professional prestige is relevant*, albeit not a concern because of the engineering profession’s current high rankings.

The internal contradiction notwithstanding, the position paper’s claim that engineers rank high in national polls is not supported and may be unsupportable. A recent Harris poll on the prestige of professions and occupations placed engineers in the middle of the pack—above real estate agents, journalists, lawyers, members of Congress, and farmers; but below clergy, police, teachers, military officers, nurses, doctors, scientists, and firefighters.²⁰

The 5XME Report more closely reflects the Harris data, noting that “engineering is held in low regard by many people” and attributing the profession’s lack of prestige to perceptions that:

- Engineers are replaceable and disposable commodities, not leaders and decision-makers.
- Engineers focus on narrow technological problems, and not broader societal needs.
- Engineers are narrowly educated in scientific and technological disciplines.⁹

In “Engineering for a Changing World,” James Duderstadt, President Emeritus of the University of Michigan, reinforces this message, writing that “the engineering profession still tends to be held in relatively low regard compared to other learned professions such as law and medicine. Unfortunately, many global corporations tend to view engineers as disposable commodities, discarding them when their skills become obsolete or replaceable by cheaper engineering services from abroad.”²¹

Both 5XME and Duderstadt contradict the ASME position paper’s claim that engineers rank high in national polls. More importantly, they identify the principal source of engineers’ professional prestige not in *exclusivity*, as the position paper suggests, but rather in the nature of the engineers’ work, their status vis-à-vis their employers, and the breadth of their education. These ideas are strongly supported by Freidson’s well-established sociological model of professionalism, discussed below.

For its part, ASCE has *never* used professional prestige as a justification for enhanced licensure standards. The word “prestige” does not occur in ASCE’s *Vision for Civil Engineering in 2025*.¹ It is used only once in the Civil Engineering Body of Knowledge for the 21st Century—and the context is a refutation of the common claim that licensure “is merely a shallow ‘prestige’ credential.”³ ASCE has consistently and rigorously justified increased educational requirements for licensure in terms of (1) the future challenges confronting 21st-century engineers, (2) which can best be met by engineering professionals who have fulfilled an appropriately defined body of knowledge, (3) which is defined in terms of clearly articulated outcomes, (4) which cannot be achieved through the current four-year baccalaureate degree. If enhanced prestige is a second-order side effect of enhanced education, then so be it; but professional prestige has never been a goal of ASCE’s “Raise the Bar” initiative.

6. “ASME believes that the typical scope of an ABET Accredited bachelor’s degree can and has been demonstrated to accommodate technical breadth and flexibility and the intellectual skills necessary for engineering graduates to (1) pass the Fundamentals of Engineering (FE) Examination, (2) successfully complete a four-year internship under a licensed engineer and (3) go on to pass the final Principles and Practices Examination (PE) before being licensed as a Professional Engineer.”

In the position paper, this argument is presented as the first point of opposition to “a mandatory, across-the-board requirement of BS+30”, and then it is repeated nearly word-for-word as the first point in the Conclusion section. We might reasonably assume that this argument is the ASME Board of Governors’ principal point of opposition to enhanced educational requirements for licensure.

In a narrow sense, this point is true and, indeed, self-evident. Without a doubt, the current four-year baccalaureate degree does an adequate job of preparing aspiring engineers to pass the current FE Exam and the current PE Exam. If the purpose of ASCE’s “Raise the Bar” initiative were to increase exam pass rates, the position paper’s argument would be both logical and compelling. But the purpose of the initiative is *not*, nor has it ever been, to increase pass rates; the purpose is to better prepare engineering professionals to meet the extraordinary challenges of *the future*. As such, the ASME paper’s principal point of opposition misses the point entirely.

