AC 2012-3121: REDUCED CREDIT HOURS AND ENGINEERING LICENSURE: A PROPOSAL TO BREAK THE IMPASSE

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Abstract

In recent years the National Society of Professional Engineers (NSPE) and the American Society of Civil Engineers (ASCE) have been leading an effort to require a bachelor’s degree plus a Master’s degree or at least 30 additional acceptable credit hours in order to fulfill the educational requirements for a P.E. degree. The BS + 30 proposal, also known as the Raise the Bar Initiative, has been met with staunch opposition by other professional societies, such as the American Society of Mechanical Engineers (ASME), which want to retain the BS degree as the first professional degree. In many of the debates on this issue it seems that the parties are talking past each other using specialized definitions and not really engaging each other in meaningful debate. As a result, the Raise the Bar Initiative is stalled and the planned implementation date has been slipped from 2015 to 2020. This paper sets forth a comprehensive five-step plan to reconcile the competing interests in the Raise the Bar debate, proposing a politically feasible way to close the industry exemption, retain the BS degree as the first professional degree, and simultaneously restore 30 hours of engineering content subsequent to the BS degree and prior to registration as a PE. The key to the proposal is to focus first on Raising the Bar for Engineering Interns, after which changing the requirements for Professional Engineers will be more politically feasible.

The five steps are: 1) retain the BS as the educational requirement for Engineering Interns, 2) eliminate the industry exemption for Engineering Interns, 3) require continuing professional development (CPD) courses for Engineering Interns, 4) increase the CPD requirements for both Engineering Interns and Professional Engineers to 45 hours per year, the equivalent of one 3-credit hour college course per year, and 5) after ten years have passed, require the equivalent of 30 credit hours after the BS degree prior to registration as a PE. Once the first four steps have been in place for ten years, the first batch of EI’s to become registered under the new system would have 450 PDH’s (or the equivalent of 30 additional credit hours), at which point they would meet the educational requirements of the Raise the Bar Initiative to qualify for the PE exam. By focusing first on Engineering Interns, a politically feasible method is proposed to both close the industry exemption and phase in the adoption of the Raise the Bar initiative.

Introduction

In recent years most engineering programs have undergone a mandated reduction in student credit hours from an average of approximately 148 credit hours 30 years ago, to a nationwide trend to move toward a maximum of 128 credit hours for a Bachelor’s degree, with some pressure to move toward a 120 hour degree. These mandates are usually imposed upon all degree programs at the university by the various state legislatures in an effort to reduce costs and to improve graduation rates. These mandates have impacted the professional programs, such as engineering and nursing, more than other majors. As engineering programs strive to implement the required changes, external constraints are imposed on the way the cuts can be achieved by such organizations as the State Board of Regents, the Accreditation Board of Engineering and
Technology, Inc. (ABET), and the host university itself. These constraints have all tended to force the reduction of engineering content in a standard engineering program.

A reaction to these cuts has come in the form of proposals to de-certify the B.S. degree as the first professional degree for the practice of engineering. The National Society of Professional Engineers (NSPE) and the American Society of Civil Engineers (ASCE) have been leading an effort to require a bachelor’s degree plus 30 additional credit hours (commonly known as the B.S. + 30 proposal) in order to fulfill the educational requirements for a P.E. degree. If implemented, the BS + 30 proposal would bring engineering more in line with the Department of Education’s definition of a “first professional degree” as one that requires at least six years of education\(^1\). However, the BS + 30 proposal has been met with staunch opposition by the American Society of Mechanical Engineers (ASME) and eight other professional engineering societies, as well as the Executive Council of the American Society of Engineering Education (ASEE) Engineering Dean’s Council, the Texas Dean’s Council, and the American Council of Engineering Companies\(^2\)\(^-\)\(^5\), all of which want to retain the B.S. degree as the first professional degree.

While the controversy over licensure requirements rages unabated, the simple fact remains that most engineers practice in industry or government without being licensed under any set of criteria at all, using the gaping loophole called the “industry exemption.” Recent engineering disasters such as the Gulf Oil Spill have led to renewed calls to close the industry exemption, but since industry generally believes that it benefits from the loophole, the political willpower never seems to exist in the state legislatures to eliminate the industry exemption.

