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ENGINEERING CERTIFICATION; ACADEMIC CONCERNS AND INDUSTRY NEEDS

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Abstract

Engineers play major role in most real-life activities of our era. Therefore, consequences of their interaction with the world around them could make a big difference since they may prove visionary or, on the other hand, highly destructive.

With this importance of engineers in mind, academia as well as industry and legal authorities in industrialized societies implement rigorous programs to authenticate, regulate, and set minimum requirements for sound engineering practices. Such authenticating and regulation efforts merge as a form of cooperation and mutual understanding between academic bodies, industry-practice maintainers and legislative authorities.

With this diversity in dealing with any effective certification practice for engineers, engineers as well as the community around them must understand needs, requirements, and boundaries. Furthermore, all parties must establish effective interactions leading to professional certification programs where technical disagreements or weaknesses are reduced to a minimum.

This paper touches these issues and outlines concerns and ambitions towards a sound identity and a more effective role for engineers in the Kingdom.

1. Introduction

An article titled "To License or not to License; That's the Question" was published in the Mechanical Engineering magazine in May, 1999 [1]. The article stirred the engineering society vigorously and engineers kept responding and debating the subject for more than a year. The following input is one of the many interesting ones that came as a response to the article [2]:

I read with dismay the letters in the November issue of Mechanical Engineering *responding to the article by Emily Smith, "To License or Not to License," in the May issue. Most of the November letters were very critical of the licensing procedure in general, and questioned the worth of having a license in particular. The pervasive attitude is that licensure is not worth the hassle if one's employer does not reward one with more money or advancement.*
One letter went so far as to say that "a P.E. license is no more a guarantee of a competent engineer than a driver's license is of a competent driver." While this may be true in some instances, statements like this serve only to denigrate all types of professional licensing

and competency testing. If you were in need of a physician to operate on your heart, would you not prefer one who was licensed? Why not expect the same of an engineer who is designing a new braking system for your future car? Your life may depend on it as you swerve out of the way of that unlicensed driver.

On the other hand, another article titled "Professional Engineer Self-Regulation" was published in Professional Ethics Report in 1998 [3]. While the first article debates the virtues of a national license versus the question many American engineers started raising regarding the value of the P.E. designation, the other article approached the issue from a different perspective. It addressed the issue of the negative impact of legislation bureaucracy on effectiveness of certification and licensing for practicing engineers. Interestingly, this article was authored by Arthur E. Schwartz, General Counsel for the National Society of Professional Engineers (NSPE), the most prominent organizational body looking after the interest of professional engineers in the USA. The author argued that:

"In recent years and for a variety of reasons, there has been increasing interest among engineers, engineering societies, regulators and others in considering possible alternatives to the current state engineering licensure scheme that is in place in the majority of states. Recent legislative and regulatory activities in several states to amend significant portions of state engineering licensure laws or even to eliminate such laws and regulations entirely illustrate ongoing dissatisfaction among engineers, regulators and others with the manner in which the practice of engineering is currently regulated at the state level. The regulation of the engineering profession has evolved significantly over the past seventy-five years. During the early years (1920s-1950s), a period in which the requirements for engineering licensure were less standardized than they are today, state engineering boards were typically granted a high degree of independence and autonomy within state government in regulating the practice of engineering. However, beginning in the 1960s and 1970s, state governments began to examine and regulate more actively the activities and practices of state professional boards. Among the outcomes of the movement were:

- *Centralization of professional boards.*
- *Merging of professional boards with business and occupational boards.*
- *Creation of "super-agencies" to provide administrative staffing & budget review.*
- *Development of "one-size fits all" regulatory practices and procedures.*

In addition, professional licensing fees (including engineering licensing, examination, permit, fines, etc.) collected by the individual professional boards and used by them for board administration began to be viewed by state governments as a source of general governmental revenue. In many instances, these funds were redirected from the specific professional boards that generated them to state revenue fund accounts for general public use".

