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A global accord for the postgraduate learning and professional development of engineers: A Proposition

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Proposing a global accord for the postgraduate learning and professional development of engineers

Abstract

This paper argues the case for the establishment of a global accord for the postgraduate learning journey of engineers in a globalized and complex world. The establishment of agreements covering educational qualifications in engineering and competence standards for practicing engineers such as the Washington Accord in 1989 and APEC Engineer agreement in 1999 have resulted in increased engineering mobility and improved global standards, especially as related to entry level engineering curricular requirements. However, one could suggest that the capability to perform provided by these competencies agreements do not ensure the professional development of engineers are complementary and adequate for them to perform in an increasing complex, globalised and constantly changing engineering world. The EFQM (European Foundation for Quality Management) frameworks and the Warren Centre's PPIR (Professional Performance Innovation and Risk) protocol are suggested as proposed guiding foundations for establishing a global accord for continuing engineering education. It is proposed that a new educational and professional development framework inspired by other accredited professional programs (such as law and accounting) to be developed as a platform for establishing such a global accord. The framework has the dual aims of providing learning opportunities for engineering graduates structured in the form of personal, professional and educational development, and structured guidance and mentoring to pursue professional (or sometimes referred as chartered) recognition. A conceptual framework and a proposed learning journey have been developed and are described in the paper. The paper argues for a reformed curriculum, blended pedagogies, a change in academic staff profile, and provide recent developments in the engineering and management education sector in support. It is acknowledged that further developmental and piloting work is required to establish the robustness and agility of the proposition for internationalized adoption.

Introduction

As the world moves to a more globalised environment in many professional practices, it is opportunistic to examine the how the engineering profession has tackled the challenge of improving international mobilization and standards of professional engineers and engineering services they provide. This is often a challenge for multi-national companies and organizations that operate trans-nationally. Future engineers will need to rethink their learning journey and pathways to professional recognition to be better prepared to tackle a more regionalized, integrated, and dynamic world[1]. Anecdotally, it appears that there is a growing population of engineers seeking Chartered status with Engineers Australia. There has been recent development in support programs such as the Engineering Education Australia (EEA)'s Graduate Program in Engineering (GPE) to complement the Professional Development Program (PDP) to undertake the chartered status journey[2]. In addition, there is the EEA's Experienced Engineer Program (EEP) and the Engineering Leadership Program (ELP) specifically targeting existing and aspiring engineering managers[2].

Despite the introduction of these new support programs for engineering graduates, it may be perceived to be company-focussed rather than individual-focussed because of the professional development (PD) nature of the programs. There are some evidence to show that there is a decrease in the willingness of engineering employers to fund professional development in recent years and the uncertainty that it presents, and the foreseeable slowdown once infrastructure stimulus are exhausted. This scenario means that costs of PD and staff mobility can be a barrier to engineering graduates pursuing support for obtaining Chartered-status as individuals. More and more so, graduates are looking to official qualifications and structured life-long learning journey. Professional master programs that address the personal, professional, and educational development needs should fulfil this demand driven by the individual engineers rather than corporation they work for[1].

There are three agreements that aim to address the competency requirements of engineering graduates and professional competence. These agreements govern mutual recognition of engineering qualifications. For example, the Washington, Sydney and Dublin accords for engineering, technologist, and technician graduate respectively[3,4]. In addition, there are three agreements that aim to address the recognition of equivalence at the practicing engineer level, where individual evaluation of experience and expertise (not qualifications) are seen to meet the benchmark standard. That is, a person recognized in one country as reaching the agreed international standard of competence should be able to obtain registration in another country that is party to the agreement with minimal assessment[3,4].

These accords and agreements have allowed increased mobility of engineers and their services they provide across borders. New scientific and engineering discovery are pushing the boundary of engineering applications, particularly in complex systems and interdisciplinary engineered solutions. This scenario presents many new challenges for engineering organizations in that one project for new autonomous gold mine may start with preliminary design in London (UK) with German-trained engineers, then developed further with detailed design in Houston (Texas) with a mix of US and Brazilian-trained engineers, and followed by design validation and verification in Singapore with a mix of British and Asian-trained engineers, and project managed by Australasian-trained engineers during the construction phases in Laos, all within multi-disciplinary environments. This example reinforces the need for consistent global competency standards, recognition and registration of professional expertise, and importantly, the need for systems-based thinking in education and training. This is particularly so for professional development of professional engineers ensuring that its quality is maintained for currency, relevance, technical robustness, but importantly, complex systems-focused.

There is currently inadequate coverage of global agreement in the sphere of professional development and training of practising engineers. There is an argument that the quality of professional development will have a direct impact on the performance of practicing professional engineers. Hence, it is proposed that a new global accord be established to address this deficiency[5].