This paper sets forth a comprehensive five-step plan to reconcile the competing interests in the BS+30 debate, proposing a politically feasible way to close the industry exemption, retain the BS degree as the first professional degree, and simultaneously restore 30 hours of engineering content subsequent to the BS degree and prior to registration as a PE.

Proposed Five-Step Plan

The proposed steps are as follows:

1 - Retain the BS as the Educational Requirement for Engineering Interns

The first step in this comprehensive proposal is to retain a commitment to maintain the BS degree as the educational requirement for Engineering Interns. Many have lamented the fact that over the last 20 years or so there has been a steady reduction in the number of credit hours in a typical engineering bachelor’s degree program, and various proposals such as the BS+30 proposal and others\(^6\) have been offered up to counter this downward trend in credit hours. The BS+30 proposal would not be particularly alarming if the proposal were to remain limited in scope to a discussion of the educational requirements for the PE license, but there has been a recent move by The National Council of Examiners for Engineering and Surveying (NCEES) to insist upon additional educational requirements as a condition of accreditation for an undergraduate engineering program, which could have far-ranging unintended consequences. In fact, in its March 15, 2010 Strategic Plan\(^7\), NCEES identified Educational Requirements for
Licensure as Strategic Issue #1, and set the following goal: “Promotion to ABET and the ASEE Engineering Deans Council the need for incorporating core knowledge and competencies into ABET criteria,” and NCEES also set forth the following as part of its action plan: “Continue discussions with ABET to consider revisions to the educational requirements necessary for an institution to receive EAC/ABET accreditation.” To date ABET, Inc. itself has remained neutral on the BS+30 discussion, preferring to leave questions of requirements to be defined by the individual member disciplines, while the Executive Council of the ASEE Engineering Dean’s Council has voiced strong opposition\(^2,3\), as discussed above.

In spite of this recent move by NCEES, there is good reason to maintain the BS degree as the educational requirement for licensure as an Engineering Intern, even if engineering programs are eventually forced to reduce the number of credit hours to as low as 120 credit hours. As justification for this suggestion, it can be noted that over the same period of time when engineering programs have lost content, there has been no corresponding reduction in the pass rate for the Fundamentals of Engineering exam, which is administered by NCEES. Guidance can also be derived from the Accreditation Board for Engineering and Technology (ABET, Inc.) and from ASCE, both of which have made an effort to define the Body of Knowledge (BOK) required to succeed as an engineer, as discussed below.

There is no minimum number of credit hours specified by ABET, Inc. to maintain an accredited engineering program. Instead, ABET, Inc., through its Engineering Accreditation Commission (EAC), has established the “Criteria for Accrediting Engineering Programs”\(^8\) which specifies the familiar eleven learning outcomes commonly referred to as “a – k.” Every accredited engineering program must demonstrate that its students are able to achieve outcomes a – k, regardless of the number of credit hours in the program. Because ABET, Inc. specifies learning outcomes rather than credit hours, engineering programs across the country have responded in a variety of ingenious ways to the mandated reductions in their curricula, and have been able to reduce the number of credit hours without sacrificing quality, which must be continuously assessed and measured as a condition of on-going accreditation. There is a close correlation between the topics on the FE exam and the learning outcomes a – k, so maintaining a certain standard of achievement on outcomes a – k can be expected to indirectly maintain a level of achievement on the FE exam as well.

