Implementing Civil Engineering-specific Requirements for Professional Licensure

Dr. Matthew Swenty P.E., Virginia Military Institute

Matthew (Matt) Swenty obtained his Bachelors and Masters degrees in Civil Engineering from Missouri S&T and then worked as a bridge designer at the Missouri Department of Transportation. He obtained his Ph.D. in Civil Engineering at Virginia Tech and then worked at the Turner-Fairbank Highway Research Center on concrete bridge research. He is currently an associate professor of Civil Engineering at the Virginia Military Institute (VMI). He teaches engineering mechanics and structural engineering courses at VMI and enjoys working with the students on bridge related research projects and with the ASCE student chapter.

Craig N. Musselman, A & E Consulting

Craig N. Musselman, P.E. is a practicing civil and environmental engineer and is the Founder and President of CMA Engineers, a consulting engineering firm with offices in New Hampshire and Maine. He holds B.S.C.E. and M.S.C.E. degrees from the University of Massachusetts and has more than 35 years experience in the planning, design and construction administration of public works facilities. Musselman is a former member of the New Hampshire Board of Licensure for Professional Engineers and was actively involved in the National Council of Examiners for Engineers and Surveyors (NCEES) through committee and task force involvements over the past 10 years. For NSPE, he is the Chair of the Licensure and Qualifications for Practice Committee. He is a member of the ABET Board of Directors. Musselman is a Fellow of NSPE and ACEC and a Distinguished Member of ASCE, and he received the ASCE President's Medal in 2006 and the NSPE President's Medal in 2011, for service to the engineering profession. He is a frequent speaker on engineering licensure and education topics throughout the U.S. He also serves as the Chairman of the Board of Selectmen for the Town of Rye, N.H.

Dr. Monte L. Phillips P.E., University of North Dakota

Monte L. Phillips is an Emeritus Professor of Civil Engineering at the University of North Dakota. He received a PhD from the University of Illinois and BS and MS degrees from the University of North Dakota. During a forty year career as an educator, he served on the faculties of the University of North Dakota, the University of Illinois, and Ohio Northern University, as well as devoting time to private practice as a design consultant and forensic engineer. He is a registered professional engineer in North Dakota.

Dr. Phillips is a Distinguished Member of ASCE, past two-term North Dakota Section president, and has chaired the ASCE Experience Committee and the ASCE BOK Experiential Fulfillment Committee both constituent committees of the ASCE Committee on the Academic Prerequisites for Professional Practice (CAP^3). He has served on the ASCE Committee on Licensure and the Experiential Fulfillment Strategic Planning Subcommittee of the Committee on Licensure and Ethics. He currently serves on the ASCE BOK3 Task Committee which is preparing the 3rd Edition of the Civil Engineering Body of Knowledge for the 21st Century, and represents ASCE on the NCEES POLC Committee. He is the recipient of the ASCE 2012 William H. Wisely American Civil Engineer Award,

Dr. Phillips has been an active member of the National Society of Professional Engineers (NSPE) at the local, state, and national levels serving as national president in 1994-95. He is past president of the North Dakota Society of Professional Engineers and was awarded the North Dakota Society's Elwyn F. Chandler Award and the prestigious North Dakota National Leadership Award of Excellence in recognition of outstanding national leadership of the engineering profession. He continues to serve NSPE as chair of the Council of Fellows Executive Committee. He served a five-year term, including chair, of the North Dakota Board of Registration for Professional Engineers and Land Surveyors. He is the recipient of the 2013 NSPE Award, the society's highest honor.

Dr. Phillips has served on numerous task forces and committees of the National Council of Examiners for Engineering and Surveying (NCEES) involved with enhancing the educational requirements for entry

into the professional practice of engineering including chair of the Fundamentals of Engineering Effectiveness Task Force, the Licensure Qualifications Oversight Group, and the Faculty Licensure Task Force. NCEES recognized his service with the NCEES Central Zone's Distinguished Service Award (2001), the NCEES Distinguished Service Award (2005), and the NCEES Distinguished Service Award with Special Commendations (2013).

Dr. Phillips represented NCEES on the ABET Board of Directors for seven years and served as the 2013 - 2014 ABET President. He has been involved with the development of ABET's Strategic Plan for the future as a member of both the Strategic Planning Task Force, the Global Council, as well as their predecessors, the Strategic Planning Committee and the International Activities Council. He has served on the ABET Finance Committee, the Ad-Hoc Outreach Task Group, the Strategic Management Ad-Hoc Task Group on Governance, the Nominating Committee, and he chaired the Admissions Committee.

Dr. Phillips is a Fellow and past president of the National Academy of Forensic Engineers; a past six-term member of the Board of Directors of the National Institute of Building Science; has served 21 years on the National Board of Governors of the Order of the Engineer including two years as chair; and has authored papers and reports on engineering licensure.

L. Robert Smith P.E., American Society of Civil Engineers

Implementing Civil Engineering Specific Requirements for Professional Licensure

Abstract

The American Society of Civil Engineers (ASCE) has supported an increase in educational requirements for the professional practice of engineering for the past twenty years. These efforts were named the Raise the Bar initiative and were initially meant to apply to the qualifications of all engineering disciplines. In July 2017, the ASCE Board of Direction modified ASCE Policy 465– Academic Prerequisites for Licensure and Professional Practice to focus only on civil engineers. This renewed effort and re-focus of the Raise the Bar initiative will have profound impacts on ASCE's Raise the Bar activities.