One way or the other, these two articles, and the reaction they generate, question the principles and procedures of certifying and licensing practicing engineers. However, it remains a fact that basic goals of certifying and licensing are of prominent importance for sound and reliable engineering. NSPE's definition of a Professional Engineer (the title of a certified and licensed engineer in North America) is, in brief [4]:

"Professional Engineers (PEs) are people that have fulfilled the education and experience requirements and passed the rigorous exams that, under state licensure laws, permit them to offer engineering services directly to the public. *PEs take legal responsibility for their engineering designs and are bound by a code of ethics to protect the public health and safety*".

With such an obligation towards ethics and protection of public health and safety, engineers are equally obliged to accept the importance of and positively cope with the need to accredit, certify, and license their education and experience.

Taking into account all the above, this paper will briefly propose a scheme for certifying engineers in the Kingdom. It will touch academic, legislative, and industrial concerns and requirements. However, the author assumes no authority nor he claims that the proposed concepts herein are complete or the best in addressing such a complex issue. Rather, the present contribution is meant principally to stimulate more knowledgeable and active engineers all around to enrich the discussion and come up with more mature ideas and frameworks.

2. Academic Foundation

In industrialized countries (typically: the USA, Europe, Japan, . . . etc.), university education can easily be private and, therefore, quality and creditability cannot always be guaranteed. This in turn dictated the need for accreditation of educational curricula and legislation of practitioners like engineers, lawyers, and doctors. In the Kingdom, our universities are basically administered by government. However, from the author's direct interaction, they still lack the dynamics of the industrialized world universities with respect to the present issue.

For example, although NSPE clearly identifies and publish requirements for being a PE to the public, a typical American university acts proactively and outlines for students these requirements as follows [5]:

"To practice engineering for the public in the United States, you must be licensed as an engineer in each state in which you practice. In most states, the requirements are to:

1. *Complete a four-year engineering degree in a program approved by the state engineering licensure board.*
2. *Pass the eight-hour Fundamentals of Engineering (FE) Examination.*
3. *Gain four years of qualifying engineering experience.*
4. *Pass the eight-hour Principles and Practice of Engineering (PE) Examination.*

The Fundamentals of Engineering (FE) Examination covers material from your undergraduate engineering studies so the best approach is: take and pass this examination during your senior year while the material for the exam is fresh in your mind. If you do, you will have completed the first two requirements for licensure upon earning your bachelor's degree in engineering. This approach keeps open your option to be licensed as an engineer with a minimum of extra effort.
The theory of licensing engineers is that by passing the required examinations and gaining some experience, someone demonstrates a certain minimum competence in engineering to

the state and, thereby, gives some indication that they can do engineering without being likely to cause harm to the public.
In any case, you, and all engineering graduates today, should prepare to become licensed even though, in the past, you might not have bothered. At the very least, you should take the Fundamentals of Engineering (FE) Examination during your senior undergraduate year to keep your options open. Completing steps 3 and 4 listed above as necessary to become licensed can be completed later in your career if you decide you need to be licensed. Completing step 1 (the FE exam) later in your career when your knowledge of many of the fundamentals is rusty can be a killer."

As one may notice, there is a strong interaction and uniformity between professional bodies, mostly representing industry, and universities representing academia. While legislative and professional bodies outline and enforce the requirements, universities expose future engineers very early in their career to the issue and equip them with the basic requirements. In other words, engineering students do not remain isolated from the society until they graduate and then get confronted with a different world with foreign expectations and requirements. Rather, they, as an essential part of their curricula, get practically exposed to and readied for these expectations and requirements.

Things do not stop here. Rather, as S. Yedidiah pointed out in the Mechanical Engineering magazine [6], it takes much more than correctly solving the right equations to arrive at a successful design expected from a practicing engineer. He rightly stressed that:

We live in a competitive world. Consequently, engineers have to base many of their decisions not on science alone, but on comparison with other events, experience, common sense, trial and error, and educated guesses.