The ASCE Committee for Academic Prerequisites for Professional Practice has for many years been working to define the Body of Knowledge (BOK) needed for Civil Engineers to function effectively in industry as Professional Engineers\(^9\). Although developed for Civil Engineering only, the broad outlines of the BOK can be insightful for all disciplines, and other professional organizations (such as the American Academy of Environmental Engineers and the American Society of Mechanical Engineers) are beginning to develop their own versions of a BOK. Now in its second incarnation, The Civil Engineering BOK2 identifies 24 learning outcomes and specifies the level of mastery desired for each outcome using the six progressive levels of achievement of Bloom’s Taxonomy\(^10\), namely: knowledge, comprehension, application, analysis, synthesis, and evaluation. The BOK2 document also indicates the portion of the BOK2 that is expected to be fulfilled by the BS degree, by engineering experience, and by an MS degree or 30 hours of equivalent graduate level work (the proposed BS + 30). Appendix A contains a very illustrative diagram taken from the BOK2 document. The diagram shows that 20 of the 24...
outcomes are currently achieved at the application level or higher by the bachelor’s degree in engineering, which is all that is needed to pass the FE exam. It is only for the following four outcomes that the BS degree is expected to produce achievement at less than the application level: technical specialization, public policy, business and public administration, and attitudes. And for three of these four outcomes, the gap between the BS level of achievement and the application level of achievement is made up entirely by engineering experience, which argues that formal education is not necessary to reach the full performance level of achievement for those outcomes. It is only in the area of technical specialization that graduate level work is needed to grow past the application level of achievement and up through four levels of achievement in Bloom’s taxonomy to reach the full performance level. However, deep technical specialization is not needed to pass the FE exam or to begin one’s career in engineering as an Engineering Intern. Technical specialization is something that can well wait until the young engineer has gained a little experience and identified an area of particular interest.

In summary, even at 120 credit hours, most engineering programs would have no trouble demonstrating a constant high level of quality of their students, in terms of the ABET, Inc. learning outcomes a – k. Similarly, 120 credit hours would be sufficient to reach the application level of achievement in 20 of the 24 BOK2 learning outcomes, which would be more than sufficient to pass the FE exam and to begin one’s career as an Engineering Intern. It is therefore proposed that an ABET, Inc. accredited BS degree retain its place as the standard educational requirement for the first professional certification, which is the Engineering Intern.

This proposal makes a conscious choice to define the Engineering Intern as the first professional certification, which makes the Professional Engineer license the second professional certification. If this distinction is accepted, then the BS retains its place as the “first professional degree,” and the BS+30 debate shifts from a debate over the “first professional degree” to a discussion regarding whether there needs to be a second professional degree (MS or equivalent) or not. One reason to make this distinction between first and second professional degrees is to make it clear that the BS+30 proposal really has very little to do with undergraduate engineering education, and so efforts to get ABET, Inc. to change the requirements for an accredited engineering BS program are out of place. There is another reason to make the distinction, which will be discussed below.

2 - Eliminate the Industry Exemption for Engineering Interns

The second step in this proposal is that the infamous “industry exemption” should be eliminated – not at the PE level, which is impractical, but at the level of the Engineering Intern instead. Since its inception in 1934, NSPE has consistently promoted the general principle that all who practice engineering should become registered Professional Engineers (PE’s) and NCEES has identified the “Elimination of exemptions in the practice acts” as one of its goals in its most recent Strategic Plan.

The state legislatures have generally been guided by the NCEES Model Law when enacting the necessary legislation to define and regulate the practice of engineering in their jurisdiction, but industry and governmental entities have always insisted upon various forms of exemptions for themselves. The many exemptions have led to some very strange results. For instance,
Model Law defines engineering (partly) as, “any service or creative work, the adequate performance of which requires engineering education, training and experience...insofar as they involve safeguarding life, health, or property.” Yet by virtue of various exemptions, the work done by the engineers at NASA does not (by definition) constitute the “practice of engineering.” Strangely, neither does the bulk of the actual engineering work that gets done in this country – engineering work that produces and distributes most of the various forms of energy used, and that produces most of the products the public relies upon everyday, such as airplanes, automobiles, and cell phones. It is obvious that “engineering education, training, and experience,” are necessary to perform these tasks, and that they all involve “safeguarding the life, health, or property” of the public, yet these exempted tasks are not construed to constitute the “practice of engineering,” and the exempted products are not considered “engineered products.” In the presence of the “industry exemption,” the definition of what constitutes the practice of engineering loses all functional meaning and is in effect reduced to the trivial and circular definition that “engineering” is the work done by a licensed Professional Engineer. The net result of the so-called “industry exemption” is that only between 10% and 20% of all degreed engineers ever become registered Professional Engineers, so in effect, the exemption has become the rule, and licensure, which should be the rule, has become the exception.

Defining the bulk of the engineering work done in this country to not really be “engineering,” has led to other strange results. For example, the ASCE Paraprofessional Exploratory Taskforce Committee (PETC) defines all engineers besides the 10 – 20% who are PE’s to be “Engineering Paraprofessionals (EPP’s),” even though the education, the length of experience obtained, the job titles used, the actual work they perform, and “the levels of responsibilities may include those for which professional licensure would be required in non-exempt service.” Figure 1 below is taken from the PETC report.