The United States has a longstanding tradition that engineering licenses are granted by each jurisdiction (states and territories). If additional education requirements are implemented through licensure, each of these jurisdictions will need to determine how to address these new education standards that would apply only to civil engineers.

The authors, under the auspices of the ASCE Committee on Licensure, have researched this topic and determined there are two possible routes for different education requirements for licensure among engineering disciplines: discipline specific licensure and a civil centric approach. Discipline specific licensure would require that licensing boards consider applicants for each area or specialty of engineering both separately and differently. The requirements whether education, experience, or testing could vary, the license could be linked to a unique niche of engineering work, and the license would have a specific designation for each area of engineering. The civil centric approach would maintain a general professional engineering license for all engineers, but would allow the licensing jurisdiction to vary the requirements for applicants based on their education background. For example an applicant with a bachelor's degree in civil engineering would also need a master's degree to pursue licensure.

Both of these approaches are unique and would require substantial changes to most licensing jurisdiction's rules. The authors analyzed both the discipline specific and civil centric approaches for their respective strengths and weaknesses. Current licensing jurisdictions that use variations of these methods were investigated to see the past successes and impacts on licensing boards. In addition, conflicting policies from other professional groups and similarities to licensure processes of other professions were considered. The results are presented from both a policy and a practicality standpoint. The conclusion is that changes to licensing jurisdiction rules and policies may be beneficial to the ASCE Raise the Bar efforts, but implementation would be difficult. The consequences need to be carefully weighed by the civil engineering community before moving forward with this strategy.

Introduction

The Professional Engineering (PE) license is very important to the engineering profession in the built environment. The designation signifies a minimum level of competency for engineers based on education, experience, and examinations. Obtaining a license allows a person the privilege of practicing engineering independently and being the engineer of record in responsible charge of projects.

Various forms of professional licensure have existed in many professions for hundreds of years. One of the primary reasons for professional licensure laws in the modern age is to protect the public. Current engineering licensure laws in all fifty five jurisdictions (states and territories) are intended to help uphold the public trust in engineering by certifying that engineers place public health and safety paramount above all other considerations including client or employer benefit and personal gain.

The requirements for professional engineering licensure vary somewhat among states, but the process has much in common. First, a degree from a program accredited by the Engineering Accreditation Commission (EAC) of ABET or a degree determined equivalent must have been earned prior to application for licensure. Second, an applicant needs to have a prescribed number of years of progressive engineering experience working under a licensed engineer. Third, he or she must pass a series of exams, typically the standardized fundamentals of engineering (FE) and professional engineering (PE) exams, administered by the National Council of Examiners for Engineering and Surveying (NCEES). These requirements have remained relatively unchanged for many years.

Over 80% of jurisdictions have not adopted a discipline specific licensure method [1]. They maintain a general PE license for engineers of all disciplines. Engineers may choose the appropriate PE exam closest to their area of expertise. The process is the same regardless of the area of practice, expertise, or degree earned. Additionally, the experience and education do not necessarily have to align. Once licensed it is ultimately the engineer's responsibility to only practice in his or her area of expertise unless they are in a discipline specific jurisdiction. Using this method puts the responsibility on the individual engineer to define his or her area of competence and practice in this area in non-discipline specific jurisdictions.

There has been discussion on the broad scale whether licensure requirements should be amended. One of the most significant proposed changes that has been discussed for many decades is the amount of education required for licensure [2]. A baccalaureate degree from a program accredited by EAC/ABET has been the standard minimum education level for the professional engineer since the early years of licensure in the United States. The engineering profession has gone through significant changes and continues to change in the modern era. Many civil engineers have suggested a more advanced degree or knowledge base is needed to effectively engineer the modern world. If additional education is to be required as a prerequisite for

licensure, then this could possibly cause a major overhaul of the licensing process in each jurisdiction within the United States.

Background

Historical Engineering Licensure

The PE license has been an instrumental part of the engineering profession since its inception over 100 years ago. A review of the history of licensure shows that the process came about at a time when engineers were developing the concept of a profession. The public desired a standard that would help them identify minimally competent engineers and the engineering community wanted to promote the unity, professionalism, and ethical nature of engineering practice. Early licensure laws in the United States were developed state by state throughout the first half of the 20th century [3]. The process took many decades to fully implement and met particular resistance from industrial corporations that employed a significant percentage of engineers.

One of the key outcomes in the development of the early laws was the institution of the industrial exemption. Many large industrial corporations that employed engineers did not like the idea of requiring all engineers to become licensed to practice engineering. The accepted norm was that engineers working under the direction of the company's leadership and standards would provide enough safety for the public. While this may have seemed like a minor compromise at the time, many fields of engineering today do not promote licensure and most engineers are not licensed. This can be traced back to this historical precedence and it continues to be a challenge to licensure proponents to this day [2], [4]. When discussing any changes to licensure laws no matter the size, there is always the industrial exemption clause that must be considered because of its straightforward opposition to the licensure concept.