This draws the attention to how much important it is for the academic institutions to equip engineers to look much farther than just at equations. In other words, for successful professional engineering, and subsequent effective certification and licensing, our universities must deeply interact with industry. Many years ago, the author got astonished as afresh graduate when he found industry using, most of the time, empirical correlations they accumulated from their field experiences over the years instead of the theoretical basics we learned at college.

3. Industrial Interaction and Expectations

As pointed out above, the author, and almost all colleagues he talked to in industry, realized that our industries are gravely separated from our academic institutions. Furthermore, all realized that although universities can effectively help in addressing many technical problems in real life, these industries prefer to stay isolated because they do not want to take any risk. The problem stemmed, in the author's opinion, from two things:

- Conservatism, or even complete silence, from industry side when it comes to stating expectations from academic institutions and interaction with these institutions.
- The subsequent too theoretical, and highly isolated, treatment of academia when dealing with technical problems.

For academic institutions, the issue was briefly visited in the previous section. For industry, things need to change correspondingly. In the more industrialized societies (e.g. North America and Europe), industry go much more in their interaction with the academic institutions around them. Among the main steps they usually take are the following:

- Identifying technical problems they encounter and can be good research subjects. Once they identify these problems, they prioritize them and communicate their needs and expectations to academia in the clearest way possible.
- Consultation of academic experts. By this, industries contract academicians on part-time basis to interact with them and get from them more scientifically-founded advice on problems they encounter. This approach, compared to the first one, calls for these experts (and in many cases their students) to come to the field, get exposed to, and comprehend the real-life technicalities instead of remotely expecting from them a complete solution for an entire problem they never interacted with in the field.
- Communicating back to academicians so that future interactions can be more effective. They do not just give up and accuse academicians of being too much theoretical or of being naive in their approaches to solving problems they trusted them to solve.
- Sponsoring research activities and hosting on-training students. Industry from this perspective volunteer to host and sponsor academic activities at their premises. Although they sometimes do not directly benefit from such interactions, they definitely benefit indirectly. The more the interaction with academic institutions the more is the availability of chances to end up with better solutions for technical problems and the more academic activities get aligned with industry expectations.
- Membership in technical societies and regulatory boards. In industrialized societies, it is not surprising to see how much smooth is the interaction between industry and academia when one knows that technical societies, boards, and organizations are equally shared by both. In many of these, one indeed finds among the governing boards: university professors, industry experts and managers, and finally policy makers representing legislative authorities.

These effective interactions in the more industrialized societies help observers to easily visualize how wide is the corresponding gap we have here. Therefore, one feels it is time for a real change to take place, especially with the present inspiring motive from KFUPM towards establishing effective means for certification and licensing of practicing engineers. More on this will come in a following section.

4. Accreditation and Legislation

This issue covers two major and highly relevant topics: accreditation of academic institutions, and certification and legislation of engineering practice.

4.1 Accreditation

On the accreditation side, one needs not to worry much at present about the creditability of academic curricula at our institutions since these are overseen by government. However, with the ongoing trend of privatization and the more flexibility being granted for many educational sectors in the Kingdom, it may be time to start considering the establishment of a body responsible for accreditation of academic curricula for our institutions. As a website relevant to the issue puts it [7]:

Accreditation provides a way for educators to examine institutions and determine whether they have the resources to provide the education that they promise. At its worst, accreditation can be a costly mess of bureaucratic hurdle, which consumes an institution's resources without significantly improving the education it offers. Lack of accreditation does not necessarily mean that an institution is worthless. Some institutions are very new and have only just begun the accreditation process, which takes a few years. Others may choose to forgo accreditation for philosophical reasons. However, lack of accreditation is a warning signal, a sign that you need to carefully utilize to evaluate an institution and its programs to be sure they will fit your needs.