![Figure 1 - ET, EPP, and EP Type of Activities, Range of Authority, and Level of Training, Certification, Experience, and Responsibility (Figure 4.3.1 in the PETC Report)](image-url)
In the figure above, the distinction between an Engineering Technician (ET), an Engineering Paraprofessional (EPP), or an Engineering Professional (EP) depends chiefly upon the level of training, certification, experience, and responsibility of the person performing a task. The figure and the accompanying PETC report also indicate that ET’s are only qualified to solve well-defined problems under strict supervision, that EPP’s can solve broadly defined problems in support of an EP, but that only EP’s are qualified to solve complex problems. The report defines an EP as follows, “An Engineering Professional (EP) is a position that encompasses responsible charge of engineering work and, therefore, must be held by an individual licensed to practice engineering.” An Engineering Paraprofessional is defined as, “a position supporting an EP.” The report indicates that, “EPPs are generally engineering technologists,” but also states that EPP work may also be performed by degreed engineers.

So where do the bulk of the nation’s degreed engineers who do the majority of the nation’s engineering work in this country fit into this continuum? Because they are not licensed, they are of necessity relegated to the diminutive (and somewhat pejorative) status of Engineering Paraprofessionals. In common usage a paraprofessional is a person who has at most an Associates degree in their field, and who can only work in very limited roles under strict supervision. Examples from other professions include paralegals, nurse’s aides, dental hygienists and assistants, teacher’s aides, and bookkeepers. Under normal circumstances it would probably never occur to someone to compare a senior NASA engineer to a paralegal or a dental assistant, based on a comparison of the respective levels of education, experience, ability to work without supervision, or the complexity of the problems solved, yet that is the comparison that must be drawn when one abandons a functional definition of an Engineering Professional and adopts instead the trivial and circular definition that an Engineering Professional is a PE and that all other degreed engineers, regardless of the type of work they do, are merely Engineering Paraprofessionals.

Another issue the ASCE Paraprofessional Exploratory Taskforce Committee (PETC) grappled with was trying to identify how to incorporate graduates from Civil Engineering Technology (CET) programs into the larger Civil Engineering workforce. In the PETC report, the CET graduates are lumped with degreed (but not licensed) engineers in the EPP category. Noting that there was a clear credentialing standard for the EP category (the PE license), the PETC report [page 42] perceived a lack of a credentialing standard for the EPP category.

“Given that much of the routine work in the enterprise of civil engineering appears to fall under the classification of EPP (see Tables 4.2.1, 4.2.2 and 4.2.3), an EP would seem to be under-utilized when performing EPP work. While some “non-responsible-charge” work by EPs is inevitable, extensive work by EPs at EPP tasks can be inefficient. A more cost-effective application of effort would appear to be the use of EPPs. Therefore, recognition of the EPP position would be of substantial import.”

“Furthermore, there are many graduates of civil engineering and CET programs who will choose not to attain a P.E. and find career satisfaction working as an EPP. Some recognition of their competency is needed within and outside of the profession. To attain this recognition, it would be helpful to have minimum credentialing standards. Such a system could be a second or simultaneous step in the ‘Raise the Bar’ campaign.”
The PETC then sets for itself the near-term goal[^14] to “Evaluate the need for standardized, formal credentials that can be used to demonstrate entry-level and continued competency of paraprofessionals in civil engineering.” Perhaps it was because the PETC was focused on reconciling the differences between technology graduates and engineering graduates that they overlooked the obvious fact that a standardized formal credentialing system to demonstrate entry level competency in civil engineering (and all other engineering disciplines) already exists. It is the process leading to certification as an Engineering Intern, which includes the requirement to attain specified minimum educational standards and to pass the Fundamental of Engineering exam. If in Figure 1 above the term EPP were replaced by Entry Level Engineer (ELE) and the term EP were replaced by the term Senior-Level Engineer (SLE), then a functional definition would exist that would apply equally well in all engineering disciplines and in all industries, and the credentialing question would be solved. The Engineering Intern certificate would be the proper credential for an Entry Level Engineer and the Professional Engineer license would be the appropriate credential for the Senior Level Engineer. The proposed ELE/SLE distinction also highlights the need for a completely separate credentialing standard by which engineering technologists could someday be recognized as full-fledged Technology Professionals in their own right, rejecting the externally imposed and diminutive designation as Engineering Paraprofessionals.