Civil engineering is one discipline of engineering that continues to be a strong supporter of licensure among most of its members. Due to the nature of their work in the built environment, many of their jobs require licensure to obtain promotions and become leaders on projects. The American Society of Civil Engineers (ASCE) promotes licensure through many avenues including its policy statements, Committee on Licensure (COL), Code of Ethics, and licensure's strong tie to the civil engineering Body of Knowledge (BOK2) [5], [6], [7]. While many other engineering disciplines have not similarly embraced licensure to as high a degree, the civil engineering profession's leadership continues to strengthen licensure inside the profession through education of its members and outside the profession through government lobbying efforts and public awareness campaigns.

The State of Licensure

Currently licensure is in a period of uncertainty and possible change. There are many movements inside and outside of the engineering profession that are attempting to amend or eliminate licensure altogether. Those outside the profession who propose to eliminate licensure

are individuals who view all forms of licensure as a detriment to the economy, business, and society as a whole. They feel the free market and individual common sense are sufficient to select competent engineers for projects [8]. These movements to limit licensure are not new and will likely always exist [9]. In recent years, legislative efforts to eliminate licensure in a number of states have been focused on licensure of trades, but professions such as engineering get associated with many anti-licensing campaigns. This serves as a reminder that the engineering profession must always be ready to justify and defend licensure and must always work on educating the public about the profession. Any efforts to change licensure requisites become moot if the primary basis for licensure is forgotten or not clearly communicated.

While the external forces may continue to pose a threat to licensure, the more immediate challenge is to continue to promote licensure within the profession. Many avenues have been suggested to increase participation in licensure including the early taking of the PE exam. Traditionally those on the path to licensure took the FE exam, obtained the required years of experience under the responsible charge of a licensed engineer, and then took the PE exam. Today the PE exam can be taken prior to obtaining the necessary required experience in some licensing jurisdictions. One of the arguments for allowing this is to get more prospective engineers to take the PE exam. While this doesn't facilitate licensure, many in the profession feel early takers of the exam are more likely to get the experience and ultimately become licensed than if they have to take the PE exam four or more years after graduation [10].

Another movement within the civil engineering profession that has direct ramifications on licensure is the ASCE Raise the Bar (RTB) movement that started over 20 years ago. Those in favor of this change believe that the requisite knowledge base for civil engineering has progressed in depth and breadth while the requirements for a bachelor's degree have lessened and that a traditional four year engineering degree is not sufficient for a professional engineer [8], [11]. To counter this problem, ASCE's proposal has been to require engineers to obtain a master's degree or equivalent prior to obtaining a license as a professional engineer. As one might expect this proposal has met resistance from some engineers and engineering societies [12]. Many have suggested that professional licensure is already protecting the public sufficiently, therefore there isn't the need to change the current licensure laws. The intense debate among engineering disciplines has led to a stalemate in the progress of RTB. No state licensing board has revised the education level required to obtain an engineer's license since the beginning of this effort.

Even within the civil engineering community there has been resistance about the necessity of the master's degree or equivalent. By definition, licensure sets a minimum competency level needed for an engineer to practice at the professional level. Through the RTB efforts the civil engineering BOK2 was produced that sets a standard for competency upon licensure. These levels are not in agreement with licensure requirements and they are currently being debated and reviewed. There has been discussion over whether licensure should be directly linked to the BOK2 outcomes, because these topics may be at higher outcome levels than minimum

competency. It has also raised opposition from those who are specialists in a particular area as well as from those who practice as generalists. This discussion is ongoing as the ASCE BOK committee reviews and revises the next version of the BOK.

Due to broad opposition to the RTB effort from other engineering disciplines, ASCE has recently reviewed its plan on promoting additional education requirements for professional engineers. In 2017 many of the relevant policy statements including Policy 465 "Academic Prerequisites for Licensure and Professional Practice" were amended [13]. The new policies are civil engineering centric. While previous efforts were trying to revolutionize engineering licensure on a broad spectrum regardless of discipline, the new focus is solely on those that identify as civil engineers.

The authors of this paper have studied how these changes would affect the jurisdictions that control engineering licensure. In the majority of cases engineering licensure has been a generic license for all those in engineering; there is no clear demarcation among the specific fields such as civil, mechanical, or electrical engineering [1]. The question remains whether a civil centric approach would be a practical solution to RTB for civil engineers. Through a study of current state laws and a comparison to other professions, the implementation of civil specific licensure was reviewed and analyzed for its use in promoting the RTB efforts.

Licensure Methods

There are multiple approaches to require additional education to become a licensed engineer. Historically, civil engineering programs had more curricular requirements to obtain a degree therefore, one solution is to return to a more robust bachelor's degree in engineering [8]. Providing bachelor's degrees with a minimum number of approximately 150 credit hours instead of the current average of 128 would significantly improve the knowledge base of new engineering graduates [14]. While a seemingly easy solution, increasing credit hours on the baccalaureate level is fraught with a number of well documented challenges including cost, requiring more than four years of study, and political pressure on the state level [12]. The Canadian government has taken this approach by working closely with their accredited universities and keeping the bachelor's degree at an average of 155 semester credit hours [15]. However, there are significantly fewer accredited Canadian engineering programs which led to stronger bonds between the academic institutions, the provinces, and the accreditation boards for Canadian engineering programs [15]. Additionally, there is no standardized technical examination required for Canadian engineers to become licensed. They rely heavily on the education process to ensure that qualified candidates become licensed. The Canadian process is substantially different from the licensure process in the United States [16].