In defending the status quo as “decreed by tradition and practice,” the position paper is saying, in effect, *if it ain’t broke, don’t fix it*. Yet many individual and institutional voices from across the engineering profession have expressed serious concern that our current educational paradigm is inadequate to meet the challenges of the future. In the 2007 report “Moving Forward to Improve Engineering Education,” the National Science Board (NSB) summarized this inadequacy as follows:

Basic engineering skills (such as knowledge of the engineering fundamentals) have become commodities that can be provided by lower cost engineers in many countries, and some engineering jobs traditionally done in the U.S. are increasingly done overseas. To respond to this changing context, U.S. engineers need new skill sets not easily replicated by low-wage overseas engineers. The problems that have driven engineering—even in recent years—are changing, as technology penetrates more of society. Systems have become more tightly coupled. Engineering thinking needs to be able to deal with complex interrelationships that include not only traditional engineering problems but also encompass human and environmental factors as major components. In addition to analytic skills, which are well provided by the current education system, companies want engineers with passion, some systems thinking, an ability to innovate, an ability to work in multicultural environments, an ability to understand the business context of engineering, interdisciplinary skills, communication skills, leadership skills, an ability to adapt to changing conditions, and an eagerness for lifelong learning. This is a different kind of engineer from the norm that is being produced now.”²²

Given this radically changing context for engineering practice, the NSB concludes that “a continuation of the status quo in engineering education in the U.S. is not sufficient in light of the pressing demands for change.”

The NSB's challenge to the adequacy of our current four-year baccalaureate degree is powerfully echoed in the 5XME Report,⁹ Duderstadt's "Engineering for a Changing World,"²¹ the writings of prominent thinkers like Augustine⁷ and Grasso²³, the Body of Knowledge documents published by ASCE³ and the American Academy of Environmental Engineers,²⁴ the National Society of Professional Engineers (NSPE) Position Statement No. 1752 (Engineering Education Outcomes),²⁵ and most importantly, the National Academy of Engineering (NAE) strategic vision report, *The Engineer of 2020*.²⁶ Even ASME's own *2028 Vision for Mechanical Engineering* observes that "The increased breadth and complexity of modern engineering practice are straining the standard four-year curriculum for engineering education."²⁷

In every case, these documents call for more broadly educated engineers who can bring a more holistic approach to problem-solving—engineers who understand systems thinking, business principles, public policy, and leadership; who can communicate effectively and adopt a global perspective; and who display adaptability, entrepreneurial spirit, creativity, and practical ingenuity. How can all of these new competencies be addressed in the already strained four-year engineering curriculum? The most frequent answer is that they cannot—that adequate preparation for professional practice must include additional formal education beyond the baccalaureate degree, and that the baccalaureate degree itself must undergo fundamental change.

The National Academy of Engineering recommends that the B.S. degree should be considered as a pre-engineering or "engineer-in-training" degree, and that the master's degree should become the engineering professional degree.²⁸ The 5XME Report develops this concept further, recommending that:

- The bachelor's degree should introduce engineering as a discipline, and should be viewed as an extension of the traditional liberal arts degree where education in natural sciences, social sciences and humanities is supplemented by education in the discipline of engineering for an increasingly technological world.
- This bachelor's degree in the discipline of engineering can be viewed as the foundational stem upon which several extensions can be grafted: (1) continued professional depth through a professional master's degree in engineering, and (2) transition to non-engineering career paths such as medicine, law, and business administration.
- The masters degree should introduce engineering as a profession, and become the requirement for professional practice.⁹

This is a compelling vision for the future of engineering education—one that proactively addresses the challenges that lie ahead. It stands in sharp contrast with the complacent defense of the status quo reflected in the ASME position paper.

7. "ASME believes that increasing educational requirements for licensure should not be used as a tool to offset the nominal decrease in graduation requirements for the FPD* ...[because] this gradual change over time has resulted in no drop in the national test scores in either examination required for engineering licensure."

The ASME position paper acknowledges that "legislatures and state higher education authorities have reduced the coursework required for a baccalaureate degree from as high as 150 to as low

* First Professional Degree

as 120 semester credits, primarily due to budgetary reasons.” But the paper asserts that this decline has not affected engineers’ preparation for professional practice because engineering education has become more efficient. “Thanks to the power of computers, slide rules are no longer needed.”

The assertion of increased efficiency is difficult to prove or to disprove definitively. Certainly, the availability of modern information technologies has created some curricular efficiencies. In civil engineering, for example, most programs teach fewer classical structural analysis methods than they did thirty years ago. Yet much of this efficiency must certainly be offset by growing requirements for curricular coverage of these new technologies themselves. For example, courses in computer-aided design (CAD), geographic information systems (GIS), building information modeling (BIM) did not exist thirty years ago but are common in civil engineering programs today.