Samples of Existing Engineering Accords

There are three agreements covering mutual recognition in respect of tertiary-level qualifications in engineering:

- The Washington Accord[3] signed in 1989 - Recognizes the substantial equivalency of accreditation systems of signatory organizations and the engineering education programs equivalent to 4 years duration accredited by them, and establishes that graduates of programs accredited by the accreditation organizations of each member nation are prepared to practice engineering at the entry level. More information including current members of the Washington Accord can be obtained from the Washington Accord website; www.washingtonaccord.org.

- The Sydney Accord[3] commenced in 2001 - Flowing from the Washington Accord, a similar Agreement was developed for Engineering Technologists or Incorporated Engineers, called the Sydney Accord (SA), which was signed in June 2001. It recognizes substantial equivalence in the accreditation of qualifications in engineering technology, normally of three years duration.
- The Dublin Accord[3] commenced in 2002 – It is an agreement for the international recognition of Engineering Technician qualifications, normally of two years duration. In May 2002 the national engineering organizations of the United Kingdom, Republic of Ireland, South Africa and Canada signed an agreement mutually recognizing the qualifications which underpin the granting of Engineering Technician titles in the four countries. Since then, two further economies have attained provisional membership, and are working towards signatory status. They are New Zealand and the United States.

There are three agreements covering mutual recognition and registration in respect of individual professional expertise and the capacity to perform independently in engineering:

- Asia Pacific Economic Cooperation (APEC) Engineer agreement[3] commenced in 1999 – This is an agreement between APEC countries for the purposes of recognizing "substantial equivalence" of professional competence in engineering. APEC countries can apply to become members of the agreement by demonstrating that they have in place systems which allow the competence of engineers to be assessed to the agreed international standard set by the APEC Engineer agreement. The representative organization in each economy creates a "register" of those engineers wishing to be recognized as meeting the generic international standard. Other APEC economies generally should provide equivalency when an engineer seeks for his or her competence to be recognized. The Agreement is largely administered between engineering bodies. Registration on the IPER register with APEC Engineer ensures that professional engineers have the opportunity to have their professional standing recognized within the APEC region thereby contributing to the globalization of professional engineering services. This is of particular benefit to engineering firms that are providing services to other APEC economies but it also adds value to individuals who may wish, at some stage, to work in these economies.
- The Engineers Mobility Forum (EMF) agreement[3] commenced in 2001. It operates the same competence standard as the APEC Engineer agreement but any country/economy may join. The Engineers Mobility Forum Agreement was signed by engineering institutions from Canada, South Africa, the United Kingdom, Australia, Ireland, New Zealand, Hong Kong, the United States, Japan, Malaysia, and Korea. Its purpose is to enable progress towards removing artificial barriers to the free movement of professional engineers among countries, while ensuring that qualifications are met. Signatories have agreed to establish and maintain an EMF International Register of Professional Engineers as a basis for consultation within their respective constituencies. An EMF International Register is being established by Australia, Canada, Hong Kong China, Ireland, Japan, Korea, Malaysia, New Zealand, South Africa, UK and USA. The EMF International Register of Professional Engineers signatories aim to facilitate cross-border practice by experienced professional engineers by establishing a framework for their recognition, based on

confidence in the integrity of national assessment systems. Each signatory will maintain its own register and will share information with other signatories.

- The Engineering Technologist Mobility Forum (ETMF) agreement[3] commenced in 2003. The parties to the Agreement have agreed to commence establishing a mutual recognition scheme for engineering technologists. It operates along the same lines as the Engineers Mobility Forum agreement, focusing on Engineering Technologists.

Development Framework and Evaluation Protocol

One possible development framework to adopt for a global accord is the European Foundation for Quality Management (EFQM) self-assessment model for continuing professional education[6]. The model is based on the nine criteria which underpin the excellence of an organization. The criteria include five Enablers and four Results. The enablers cover what an organization do, and the results criteria over what an organization achieves. The model illustrates that Leadership drives Policy and Strategy delivered through People, Partnership and Resources. The criteria determine the level of Customer satisfaction, People satisfaction and the impact on Society as a while. The original version of EFQM self-evaluation matrix focused on management practices, and later adopted in 2007 by the project DAETE (development of accreditation in engineering education and training)[7]. A tool was developed from the project to establish guidelines for the quality evaluation of Continuing Engineering Education.