A separate approach to increasing education requirements for licensed engineers would focus exclusively on a specific discipline of engineering. In this case each discipline could have licensure requirements applicable to that specific discipline. Civil engineers would explicitly define their profession and then advocate that PE Boards in each jurisdiction require specific

requirements for licensure that may or may not be the same as other disciplines of engineering. This method would help meet the Raise the Bar requirements for civil engineers and would leave the option for other engineering disciplines to create their own separate path for licensure if desired. As with any of these methods of changing licensure requirements, civil engineering centric licensing would require careful consideration for implementation. A survey of current discipline specific licensing methods used in a few jurisdictions provides insight into how this might be implemented.

Discipline Specific Licensure Methods

A survey of current licensure jurisdictions reveals that requirements and implementation methods for discipline licensure are not uniform. Those jurisdictions that differentiate licensure based on engineering discipline are of interest. Currently, there are nine jurisdictions that license based on discipline: Alaska, Arizona, California, Hawaii, Massachusetts, Nebraska, Nevada, Rhode Island, and Vermont. There is no common method of licensing based on discipline. Every jurisdiction except Nevada and Vermont are substantially different from one another. Out of these nine states, there are three broadly defined approaches of discipline licensing that are of interest [1].

Method A – Defined Discipline, Practice Limited

The first method of discipline specific licensure is based upon an applicant's education and experience. Each branch of engineering is specifically defined by the jurisdiction and an applicant is placed in the most appropriate area upon application. This method does not necessarily take into account the specific PE exam that the applicant took. Once licensed, engineers are then required to practice within their discipline definition. It is noted that many disciplines do overlap; therefore there is a degree of judgment required when defining area of expertise. An applicant can also request to be licensed in an additional area based on his or her education and experience. Alaska's PE licensure system is an example of this method.

Method B - Exam Defined Discipline, Practice Limited

The next method of discipline specific licensure is based upon the PE exam that a candidate chooses to take. Each discipline is named, but not explicitly defined in most of the jurisdictions with this type of system. If a candidate wanted to practice in multiple areas of engineering, then he or she may need to pass multiple PE exams. Nevada and Vermont have similar systems in place.

Method C - Exam Defined Discipline, Practice Not Limited

This method of discipline specific licensure is commonly called a "Title Act." The applicant is typically required to take a specific exam in order to earn the title for that

type of engineering. However, there is no regulation as to what type of work may be undertaken once licensed. The only restriction is that an engineer practice in areas of competence based on education and experience. Nebraska and Massachusetts are examples of this system.

As seen there are a limited number of states that use some form of discipline specific licensure. There is no national standard and no national organization has a policy or guidance on discipline specific licensure [1].

Licensure Methods under Consideration

Based on the current discipline specific approaches, two general models have been formulated that would build off the current methods and assist with raising the education requirements for civil engineers. The two models for consideration are referred to as discipline specific and civil centric. A typical model of each method is described and then analyzed for strengths and weaknesses from an implementation and practicality standpoint.

Discipline Specific

The discipline specific method is defined as:

- Each jurisdiction would clearly define different areas of engineering based on education, experience, and/or a specific PE exam.
- The PE license for each engineering field would have a designation specific to the discipline. There would be no general PE license, but rather PE licenses with a unique identifier.
- Civil engineering discipline specific licenses could require additional education requirements such as a master's degree or equivalent.
- Civil engineers would be required to work only on projects in their area of expertise as defined by the jurisdiction.
- A jurisdiction could publicize a list of licensed civil engineers that could be used to enforce practice within the area of civil engineering. Engineers licensed in other areas would not be allowed to declare their competency and begin to practice within the civil engineering defined area. They would have to go through the civil engineering process to get licensed as a civil engineer.
- The discipline would be specifically shown on the engineer's seal.

Implementing the discipline specific method would require significant changes to current licensure rules in almost every jurisdiction. As noted, only nine jurisdictions have some form of discipline specific license and all but two have significant variations. One of the most challenging parts of making this change would be to clearly delineate among the areas of engineering. The practice of engineering allowed for each type of PE license would have to be explicit. Many fields of engineering overlap in their area of practice and this would have to be

considered when determining any practice limitations for each license. Education would have to be clearly dictated for every engineering field and experience would have to be relevant to the license desired.

The potential benefits of this method could be helpful to the public and licensing boards. The scrutiny that an engineer undergoes to ensure they work in their area of expertise would be extensive upon entry. A public record would be available to everyone interested in knowing if an engineer is licensed in a specific discipline. The specific area of practice could be listed on the engineering seal the PE uses, thus indicating their acceptable area of practice. Egregious errors of working outside an area of expertise would be easy to document, facilitating enforcement. Additionally, each field of engineering might have more flexibility in influencing the jurisdiction requirements for licensure. Under this system there could feasibly be different experience and education requirements for each specific discipline of engineering. While civil engineering may take the lead to increase education requirements, other disciplines could follow civil engineering or even create their own unique requirements for license. This prevents each field of engineering from having to agree on a universal set of requirements for a universal engineering license.

Civil Centric

The civil centric licensure method would be defined as:

- Licensure applications would be differentiated solely based on education.
- The PE license would be a universal designation for all disciplines of engineering. There would be no discipline specific indication on the seal or within practice.
- Those with an accredited civil engineering bachelor's degree would not be allowed to take the PE exam until they obtained a master's or equivalent.
- Once licensed a person must work in their area of expertise.
- Enforcement would not change significantly from most current methods with general PE licenses. A person would be required to only work in their area of expertise.