The difficulty in implementing the proposed ELE/SLE distinction, is that due to the “industry exemption” most engineers (who are in actual fact practicing engineering by performing work that requires engineering education, training and experience, and that involves safeguarding life, health, or property) are not required to obtain either credential. Thus any effort to raise the minimum standards for licensure (such as the BS+30 proposal) without first closing the gaping loophole that is the industry exemption will have limited effect in terms of protecting the life, health, or property of the public. In fact, the net effect may simply be that even fewer people will seek licensure, or a career in any field of engineering (such as Civil Engineering) where licensure is usually required. Such a result would surely be an unintended negative consequence.

The necessary first step in any meaningful reform, therefore, must be to eliminate the notorious “industry exemption,” although doing so will not be easy. In 2005, Neil Norman, Past President of NSPE, wrote an informative white paper summarizing the history of the industry exemption and the many unsuccessful attempts to overturn it[^15]. Because of this dismal history of attempted reform, no one really wants to discuss the industry exemption anymore, believing any such proposal to be dead on arrival. The recent Gulf Oil Spill disaster, however, did lead to renewed calls for the repeal of the industry exemption[^12, 16-18], but it would now appear that the crisis has passed with no significant reform taking place, except for the added requirement that in the future a Professional Engineer must certify the well casing designs and cementing procedures[^19]. So the most devastating engineering disaster in recent memory only led to the removal of the exemption for certain products and processes, rather than the elimination of the industry exemption as a whole, or even the elimination of the exemption for an entire industry (such as the oil industry). It is not reasonable, therefore, to imagine that the industry exemption will be lifted anytime soon at the level of the Professional Engineer.

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[^15]: Neil Norman wrote an informative white paper summarizing the history of the industry exemption and the many unsuccessful attempts to overturn it.
[^12]: The recent Gulf Oil Spill disaster led to renewed calls for the repeal of the industry exemption.
[^16]: The crisis has passed with no significant reform taking place, except for the added requirement that a Professional Engineer must certify the well casing designs and cementing procedures.
[^19]: The industry exemption was only removed for certain products and processes, rather than the entire industry or the entire profession.
There is another possibility, however, that is much more politically feasible and that could have a very significant impact on safeguarding the life, health, and property of the public. That possibility is to require that after a certain date all Entry Level Engineers will have to become certified as an Engineering Intern before they can practice engineering of any type, regardless of where they work, whether in government, industry, or in a consulting company.

Industry may not object to this proposal very strenuously, primarily because they do not have to pay for it, since in most cases the FE exam will be taken during the senior year at the university. And since the majority of the engineering work actually done in this country is done by Entry Level Engineers under the supervision of a smaller number of Senior Level Engineers, the impact of this relatively minor reform would become very large over time as the newly licensed EI’s eventually move into the role of Senior Level Engineers. Within 20 to 30 years of adopting this proposal, virtually all practicing engineers would possess at least one standardized credential that could demonstrate and insure continued competency.

3 - Require Continuing Professional Development for Engineering Interns

The third step in this proposal is that once every engineering graduate is required to become licensed as an EI, the same Continuing Professional Development (CPD) requirements that generally apply to Professional Engineers (in 32 states) should also apply to Engineering Interns. The justification for this is the same as the justification for Professional Engineers, coupled with the long overdue recognition that Engineering Interns actually practice engineering, and that in order to safeguard the life, health, and property of the public, Engineering Interns need to stay current in their field. Although it was reasoning from a different context, the PETC Report\(^{14}\) reached a similar conclusion regarding the need for continuing education requirements for Engineering Interns (who are referred to as EPP’s in the PETC Report), as shown below:

“In regards to demonstrating continued competency, most states now require EPs to attain some level of continuing education to qualify for renewal of their P.E. license. The details of required continuing education for EPs vary by state board of registration. Through continuing education, the EP is assumed to maintain currency and competency within their discipline, and consequently provide continued protection of public health, safety and welfare. It seems reasonable that a similar continuing education standard should be required of EPPs…”