A protocol for self-evaluation is required to support such a framework in terms of the criterions for developing engineering education programs with respect to the requirements of professional and/or registered engineers. A suggested protocol for professional engineering practice could be derived from the Warren Centre's PPIR (Professional Performance Innovation and Risk) Protocol[8] in defining the standard of performance of an engineering task which can be expected by employers, clients and other stakeholders. The protocol aims to:

- informs and guides the professional engineer acting individually or as a team member on the essentials of performance in undertaking an engineering task;
- informs and guides all parties to, and stakeholders in, an engineering task on the role and obligations of the professional engineer and the effective use of such services; and
- defines the essentials of performance against which the duty and standard of care of the professional engineer can be assessed objectively, both in prospect and in retrospect

The EFQM framework and the Warren Centre's PPIR protocol are suggested as a proposed foundation for establishing a global accord for continuing engineering education. It is of the view that further discourse with major engineering bodies is required to take the proposition from the conceptual and piloting stages to a stage for establishment of a global accord.

Curriculum Model for Professional Engineering Programs

Head[9] (2008) concluded that one skill that is in short supply is the ability to manage complex systems and provide sustainable outcomes through design-and-performance specification, quality management and whole-of-life system operational management. Goh et al[1] and Galloway[10] argue for the need to broaden current and future engineers' skills sets to become not only technically competent but also competent in communication and management practices which are somewhat taught in undergraduate, but never had the opportunities to refine at the postgraduate levels. Goh[1] and Galloway[10] propose new Master degrees in Professional Engineering. Both authors lay out non-technical areas in which engineers must become proficient: globalization, innovation, communication, ethics and professionalism, diversity, and leadership (**21st Century Skills Set**).

To Human Resource (HR) managers and Learning & Development professionals, learning is much more than just creating courses, it is also about managing and developing their people. Within the HR profession, there is a growing recognition that formal training accounts for only a fraction of organizational learning, and disseminating knowledge in a formal classroom is incredibly expensive and inefficient[11]. Most HR professional refer this view in the form of the "70-20-10" approach of leadership development[12]. Though EEA is actively looking at developing engineering workforce with their educational products, it is observed that there is an over-reliance on structures that focus on compliance and competencies, as opposed to a learning journey approach inclusive of personal, professional and educational development. It can be argued that there is no one-size-fits-all approach for the 21st century where "boxes" can be ticked for engineering managers. Therefore, the question must be asked on how we can provide recognition and articulation of informal learning. One such method is the student-centric **Work-Intergrated Learning** (WIL).

In this age of ever changing technologies and application convergences, are our discipline-based programs (civil, electrical, mechanical, environmental, etc) established in the 20th Century still relevant? Could our training of 21st century engineers of tomorrow be a melting pot of traditional engineering disciplines infused with 21st century principles? In some way, the drivers for change mentioned in this paper challenge the existing discipline-based political structure and identity of the engineering profession. Another question do arise in that "do the existing cohort of academics have the right skills, training, and incentives to drive change and reform?" Does this suggest that 'traditional' research training (eg. PhD) may not be the best preparation for engineering educators; particularly for academics delivering engineering courses at the professional and management levels? Perhaps **a new breed of professionally accredited academics** is required to be specially trained based on collaborative efforts between universities and industry.

From earlier works by Goh[13,14,15] concluded that 'Integrity' and 'Leadership' essential elements for developing professional engineers. Other important areas were 'communication', 'business acumen', 'strategic planning', and 'financial management'. **Adaptability** and **agility** are also important areas citing recent changing business paradigm. This observation is well supported by the two recent IBM reports[16,17] in that an adaptive workforce is required to respond to competitive and quickly shifting global markets, a precursor for future organizational success. Creating an adaptable workforce requires more than a series of HR programs, it starts with leadership and the ability to "crack the code" for talent.

Engineers will also have to face the complexity of managing four generations of workers, from baby boomers to Gen Z (born after 1995), plus managing an increasingly diverse workforce in gender and culture[18,19]. **Diversity** will be a large component of the learning journey[13,14,15]. The new program should also have mechanisms to nurture **emotional intelligence**[13,14,15]. Another aspect that needs to be considered is developing confidence. Mortimer[20] states, "The more effective people are those who can grasp the imagination of their team. They have the personal magnetism and intelligence to build around them and to continue to embrace talent within their organization. That's another way of saying they're confident."

An under-rated component of leadership development is in **intelligence leadership**. The data indicates 19% of S&P/ASX100 leaders achieved honors in their undergraduate degree[20]. At the postgraduate level, 25% have an MBA, and 7% have no tertiary qualifications [20]. The interesting element of the data is that a large cohort had non-management qualifications; 19.5% higher technical qualification and 8.5% had PhD qualification. These observations provide some evidence that it is beneficial to include a research-based component into the learning journey.

A Proposed Learning Journey

The future operating environment requires engineers who possess[1,13,14,15]:

- Ability to nurture and lead an adaptive workforce;
- Ability to manage diversity and multiple-stakeholders;
- Genuine social and ethical attributes;
- Strong emotional intelligence;
- Strong intelligence leadership;
- Strong leadership in sustainability;
- Confidence in presence and abilities;
- Strong business and commercial acumens; and
- An in-depth knowledge of one's industry.