Implementing these licensure application procedures would require significant changes to the current policies for applying for licensure in all jurisdictions except for Nevada and Vermont. Applications would include information defining an applicant's degrees. For ABET accredited civil engineering programs a transcript would be enough to verify the correct level of education. The challenge would come for those that applied with a general engineering degree or a multi-disciplinary degree with an emphasis in civil engineering. A determination would need to be made as to what constitutes civil engineering in such cases. Likewise, there would need to be specific guidance on what type of master's degrees or equivalent education would be required for those with a civil engineering bachelor's degree. Education beyond the EAC/ABET baccalaureate level would need to define acceptable content, possibly including academic and professional development activities.

With this approach, ASCE might consider changing its ABET program criteria to coincide more closely with the civil engineering BOK outcome levels. Technical depth could be obtained as part of the graduate rather than baccalaureate program as presented in the BOK. ASCE has the ability to propose such accreditation changes through ABET. With such a change, civil engineers with only an undergraduate education would not have the ability to either practice independently or pass the PE exam, thus essentially requiring graduate education to practice as a civil engineer.

There may be benefits and downsides of using this method for the public and licensing boards. A licensed engineer would not have public designation as a discipline specific engineer, however they would have a public record that they applied as a civil engineer and have advanced credentials. The additional education requirements may not be clear to the public because the license for all engineers would be the same regardless of area of practice. The licensing board would have a record identifying them as having the education requirements for civil engineering and could be used as a check for competence to practice in civil engineering.

A significant disadvantage to this concept is that engineers licensed in another discipline not requiring the advanced education, including closely related disciplines such as agricultural or environmental engineering, could be licensed with a lesser education level, and practice civil engineering in areas where they are competent. This could be a significant challenge to define, a bigger challenge to enforce, and very disconcerting to many civil engineers.

Impact on the Engineering Profession

Changing the licensure requirements for engineers might help the Raise the Bar initiative and help clearly define the standard for practice for civil engineers. However, as with all change there are impacts that need consideration.

Comity among licensing jurisdictions is an important aspect that allows engineers to easily facilitate performing work in multiple areas of the country. Currently there is a program wherein NCEES thoroughly reviews applicants' qualifications and issues a "Model Law Engineer" designation which is accepted by most jurisdictions [17]. Currently, those states that have different standards require additional documentation for licensure. The introduction of either civil centric or discipline specific licenses would pose an issue for comity and the Council Record program. Those states that require more education would not be able to recognize those with PE licenses that have not adopted the updated civil engineering licensure process. Those with civil centric or discipline specific licenses would likely be recognized in other states under current agreements. This would convolute the comity system in place, however it should be resolvable with proper administrative procedure. The ability to have a comity system that facilitates the ability of PE's to practice in many different jurisdictions is of extraordinary interest in the engineering profession, and will likely be of ever increasing importance in the future.

A serious downside for the civil engineering profession could be recruitment and retention of students in civil engineering programs. Obtaining a master's degree or equivalent would require additional time in school and more money to obtain a degree [14]. Currently civil engineers are not the highest paid engineering graduates, so this change would work against recruiting efforts from an economic standpoint [18]. There would need to be a messaging campaign to help students view the long term impact of civil engineers, consider other benefits of being a civil engineer such as the humanitarian side, and consider pride in being part of the civil engineering profession. Simply marketing civil engineering based on economics would reduce the number of students interested in civil engineering because similar engineering majors would require less time and money to obtain a degree that pays just as well or more.

The National Society of Professional Engineers (NSPE) serves as a unifying voice among all the engineering professions that has promoted licensure since its founding in the 1930s. NSPE has a current policy (Position Statement No. 1778) that explicitly states that a discipline specific title for licensure "weakens rather than strengthens the integrity of the license [19]." However, in Professional Policy No. 168 NSPE supports the concept of additional education beyond the "…four year ABET/EAC program…for the practice of licensed professional engineering [20]." These statements imply that NSPE wants unity within the professional engineering community but is not against RTB. They simply do not want a fragmented licensure process. The idea of a civil centric policy does not go against the universal generic PE license, but may not be supported by NSPE because of the emphasis on isolating engineering fields upon applying for licensure.

Many PE Boards that have "generic PE licensing" systems have historically been opposed in concept to licensing engineers by discipline. If that were not the case, discipline specific licensure might have proliferated decades ago.

The most important goal of licensure is to protect the public health, safety, and welfare. These public concerns would not be harmed by increasing the education requirements, but there is no published data within the engineering profession that it would definitely be improved. However, public perception of a profession is very important. The civil engineering communities' push for additional education requirements might be seen as a positive development if it is clearly communicated to the public. As was shown during the progressive era when licensure was first proposed, "transcendent value" or working toward the public's best interest is appealing to many engineers and is well received by the public [21]. The current emphasis on rebuilding the infrastructure for the next generation makes this a great time to communicate the need for additional education for civil engineers. When the message of licensure is clearly tied to a need to increase public safety, the public's response has been positive as demonstrated in other professions.

Comparison to Licensure of Other Professions

Making changes to licensing rules and laws is not unique to the engineering profession. Many other professions have faced similar challenges. A brief review of the changes that have occurred in other professions along with a summary of the effects is useful. These changes can be used as a comparison to the changes that have been proposed herein for the engineering profession.