The position paper’s claim is also weakened by its use of the FE and PE Exams as the sole measures of educational outcomes. These tools provide reasonably effective measures of technical knowledge; however, because the PE Exam is voluntary and the FE Exam is usually voluntary, these exams test only those individuals who choose to be examined. Thus, for example, students who choose not to take the FE Exam because they have been inadequately prepared are not reflected in published exam pass rates.

More importantly, the FE and PE Exams do not test broader, “softer” professional competencies like systems thinking, business principles, leadership, and practical ingenuity—the very competencies that are driving the “Raise the Bar” initiative. ASME claims that declining credit-hour requirements are not a problem, because they have not adversely affected test scores; ASCE would counter that declining credit-hour requirements *are* a problem, because they leave even less space in an already overburdened four-year curriculum for the new broader knowledge and skills that engineering professionals will need to meet future challenges.

8. “Continuing education is an essential life-long need for engineers, and significant learning is necessary for engineers of all disciplines beyond the studies that qualified them for the FPD. These principles are already incorporated within the present system....”
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ASCE certainly concurs with the value of continuing education; however, continuing education cannot be a substitute for the high-quality educational outcomes provided in an ABET-accredited institutional context.

In comparison with traditional four-year engineering degree programs, the Civil Engineering Body of Knowledge calls for greater curricular emphasis on fundamentals (math, basic science, and engineering science), enhanced professional practice breadth (communication skills, business, public policy, globalization, leadership, teamwork, etc.), and greater technical depth in the discipline. All but technical depth are to be attained through the baccalaureate degree. This allocation of outcomes to the baccalaureate and master’s degree levels is critical because, even in the future, the baccalaureate degree will continue to be the sole ABET-accredited degree in most engineers’ formal education. Thus only the outcomes addressed at the baccalaureate level will be subject to the rigorous quality control provided by the ABET process. Fulfillment of these

outcomes could not reasonably be attained through continuing education, because there is no mechanism for ensuring that decentralized continuing education programs will produce the specific outcomes constituting the professional body of knowledge.

9. Due to the federated nature of licensing jurisdictions, some states may adopt the BS+30 and others will not, causing disparities and hindering licensee mobility.

Comity licensure has been a long-standing concern for NCEES; it is certainly not a new issue for implementation of the new Model Law. Indeed, there have *always* been significant variations in licensure standards across jurisdictions (e.g., limitations on structural and seismic practice and variations on continuing education requirements). In response to these variations, NCEES has developed a highly effective system for facilitating licensee mobility while also ensuring that engineers are appropriately qualified to practice in their jurisdictions. NCEES facilitates licensee mobility through its Records Program (including the designation of “Model Law Engineers”) and through a well-established set of rules and procedures for managing comity licensure.²⁹ This same system will apply to the new Model Law and Rules, and there is no reason to doubt that it will continue to work effectively.

It is worth noting that *any* change to the NCEES Model Law will inevitably introduce disparities in licensure requirements across jurisdictions. Thus the position paper’s argument above could be used as a justification for never making *any* change to licensure statutes or rules. This sort of inflexibility would be a substantial bar to progress.

10. “There is no clear benefit to requiring the BS+30, but there is considerable cost that will affect both firms and individuals.”

Although this point is largely a restatement of arguments made elsewhere in the ASME position paper, it is included here as a separate item because it adds the issue of increased cost to *firms*—i.e., the employers of engineers. This point can hardly be disputed. Engineers with master’s degrees earn more than engineers with only baccalaureate degrees; thus if educational standards for licensure are raised, employers are likely to pay more for licensed engineers.

One can certainly argue that better qualified engineers will provide more value to their employers, and so the added cost is warranted. One can also argue that the higher cost of professional engineers will cause firms to more clearly delineate professional and non-professional work; to employ their professional engineers only for critical, high-end work involving the application of discretionary judgment; and to employ larger numbers of lower-paid paraprofessionals to handle most routine tasks. (Duderstadt has provided a compelling argument for this model of workplace organization.²¹) These arguments notwithstanding, the potential for added cost to the firm must be acknowledged.

But is a higher price tag for engineering services necessarily a bad thing? The answer, of course, is a matter of perspective. To the employer, it represents an increased cost of doing business and a potential loss of profits; but to the engineer, it represents increased compensation for a higher level of professional work. And to the student, it may represent a compelling reason for choosing to study engineering.

The firm's perspective, though entirely understandable, is potentially very damaging to the engineering profession. This point can be best explained in the broader context of the Sociology of Professions.