For useful comparison with our case in the Kingdom, let's see how a representative industrialized society tackles the issue. In the USA, there is a central body responsible for such an accreditation, The Accreditation Board for Engineering and Technology (ABET). ABET is a federation of major professional engineering and technical societies. Since 1932, ABET has provided quality assurance of education through accreditation. ABET accredits more than 2500 engineering, engineering technology, computing and applied science programs at over 550 colleges and universities in the USA. ABET is recognized by the governmental Council on Higher Education Accreditation (CHEA). Interestingly, ABET covers under its umbrella more than 30 major engineering-related organizations with members from all governmental, public, and private sectors. Therefore, it represents an ideally dynamic and rich, yet creditable, body with high-level authority and wide-spectrum interaction [8].

4.2 Certification and Legislation

For certification and legislation of engineering practice, two major steps constitute the practice in the industrialized world.

Typically, in the USA with the most elaborate arrangements in the field, these two steps are:

- Technical certification of practicing engineers so that it is made sure that their relevant knowledge is sound and alive, and
- Legal processing and licensing of certified engineers so that they can legally practice their profession.

The National Society of Professional Engineers (NSPE) is the most prominent organizational body looking after the interest of professional engineers in the USA, as mentioned earlier. NSPE is the only engineering society that represents individual engineering professionals and licensed engineers (Professional Engineers, PEs) across all disciplines. Founded in 1934, NSPE strengthens the engineering profession by promoting engineering licensure and ethics, enhancing the engineer image, advocating and protecting PEs' legal rights at the national and state levels, publishing news of the profession, providing continuing education opportunities, and much more. NSPE serves some 60,000 members and the public through 53 state and territorial societies and more than 500 chapters in the USA. Among its activities, NSPE established a thorough code of ethics for practicing engineers to follow. The first reference to a Society Code of Ethics is found in May 1935. In 1946, the society Board approved the Canons of Ethics for Engineers as prepared by a joint committee sponsored by the Engineers' Council for Professional Development, a country-wide coordinating body of technical engineering societies. The code was published in the January 1947 issue of The American Engineer. Between then and February 2001, the NSPE Board approved many changes to the code and ended up with the present version, which all practicing engineers in the USA must comply with while performing their technical duties [4].

The code starts with a Preamble stating that:

"Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity. Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct."

Additionally, the code outlines the ethics of practicing engineers by means of 6 Fundamental Cannons, 5 Rules of Practice, and 9 Professional Obligations.

As pointed out earlier, for engineers to be able to benefit from and be responsible for the title of Professional Engineer, PE, the following must legally be comprehended with all the requirements mentioned within:

- Graduation from an accredited engineering curriculum.
- Approximately four years of responsible engineering experience
- The successful completion of a two-part written examination.

Some states may waive the written examination on the basis of education and experience, but the trend is toward an examination requirement.

Most state laws provide for a pre-licensure certificate for those who do not yet have four years of engineering experience. These are generally known as "Engineers in Training" (EIT), although some states use other names like "Intern Engineer," or "Engineer Intern."
The requirements for an EIT are usually graduation from an accredited engineering curriculum plus the successful completion of an examination on fundamental engineering subjects, the FE exam.

The EIT program is designed for new engineering graduates so they may begin the licensure process while the broad scope of the fundamental engineering subjects are still fresh in their minds. The certificate does not authorize the practice of engineering, but it does signify that the individual has successfully completed an examination in engineering fundamentals, which is the first part of the examination process for full licensure. After acquiring the necessary engineering experience, EITs then need to complete only the second portion of the exam—Principles and Practice—relating to their particular field of practice.

Many universities encourage engineering students to take the FE exam during their senior year, and some provide review courses. On the other hand, NSPE sponsors self-study review courses for those who take engineering licensure examinations after graduation.

Finally, once engineer completes all the above, further processing must be carried out by governmental relevant authority, typically a state engineering licensure board that regulates the licensed practice of engineering within that state.

The role of the State Engineering Licensure Board is to verify the certification process and give the legal permission for engineers to practice their profession with full capacity.