Counseling

The counseling profession, a profession dedicated to treating mental, behavioral, and emotional disorders, provides an important case study regarding the development, implementation, and unification of licensure [22]. Counseling first became licensed in 1975 in Virginia and spread to 41 states by 1994. The requirements to become licensed began to increase as it spread from state to state. These increased constraints to enter the profession is called the "escalator" effect which is one of the common results of implementing licensure laws. The profession never became unified and no standards were developed in all jurisdictions. By 1995 there was no uniform exam, every state had different experience requirements ranging from 1 to 4 years, and no minimum number of credit hours was set for a master's degree. There was documentation that master's degrees varied between 30 and 60 college credit hours with 48 being the median, however all counted for licensure in some jurisdictions. Because of the vast differences among states, what followed was a series of specialty certifications instead of a unification of licensure laws. The profession became fragmented, titles varied among jurisdictions, and the certifications were confusing to the public. In addition, moving between states became very difficult because of the lack of reciprocity or comity [23].

Medicine

Doctors were one of the original groups that fought for licensure in the 1800s. Their battle to maintain licensure took upwards of 100 years to finally define the need and importance of licensure for the public's safety. The medical profession was very fragmented, did not have uniform education requirements, and even lost licensure for a brief period during the mid 19th century. During the 1800's there was not abundant public trust, pay was very low, the smartest students did not study medicine, and the profession had a lower image than many other professions such as law [24].

Part of the reason medical licensure took hold in the United States was because of the increase in complexity of diagnostic tools and medicines and the distrust in the preparation programs for medical professionals. The public simply could not understand what they were paying for, if it was a legitimate technique or diagnostic, and if it was being administered by a true professional or just a "quack." Doctors saw the authority of their profession eroding and decided to fight against hospitals, drug companies, and insurance companies for control of their profession. To combat these challenges doctors became unified with a mission to look after patients and to

require an education from medical schools with accepted standards. They purposely did not align themselves with business or hospitals [24], [25]. Doctors became a cohesive unit in the early 20th century after decades of infighting. During the beginning of the 20th century the focus on the one-on-one relationship between doctors and patients was very important. The public needed doctors and wanted to trust them, but needed assurance. This trust was fulfilled by licensing doctors [25]. Many modern day medical schools came out of this transition and their curriculums and prestige were positively affected by the introduction of medical licenses.

The licensure of Medical Doctors (MD) in the United States has continued in its original form as medical disciplines have proliferated and technologies have expanded. Jurisdictions license MD's at a minimum level of competence. Advanced specialization is recognized by means of rigorous post-licensure certifications managed by the medical profession recognizing additional experience, education and capability in many medical specialty fields. Licensure as an MD provides the public with assurance of a basic level of competence and the ability of the licensing board to effectively enforce ethical requirements. Advanced specialization is recognized outside of the licensure system. Most employers require such advanced specialty certifications for MD's to practice in specialty areas.

Psychology

Psychology is a profession that developed after World War II and initially raised the requirements for entry into the "clinical psychology" field to a doctoral degree [26]. To this day licensed psychologists are required to have a doctoral degree in all but four states. All states required a standard exam be taken administered by the American Association of State Psychology Boards, and most states require an additional oral or written exam on a variety of topics including competence to practice and ethics. Additionally, they require a two year internship period before becoming licensed [27], [28]. Psychologists set this high standard in 1949 largely to set themselves apart from the medical doctors and psychiatrists [26]. This rigor was not immediately adopted by all states, but was eventually accepted by the 1970s in most states. From an education standpoint, psychology has one of the more rigorous paths to professional practice.

The challenge psychologists have always had is finding well paying jobs. When compared to thirteen other professional fields including medical doctors, lawyers, and nurses, psychologists remain one of the lowest paying professions and have one of the longest paths toward becoming licensed [27]. This profession has demonstrated that licensure requirements alone do not translate into more income and prestige. There are even plans in some states to lower the bar because entry is not cost effective and valued [29]. Today many states have separate types of licenses for clinical psychologists versus school psychologists or other psychology fields. Many of these fields only require a master's degree instead of a doctorate [26].

Accounting

Studying the development of the licensure process for accountants demonstrates that adding education requirements is possible. In 1988 the American Institute of Public Accountants (AICPA) determined that accounting needed a more robust education requirement for licensure as a Certified Public Accountant (CPA). The average program required 120 semester credit hours for an accounting degree and the AICPA determined 150 was more appropriate for a bachelor's degree. After AICPA adopted this policy, most jurisdictions adopted the 150 credit hour standard by the year 2000. The long term results did not indicate a decline in pass rates or in the number of accountants taking the test [30].

Discussion

As long as professions have existed, there has always been the question of setting the right requirements to enter the profession. Having requirements that are too high are viewed as protectionist policies used to decrease competition. On the opposing side is the view that the requirements must be robust enough to ensure the safety of the public. Historically, setting the right level of requirements and getting the first licensure law in place is the hardest step in the process. As seen by the medical profession, the first step can take over half a century. At the same time getting a unified body together to make these laws is also very important. The medical and counseling professions had difficulty getting a unified front to promote and justify licenses. Today medicine has seen the fruits of their labor while the counseling profession is still struggling. In some ways engineering is a mix of these two professions. There is a degree of unity for the PE license among engineers, but there are disagreements about how to maintain licensing and who needs to be licensed.