From the attributes above, it is proposed that the learning journey start in the early years working as a graduate engineer in pursuit of their professional or chartered status. It should incorporate and integrate personal, professional and educational development with close supervision by mentors, both within the industry and academia. It is possible to complete the learning journey in an intensive 3 year timeframe, but a more realistic 5 year timeframe is recommended as the step for most graduates to management starts generally after 6 years of work experience[14]. The learning journey should also be reinforced by peer-support networking in a virtual social network which students and alumni can access across institutions. This learning journey is illustrated in Figure 1.

Under the educational development stream, it is proposed to embed principles such as Innovation, Leadership, Globalization and Sustainability, as part of the 21st Century Skills Set[14], into relevant technical and engineering curriculum infused within the personal, professional and educational development framework. It is envisaged that the learning journey may involve short-term placements in another industry such as banking or the arts.

Under the professional development stream, the workplace becomes the classroom, and the classroom becomes the workplace. The former is where work-integrated and informal learning are recognised and captured for articulation; the latter is where the research-based learning is part of the company's innovation or R&D program. These scenarios will be able to build-on in practice the necessary "soft-skills" but also develop rigour in "intelligence".

Under the personal development stream, there is a case for self-directed but collaborative peer-driven learning in a philanthropic environment where there is a melting pot of diverse profiles of participants but also of the recipients of the charitable work. The learning in these philanthropic environments will hopefully develop the ability to manage diversity and be adaptive, but also to develop empathy for social and environmental concerns. In conjunction with coaching/mentoring, these activities are conductive aids for developing "integrity".

Engineering educators will also need to take a life-long learning perspective to their client, in this case, the aspiring professional engineers. This may require engineering educators to be retrained and reequipped to be able to coach and mentor and facilitate personal, professional and educational development of individuals. A certification process or 'chartered status' for accredited educators of this unique program may be introduced to ensure the 'right' people are helping to facilitate the learning journeys. This framework can be replicated for postgraduate engineering coursework programs with specialised technical contents as well as management contents.

<table>
<tr><th></th><th>Personal Development</th><th>Professional Development</th><th>Educational Development</th></tr>
<tr><td>Year 1</td><td>Personalised 360 degree evaluation to construct a personal development plan; Coaching and mentoring provided</td><td>Be guided to plan for Stage 2 and/or Stage 3 competencies; identify strategic opportunities for professional development; Can be part of existing PDP or Graduate program</td><td>Be guided to plan a curriculum that best fit the organisational need; the suite of courses should consist of management, engineering, and business strands that have an overarching framework of 21st Century Skills Set (Innovation, Leadership, Globalisation, Sustainability). Start small with 1 course per semester.</td></tr>
<tr><td>Year 2</td><td>Execute personal development plan; this may include philanthropic activities or self-improvement workshops along with other participants from other disciplines and/or professions</td><td rowspan="3">Continue to record and evaluate career episodes reporting, and adjust learning plan if required. Should include a Work-Integrated Learning and short professional development courses as part of the recognition of informal learning; Could include a research component as part of a workplace project.</td><td rowspan="4">Continue with the educational development plan and complete 10 courses; Can be accelerated with residential schools or intensive coursework; Recognition of prior studies and articulation of short courses should be available. Multi-disciplinary or multi-profession student cohort is desired.</td></tr>
<tr><td>Year 3</td><td rowspan="2">Evaluation of progress in the personal development plan; adjust or refine if required. Continue to execute plan</td></tr>
<tr><td>Year 4</td></tr>
<tr><td>Year 5</td><td>Review and evaluate; Submit a portfolio of reflections</td><td>Submit Career Episode Report to EA for assessment</td></tr>
</table>

Figure 1. A proposed learning journey for professional engineering program

Conclusions

This paper argues the case for the establishment of a global accord for the postgraduate learning journey of engineers. The establishment of agreements covering educational qualifications in engineering and competence standards for practicing engineers have resulted in increased engineering mobility and improved global standards. However, the paper suggests that the capability to perform provided by these competencies agreements do not ensure the professional development of engineers are complementary and adequate for them to perform in an increasing complex, globalised and constantly changing engineering world. Recent engineering disasters and mistakes are exemplary to illustrate this tenet that a global accord is required for engineers to improve their appreciation and understanding of complex systems and its contexts within their respective disciplinary knowledge, but also should require one to be competent in new knowledge of within a global context. The EFQM framework supported by the Warren Centre's PPIR protocol is suggested as a proposed foundation for establishing a global accord for continuing engineering education. A proposed curriculum model is outlined. It is acknowledged that further developmental and piloting work is required to establish the robustness and agility of the proposition for internationalized adoption.

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