5. A Proposed Scheme

One unequivocally recognizes the many cultural and legislative differences we have from other societies. However, one must admits on the other hand that academic and industrial experiences are largely nation-less. Therefore, an experience gained in, say, the USA or Japan can easily be adopted in any other society with minor changes or even improvements. A good example for possible improvements strongly relates in the present case to the ethics of engineering practice. In this respect, our Islamic teachings order us to be always zealously ethical in all circumstances regardless of financially benefiting from such a noble attitude. Indeed, the author doesn't know of any relevant statement in any other religion clearer than the prophet's saying: "Allah appreciates from one of you that whenever he does something, he does it with perfection" [9].

All the above, along with the present initiative from KFUPM, encourages one to briefly propose the following scheme for effective preparation, certification, and authorization of practicing engineers.

5.1 Academic Obligation

Saudi concerned institutions should seek new and courageous practical approaches in interacting with industry and in exposing students to real life and to industry actual problems and expectations. Materializing this activity can take all, or at least some, of the following:

- Forming a research board within each university (or central for all Saudi universities and technical colleges). Relevant national organizations like King Abdulaziz City for Science and Technology should be represented in this board as well. The board should be different from the present academic research boards by means of orienting objectives, vision, and mission towards taking more responsibility and ownership and finding practical solutions to industry technical problems. It must concentrate on relationship with industries and, therefore, should involve well-chosen representatives (members) from these industries. Well-chosen means unbiased selection of highly competitive industry leaders in terms of technical knowledge and depth of experience.
- Acquiring widespread input from industries and public figures about ways and methods they foresee for materializing a successful interaction. The author sees no much value in less than a minimum of 2000 responses to a detailed and well-designed questionnaire covering all relevant aspects. Once the questionnaire feedback is collected, presumably after premium organization and follow up, a thorough and equally well-organized analysis of the feedback must take place so that clear constructive conclusions can be arrived at. Finally, and equally important, such a crucial activity must be kept alive and dynamic so that future changes and variations in expectations and needs can be properly accommodated.

- In view of the above, academic curricula and research activities at our institutions must dramatically change to cope with and satisfy raised needs and expectations. It is to be noted here that academicians shouldn't develop any fear from such changes. The change is not meant to abstract the depth of theory in our institutions' curricula. Instead, the change is meant to redirect the attention from just theoretical studies dealing with imaginary problems to deeper theoretical studies that help our engineers and industries solve present and future technical problems.
- Establishing a mechanism where more flexibility in financial sponsorship and interaction is achieved. Relevant governmental authorities should be part of this activity so that they appreciate the need for more flexibility. There initial presence and understanding should ideally lead to securing necessary approval for such a highly needed flexibility. The end result should be a configuration where industry can help sponsoring academic activities and such that our institutions are given more freedom in finding sponsors and spending revenues as research and effective education call for.

5.2 Industry Ownership

In the more industrialized world, industry leads the action. Therefore, and since our country is becoming relatively highly industrial, our industries are expected to play major roles here. More specifically, industry leaders as well as practicing engineers need to highly consider the following interaction:

- In cooperation with academic institutions, initiate practical efforts to establish effective engineering societies or groups covering all major fields. They are also expected to adopt such societies if they already exist so that they can be more effective. Adopting could be, as a minimum, by means of nominating and sponsoring good numbers of their experienced engineers as members in these societies.
- Providing generous and sustained financial support is another form of adopting engineering societies. As facts show in industrialized countries, the following means of financial support, if coordinated properly, payback to industry much more industrialists anticipate. This could be by means of:

    1. Donating sustained grants to engineering societies until these establish their structures and sustain their own stable resources, and even beyond.
    2. Give grants to brilliant students (future engineers) in their engineering research studies. This can be paralleled with suggested topics that these industries feel suitable for further study. Equally important is encouraging distinguished academicians by means of offering them generous grants to help them investigate complex technical problems.
    3. Sponsorship of conferences and technical exchange meetings relevant to engineers' interest and engineering practice.

- Communicate more positively and effectively with academic institutions. Such communications should take place before, during, and after technical interaction with these institutions. Furthermore, communications should be kept always alive, professional, and dynamic.