The benefit that engineers have is they already have licensure laws in place. Much like accounting or psychology, the engineering field is now debating the correct level of education for licensure. Both of these professions have amended their education levels. Once the first licensure law is in place, making changes to the laws is typically much easier. This effect is called the “ratchet” effect for licensing [23]. Accounting essentially added the equivalent number of college credit hours as a master's degree to their entry level bachelor's degree. They had a unified front when they made this change and were able to implement it in most jurisdictions in less than 15 years. This unification is seen somewhat within the civil engineering profession but not engineering in general. Psychology is a unique profession that serves as a caveat; don't expect wages to increase simply because of an education requirement. Increased education to protect the public is seen favorably, but it is not a good method for economic reasons alone.

Civil engineering is in a time when it has a good opportunity to make changes to licensure laws as demonstrated by the medical profession. Civil engineers are now taking into account green engineering, sustainability, resiliency, new materials, longer life spans, and many advanced tools

for design and analysis. This mimics what happened to the medical profession 100 years ago with an influx of complexity within the profession. The public already appreciates licensure laws in engineering and maintains a high degree of trust in the system. The public knows that licensed individuals are held to a higher standard and are required to protect the public [31]. With these long standing licensure laws in place, making adjustments should be easier than trying to create a new law. The key difference is the engineering field has not followed the civil engineer's lead. Engineering hasn't shown the unison that was seen in the medical profession when faced with this situation.

The success of licensure in other professions does not directly support the idea of discipline specific licensure. Breaking a profession apart into multiple licenses and designations did not work well for counseling or psychology. The professions that have shown the most success, medicine and accounting, had very unified fronts when they finally found success at implementing strong licensure laws and defining rigorous education standards. It is noted that a number of these professions do rely on additional "certifications" beyond the basic license to indicate areas in which a professional is deemed to have advanced proficiency. Mimicking the medical model is another pathway under consideration as a means to accomplish the RTB objectives.

The civil centric licensure method more closely mimics a unified license for engineers. The key difference is requiring a different educational requirement for applicants in different areas of engineering. There does not appear to be a precedence for administering licenses in this way. From a historical standpoint this may be a new, unique approach, perhaps worth considering, but challenging due to its lack of precedence. The one theme throughout all professions is licensure must always be tied to the public's safety. Civil engineers in particular must realize that a focus on "social responsibility" is a key to strengthening licensure [2]. This has been a strong theme in the civil engineering profession since the inception of licensing laws and must remain regardless of the changes proposed to licensure.

Conclusion

Engineering licensure is going through a dynamic time. ASCE has consistently promoted an increase in education requirements through the RTB movement over the past two decades. While the movement has made strides in convincing civil engineers that more education is needed, the rest of the engineering disciplines have not followed their lead. An alternate plan is to focus solely on increasing education requirements for the civil engineering profession.

Two methods of increasing education requirements have been evaluated: the discipline specific approach and the civil centric approach. Both would require changes to current laws and regulations in every jurisdiction.

The discipline specific approach would be complicated to implement, would require more thorough vetting by licensing boards, but licensure requirements would be easier to enforce.

The discipline specific method has the perceived risk of bifurcating the engineering profession, because of adding specific labels for each engineering field. Nine states currently have discipline specific licensing, and implementing Raise the Bar for all disciplines has not been successful to date in several of those states. Other professions such as counseling have had problems using this approach and maintaining a unified profession.

Other engineering organizations, and many PE Boards have been historically opposed to discipline specific licensure. Implementation in all jurisdictions would be extremely challenging.

The civil centric approach would be easier to implement, require minor changes to the application procedure, but could be harder to enforce. The civil centric approach has the risk of hurting the long-term recruitment of future civil engineers and may increase the public's perception and the prestige of civil engineering. Other professions have not used the approach of varying the requirements to obtain the same license based on the type of bachelor's degree, so there does not appear to be precedence in implementing this method. Civil engineers would be concerned that engineers of other disciplines with a lesser education requirement would be allowed to practice civil engineering.

It is not clear whether either of these licensing modifications would significantly increase the chances of adopting a requirement for additional education requirements for civil engineers. Unsuccessful legislative attempts have been made in the past to raise the education requirements for the licensure of all engineers with a general license. It is unknown if the likelihood of success would increase with an initiative to raise education requirements only for civil engineers.

Legislative attempts to require a master's or equivalent have met stiff opposition from other engineering organizations. The level of opposition may or may not be significantly less to an initiative to require additional education only for civil engineers. Other engineering disciplines in the past have indicated that they may be equally opposed for fear that the licensing board in the future would extend such additional education requirements to their discipline.

Implementing either of these methods for licensure would need to be carefully planned and executed. All successful licensure changes in other professions in the past have focused on public support and unity within the profession. From that standpoint the civil centric approach may have a better chance of success, but would need to be implemented with care and transparency to all parties involved.

The authors view the potential of successful implementation on a national basis in all jurisdictions of both of the approaches as unlikely from a practical standpoint.

References

[1] American Society of Civil Engineers - Committee on Licensure, "Discipline Specific Licensure of Professional Engineers," ASCE, Reston, 2016.