Some Perspectives from the Sociology of Professions

The Sociology of Professions is a multi-disciplinary field of scholarly inquiry that attempts to explain:

- the nature of professionalism and the characteristics of professional work;
- how professions develop, grow, interact, and sometimes wither away;
- how professions operate within a broader economic system; and
- how professions function in societies.

A detailed discussion of the Sociology of Professions is beyond the scope of this paper; however, a few salient points from the well-established work of Abbott, Freidson, and Krause are highly relevant to this discussion.^{30,31,32}

According to Abbott, the engineering profession is regarded as inherently weak, because of the corporate setting in which engineering work is typically performed. Because the process of translating engineering designs into physical products requires large amounts of capital, engineers are often dependent on large privately owned organizations. In such organizations, engineering typically represents just one specialty in a much larger division of labor. Consequently, engineers, unlike lawyers and accountants, cannot control the market for their services and generally have not been able to dominate the organizations in which they work.³²

It is hardly surprising, then, that the professional societies representing manufacturing-oriented engineering disciplines have opposed increased educational requirements for licensure. Historically, these disciplines have been strongly influenced by the commercial industries they serve;³² and these industries have often opposed engineers' efforts to professionalize, in order to preserve flexibility and obtain technical skills at the lowest possible cost.³¹ Abbott notes that industrial corporations typically hire at the baccalaureate level to save money, and then provide in-house training as a means of building their employees' loyalty to the firm, rather than to the profession, while also limiting the employees' transportability. The common claim that market forces, not licensing laws, should determine the need for master's-level education is another reflection of this corporate perspective.

Significantly, industry groups and professional societies associated with manufacturing-oriented engineering disciplines have been most vocal in warning that raising standards for licensure will cause shortages of engineers. These warnings can reasonably be interpreted as attempts to preserve the availability of *low-cost* engineering services. According to Freidson, strong professions typically seek to restrict the number of practitioners by setting rigorous standards for attainment of professional licensure. In contrast, efforts to increase the number of engineering practitioners by resisting higher licensing standards clearly reflect the best interests of industry and not of the engineering profession. In this context, the ASME Board of Governors' efforts to

preserve an ample supply of less-educated engineers reflect an industrial rather than a professional perspective.

Conclusions

In this paper, I have examined the key points of opposition presented in the ASME position paper “Mandatory Educational Requirements for Engineering Licensure.” This analysis suggests the following conclusions:

- Many of the paper’s major points of opposition are seriously compromised by false assertions (Points 1 and 5), internal inconsistency (Point 5), misuse or selective use of statistics (Points 1 and 3), and inadequate measures (Point 7). Several simply miss the point by addressing problems other than the one that ASCE’s “Raise the Bar” initiative is intended to solve (Points 5 and 6).
- In defending the status quo, as “decreed by tradition and practice,” the ASME position paper is fundamentally complacent. In sharp contrast with the NAE *Engineer of 2020* report, the 5XME report, thoughtful analyses by some of the profession’s most respected thinkers, and even ASME’s own *2028 Vision for Mechanical Engineering*, ASME’s position on licensure fails to address the unprecedented future challenges that will demand unique new competencies of professional engineers.
- In the context of the Sociology of Professions, the ASME Board of Governors’ position on licensure reflects an orientation consistent with industries’ interest in maintaining a large supply of low-cost engineering talent. This perspective is clearly not in the best interest of the engineering profession, as it will only contribute further to the commoditization of engineering services and the subordination of the engineer’s professional authority to a corporate entity.

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Appendix A. American Society of Mechanical Engineers Position Paper, “Mandatory Educational Requirements for Engineering Licensure”

Mandatory Educational Requirements for Engineering Licensure

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General Position Paper
Approved by the
American Society of Mechanical Engineers (ASME)
Board of Governors
April 25, 2008

Endorsed by:

American Institute of Chemical Engineers (AIChE)

American Society of Heating, Refrigerating and
Air-Conditioning Engineers (ASHRAE)

Executive Board of the ASEE Engineering Deans Council

Illuminating Engineering Society (IES)

Institute of Industrial Engineers (IIE)

International Society of Automation (ISA)

Society for Mining, Metallurgy, and Exploration Inc. (SME)

The Minerals, Metals and Materials Society (TMS)

The Society of Naval Architects & Marine Engineers (SNAME)

Introduction

ASME (American Society of Mechanical Engineers) is a professional organization recognized globally for its leadership in providing the engineering community with technical content and a forum for information exchange. With a membership of more than 127,000 mechanical engineers and allied professionals from around the world, ASME serves this wide-ranging technical community through high-quality programs in continuing education, the development and maintenance of codes and standards, research, conferences and publications, government relations, and various forms of outreach.