5.3 Legislation and Logistic Support

In a world that is becoming a global boundary-less body, at least from engineering viewpoint, it is obvious that governments are driving towards privatization almost in all fields. Furthermore, conscious governments are trying hard to catch the trends of paperless and automated systems with minimum bureaucratic obstacles. With this in mind, and with the genuine efforts of our respectful government to encourage good initiatives, one wishes to see the following governmental interaction takes place with respect to the present issue:

- Provide logistic support to efforts exerted by both: academic institutions and industry. Initially, it would be very effective and encouraging to help making efforts and interactions more dynamic by means of partial governmental financial support.
- Forming a central body to facilitate, support, set legalization regulations, and encourage constructive initiatives will be a good start. Relevant governmental bodies should be represented in such a central body. Among these, in the author's opinion, should be, apart from academic institutions:

  1. Ministry of Higher Education.
  2. King AbdulAziz City for Science and Technology.
  3. Ministry of Industry and Electrification.
  4. Ministry of Labor.

- Generate initiatives, and provide logistic cover for these initiatives, to encourage effective communications among all relevant parties.
- Keep rules and regulations dynamic, modern, and practical. This, however, must not compromise the quality of practices, services, or products.
- Make sure that all legal and professional requirements will always take place and will be kept current. This is very important especially with practitioners coming from abroad. In this regard, experience gained from dealing with other professionals, like medical doctors, could be referred to and benefited from.

Collectively, one may summarize the present and foreseen arrangements by means of the two following schematics. Schematic 1a shows that the present relationship is far from being considered optimum. On the other hand, Schematic 1b suggests more integration, more interaction, and more flexibility, without compromising quality.

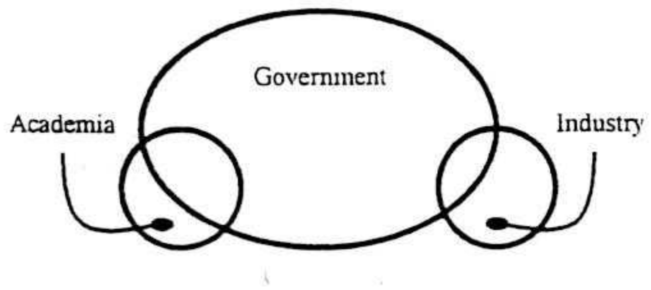

Figure 1a, Present Status

- No interaction between industry and academia.
- Less flexibility.
- No centralized organizational body.
- No obvious system for interaction and/or regulation.

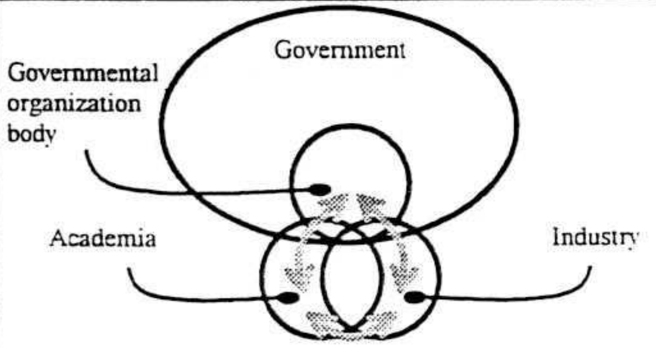

Figure 1b, Foreseen Status

- Good interaction between industry and academia.
- More flexibility.
- Dynamic and effective centralized organizational body.
- Clear interaction/regulation systems.

6. Conclusions

Although the present viewpoint may look too ideal from certain angles, the author positively draws the following conclusions:

- Starting with academic preparation for future engineers, our academic institutions need to revisit engineering curricula in view of the new and ever-changing trends in industry needs and globalization implications.
- Present industry interaction with academia look far from being impressive. New visionary trends of effective collaboration and interaction must prevail.
- Legislation and law-enforcing authorities should pay more attention to developing smooth relationship between all relevant bodies. However, legislative interaction should increase flexibility, provide effective support, and significantly minimize bureaucracy.

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