[2] E. T. Layton, The Revolt of the Engineers : Social Responsibility and the American Engineering Profession, Baltimore: Johns Hopkins University Press, 1986.

[3] M. Kam, "Engineering Licensure and Professional Practice," in *International Workshop on Institutional and Programme Accreditation*, 2011.

[4] P. M. Spinden, "The Enigma of Engineering's Industrial Exemption to Licensure: The Exception that Swallowed a Profession," *University of Missouri - Kansas City Law Review,* vol. 83, no. 3, pp. 637-686, 2015.

[5] American Society of Civil Engineers, "Public Policy Statements," 21 November 2017. [Online]. Available: http://www.asce.org/Public_Policy_Statements/. [Accessed January 2018].

[6] American Society of Civil Engineers, "Civil Engineering Body of Knowledge," 2008. [Online]. Available: http://www.asce.org/Civil_Engineering_Body_of_Knowledge/. [Accessed January 2018].

[7] American Society of Civil Engineers, "Code of Ethics," 29 July 2017. [Online]. Available: https://www.asce.org/code-of-ethics/. [Accessed January 2018].

[8] T. E. Fenske and S. M. Fenske, "Need for 'professional' education for professional engineers," *Journal of professional issues in engineering,* vol. 116, no. 4, pp. 345-350, 1990.

[9] S. D. Young, The Rule of Experts, Washington: Cato Institute, 1987.

[10] E. Kaplan-Leiserson, "A Matter of Timing," *PE Magazine,* December 2013.

[11] R. D. Kersten, "Engineering Education: Paragon or Paradox?," *Journal of Prefessional Issues in Engineering Education and Practice,* vol. 122, no. 4, pp. 147-150, 1996.

[12] M. G. Jenkins, W. V. Loscutoff and T. Nguyen, "Five-Year BS/MS in Engineering the Time has Come," in *ASEE Annual Conference and Exposition*, 2012.

[13] American Society of Civil Engineers, "Policy Statement 465 - Academic Prerequisites for Licensure and Professional Practice," 17 March 2017. [Online]. Available: http://www.asce.org/issues-and-advocacy/public-policy/policy-statement-465---academic-prerequisites-for-licensure-and-professional-practice/. [Accessed January 2018].

[14] E. J. Nelson, G. Williams, P. Richards, G. Schultz and T. Wight, "Assessing Higher Education Response to the 2006 NCEES Model Law for Professional Engineering Licensure," in *ASEE Annual Conference and Exposition*, 2009.

[15] R. Toogood, "Academic Requirements for Professional Engineer Registration in Canada," in *Joint International IGIP-SEFI Annual Conference*, 2010.

[16] B. Sparling and J. A. Kells, "Trends in Civil Engineering Education," in *Annual Conference of the Canadian Society of Civil Engineering 2008*, 2008.

[17] NCEES, "Model Law Designation," NCEES, [Online]. Available: https://ncees.org/records/model-law-designation/. [Accessed January 2018].

[18] S. Adams, "The College Degrees with the Highest Starting Salaries in 2015," *Forbes,* 19 November 2004.

[19] National Society of Professional Engineers, "NSPE Position Statement No. 1778," January 2017. [Online]. Available: https://www.nspe.org/sites/default/files/resources/GR%20downloadables/Professional-Practice.pdf. [Accessed January 2018].

[20] National Society of Professional Engineers, "Engineering Education Requirements," June 2016. [Online]. Available: https://www.nspe.org/resources/issues-and-advocacy/professional-policies/engineering-education-requirements. [Accessed January 2018].

[21] H. W. Walker, "Policy 465: Latest Struggle in the "Revolt of the Engineers"," *Journal of Professional Issues in Engineering Education and Practice,* vol. 138, no. 4, pp. 283-288, 2012.

[22] American Counseling Association, "Choosing a Career in Counseling," [Online]. Available: https://www.counseling.org/careers/aca-career-central/choosing-a-career-in-counseling. [Accessed January 2018].

[23] L. J. Bradley, "Certification and Licensure Issues," *Journal of Counseling and Development,* vol. 74, no. 2, pp. 185-86, 1995.

[24] P. Starr, The Social Transformation of American Medicine, New York: Basic Books, 1982.

[25] M. S. Larson, The Rise of Professionalism: A Sociological Analysis, Berkeley: University of California Press, 1977.

[26] T. J. Vaughn, Psychology Licensure and Certification, Washington : American Psychology Association, 2006.

[27] C. D. V. Olvey, A. Hogg and W. Counts, "Licensure Requirements: Have We Raised the Bar Too Far," *Professional Psychology: Research and Practice,* vol. 33, no. 3, pp. 323-329, 2002.

[28] L. P. Rehm and S. T. DeMers, "Licensure," *Clinical Psychology Science Practice,* vol. 13, pp. 249-253, 2006.

[29] A. T. Boon, D. J. Lutz and K. M. Marburger, "Eliminating PostDoctoral Training as a Requirement for Licensure: Perceptions and Anticipated Impacts," *Professional Psychology: Research and Practice,* vol. 46, no. 1, pp. 62-69, 2014.

[30] M. W. Killgore, E. L. Flicker and B. Aldrich, "The Case for a Master's Degree for Civil Engineering Licensure," in *ASEE Annual Conference and Exposition*, 2016.

[31] R. Dingwall, Essays on Professions, Burlington: Ashgate, 2008.