ASME endorses lifelong learning and encourages mechanical engineers to pursue graduate degrees in engineering. As the quality of engineering education improves around the world, in order to remain globally competitive, engineers who wish to advance in their careers will need to continue their education either through formal study leading to a degree, or through the various types of continuing education that are offered.

The following organizations, representing more than 300,000 engineers, have endorsed this position statement:

- American Institute of Chemical Engineers (AIChE) representing 40,000 members;
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) representing 50,000 members;
- Executive Board of the ASEE Engineering Deans Council
- Illuminating Engineering Society (IES) representing 10,000 members;
- Institute of Industrial Engineers (IIE) representing 15,000 members;
- International Society of Automation (ISA) representing 30,000 members;
- Society for Mining, Metallurgy, and Exploration Inc. (SME) representing 12,000 members;
- The Minerals, Metals and Materials Society (TMS) representing 9,586 members; and
- The Society of Naval Architects & Marine Engineers (SNAME) representing 8,500 members.

Background

In 2006, the National Council of Examiners for Engineers and Surveyors (NCEES) adopted a change to the Model Law for professional engineers to require, after the year 2015, a bachelor's degree plus either 30 additional credits or a master's degree in engineering as a prerequisite for licensure as a professional engineer (BS+30).

NCEES claims that it was motivated to add additional credits due to the decline in university and college requirements for a bachelor's degree in engineering from an average of 144 credits 25 years ago to an average of 128 credits today. NCEES also notes the Department of Labor occupational rating for engineering professions is lower than other professions, including law, medicine, accounting, and architecture due to the diminishing educational requirements.

The First Professional Degree (FPD) in engineering has long been considered to be the degree needed for the practice of engineering. The FPD informs the public and licensing bodies about the minimum requirements that qualify an aspiring professional for practice. Since the 1920s, the FPD in engineering in most regions of the world has been a baccalaureate degree, requiring the equivalent of full time study of approximately four years.

Current engineering baccalaureate degrees typically require courses in mathematics; exact sciences and life sciences; fundamentals and practice of engineering; laboratory and design experience; metrology

and experimentation; ethics and professionalism; and selected topics from other disciplines, including the liberal arts and business. Some programs also include industry-based experience in the form of cooperative education or internships.

ASME Position Statement on Bachelor's plus 30 credits (BS+30)

ASME opposes a mandatory, across-the-board requirement of BS+30, beyond the FPD currently decreed by tradition and practice.

ASME believes that the typical scope of an ABET Accredited bachelor's degree can be and has been demonstrated to accommodate technical breadth and flexibility and the intellectual skills necessary for engineering graduates to attain licensure as a Professional Engineer. The steps in achieving that status are: (1) passing the Fundamentals of Engineering Examination, (2) successfully completing a four-year internship under a licensed engineer and (3) passing the final Principles and Practices Examination. Before being licensed as a Professional Engineer, these steps assure that the knowledge, skill and ethical standards expected from a Professional Engineer are attained. Continuing education is an essential to the attainment of licensure just as it is a life-long need for engineers of all disciplines beyond the studies that qualified them for the FPD.

The reason for engineering licensure is to help protect the safety, health and welfare of the public (as stated in the National Society of Professional Engineers Code of Ethics and in the codes of most of the other engineering societies.) Legislation in these matters should be used for the purpose of public well-being only. Increasing the prestige or status of the profession by raising the bar to access does not contribute to the profession nor serve the public. The value and effectiveness of the work that engineers do should be the sole measure of the profession. Professionalism and continuous education across the decades of an engineering career, along with strict adherence to the canons of ethics, is the real foundation of public safety.

ASME believes that increasing educational requirements for licensure should not be used as a tool to offset the nominal decrease in graduation requirements for the FPD. Over the past decades, legislatures and state higher education authorities have reduced the coursework required for a baccalaureate degree from as high as 150 to as low as 120 semester credits, primarily due to budgetary reasons. Yet, this gradual change over time has resulted in no drop in the national test scores in either examination required for engineering licensure. In order to produce such results, the approach to educating an engineer has had to become more efficient. Thanks to the power of computers, slide rules are no longer needed.