“The need for such periodic demonstration of continued competency is becoming more acute in civil engineering for a variety of reasons, including both an expanding body of knowledge and the increasing use of sophisticated design tools such as computer software. Many vendors of construction products are providing design software that make it ‘easy’ to obtain solutions to design problems, but validity of the solutions must be verified for each application. Therefore, both EPs and EPPs need to maintain proficiency on both design applications and, more importantly, the fundamental concepts on which design products are based.”
Over the course of about 20 years following the implementation of this proposal, the bulk of the engineering workforce will be made up of Engineering Interns who will need to stay current in their field through CPD opportunities and/or formal education.

4 - Increase CPD Requirements

The fourth step in this proposal would be to increase the CPD requirements for both EI’s and PE’s to the level of 45 contact hours per year, of a level of rigor that is equivalent to one 3-credit hour course per year. Additionally, these CPD requirements could be specified to cover discipline specific needs (such as ethics and technical specialization). Currently, the number of required PDH’s (in the 32 states that do require Continuing Professional Development) ranges from 4 per year in Florida, 8 per year in Virginia, 12 per year in five states, and 15 per year in the remaining 25 states. By raising the CPD requirements to 45 PDH’s per year, an engineer would garner the equivalent of 12 credits hours in the first four years of service as an Engineering Intern, enough equivalent credit hours for an MS after 10 years, and enough hours for a PhD after about 20 years. Given the exponentially expanding nature of technology, there is no level of formal education (BS, MS, or PhD) that will be an adequate substitute for life-long learning. Of course formal education can still serve as a viable means of meeting the additional educational requirements for licensure, but the need for Continuing Professional Development continues, even after the degree has been earned.

5 - After Ten Years Raise the Bar to the BS+30 Level for the PE License

If the first four steps in this proposal were adopted, then the only remaining difference between the BS+30 proposal and the current proposal would be time in service prior to registration as a PE. If all four steps to this proposal were implemented, then within 10 years of adopting the proposal the vast majority of engineers in practice would have become certified as EI’s, and the first batch of EI’s would have enough credits to satisfy the proposed BS+30 requirement for licensure as PE’s. The current target for implementation of the NCEES Model Law is 2020. If this proposal were adopted this year, then by 2022 implementation of the Raise the Bar initiative would be painless, since virtually every practicing engineer would have the equivalent of the 30 extra credit hours and the industry experience needed to obtain a PE license. In addition, the bulk of the practicing engineers would have at least one professional certification and the dreaded industry exemption to fade away naturally over the course of about 30 years as EI’s who are already non-exempt become licensed as PE’s, and as older exempted degreed engineers retire.

Summary and Conclusions

This paper sets forth a comprehensive five-step plan to reconcile the competing interests in the BS+30 debate, proposing a politically feasible way to completely close the industry exemption over the course of about 30 years, to retain the BS degree as the first professional degree, while simultaneously restoring 30 hours of engineering content subsequent to the BS degree and prior to registration as a PE. The five steps are: 1) maintain the BS degree as the educational requirement for the Engineering Intern license, 2) eliminate the industry exemption at the Engineering Intern level, 3) impose CPD requirements on Engineering Interns, 4) increase the
CPD requirements for both EI’s and PE’s to 45 hours per year, and 5) after ten years, implement the BS+30 requirement for PE Licensure.

If the first four proposals were adopted immediately, the first batch of EI’s would have enough credit hours to qualify for the PE license within 10 years, and within 30 years nearly the entire engineering workforce would be registered either as an Engineering Intern or as a Professional Engineer and the dreaded industry exemption would finally be closed. Implementing this proposal would represent a monumental advance in the ability of the engineering profession to safeguard the life, health, and property of the public.

References


Appendix A

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**Key:**
- B: Portion of the BOK fulfilled through the bachelor's degree
- M/30: Portion of the BOK fulfilled through the master's degree or equivalent (approximately 30 semester credits of acceptable graduate-level or upper-level undergraduate courses in a relevant technical area and/or professional practice area related to civil engineering)
- E: Portion of the BOK fulfilled through the prelicense experience

Figure 3. The BOK rubric integrates outcomes, levels of achievement, formal education, and prelicense experience.