We currently have a workable, effective and adaptable system of examinations and supervision in practice that results in highly competent professional engineers. We also have a system of state oversight that can take action against an individual engineer or part of the system that can be demonstrated to have fallen short of professional expectations. If more front-end coursework is the remedy, it should be employed because public safety is at risk due to poorly educated engineers. This is not the case now, nor are we seeing early indicators that it will be the case in the foreseeable future.

The people of the United States are concerned about the nation's capabilities in science, engineering and technology. To compete in the modern technological society and global economy it is imperative that we expand our technologically capable workforce.

However, the low number of engineering students in four-year colleges has been going in the wrong direction nationally, as cited in the statistics* below:

- In 1981, 6.7 percent of degrees awarded were in engineering. In 1984, the figure rose to a high of 7.7 percent. Today it has dropped to 5 percent.
- During the past two decades, part of an era that has been described as science and engineering's greatest period of accomplishment, the numbers of engineers, mathematicians, physical scientists, and geoscientists graduating with bachelor's degrees in the United States have declined by 18%. The proportion of university students achieving bachelor's degrees in these fields has declined by almost 40% during that time.
- The number of engineering doctorates awarded by US universities to US citizens dropped by 23% in the past decade.

The engineering degree is one of the most challenging programs of study that one may undertake at the university and requiring an additional 30+ will make it even more difficult to attract the highly capable students we need to ensure our technological growth. Increasing the professional licensing requirements has the potential to reduce the supply of licensed engineers who are able to practice and therefore reduce our Nation's technological competitiveness.

Technological change is continuous and must be maintained over the typical 40 years of a professional engineering career. Adding an academic year of coursework would say very little about the ability of an engineer to practice today but the added cost would be a hardship. Committing an additional year to obtain an extra thirty (30) credit hours would be a very significant deterrent for anyone who might otherwise pursue an engineering degree.

There is also no evidence to suggest that adding thirty credit hours, which represents a full academic year of upper-level undergraduate coursework or graduate-level coursework, will have a positive impact on the public's health and safety. The fundamental issues affecting the public are already adequately covered under the current educational requirements. We believe that it is misguided to add a year of coursework on the front-end of a professional career as a remedy to a public safety problem that has not been demonstrated. It will discourage students from seeking a career in engineering by significantly adding to the time and cost of their education.

Conclusion:

In conclusion, ASME opposes a mandatory, across the board requirement of BS+30, beyond the FPD currently decreed by tradition and practice, for the following reasons:

- ASME believes that the typical scope of an ABET Accredited bachelor's degree can and has been demonstrated to accommodate technical breadth and flexibility and the intellectual skills necessary for engineering graduates to (1) pass the Fundamentals of Engineering Examination,

(2) successfully complete a four-year internship under a licensed engineer and (3) go on to pass the final Principles and Practices Examination before being licensed as a Professional Engineer.

- Continuing education is an essential life-long need for engineers, and significant learning is necessary for engineers of all disciplines beyond the studies that qualified them for the FPD. These principles are already incorporated within the present system as most states require professional development credit to maintain licensure.
- There is no clear benefit to requiring the BS+30, but there is considerable cost that will affect both firms and individuals (tuition, time off, fees, books, commuting, etc.)
- Due to the federated nature of licensing jurisdictions, some states may adopt the BS+30 and others will not, causing disparities and hindering licensee mobility.
- Engineers rank high in national polls compared to lawyers and other professionals and therefore there is no need to increase educational requirements to achieve additional prestige.
- ASME will continue to review the body of knowledge required for entry level engineers not from the standpoint of professional registration, which has been addressed above, but from the standpoint of the global competitiveness of graduating mechanical engineers.

ASME believes legislating this new barrier to entry into the profession is not in the public's interest and comes at the expense of engineering students, their parents and anyone who employs engineering services.

*Is America Falling Off the Flat Earth, Norman R. Augustine, Chair, Rising Above the Storm Committee, National Academy of Engineering and Institute of Medicine of the National Academies, 2007.

This General Position Paper was approved by the ASME Board of Governors on April 25, 2008.