# A New Engineering Management Master to address the personal, professional and educational needs of engineering graduates to achieve EA chartered status

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***Abstract**: This paper provides a progress report on the development of a new engineering master program as one part of a 2010 Senior L&T fellowship. The development of the new program is inspired by other accredited professional programs from the accounting and law professions. The program has the dual aims of providing learning opportunities for aspiring engineering graduates in the form of personal, professional and educational development, and structured guidance and mentoring to pursue their Engineers Australia's chartered status (Stage 2 Competencies) and potential Stage 3 status. 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. The engagement process and ongoing collaborative experience with Engineers Australia is also described.*

## Introduction

As engineering leaders continue to navigate their organisations around the global financial crisis (GFC) and sovereign debt crises, future engineers aspiring to management will need to rethink their learning journey and pathways to management to be better prepared to tackle a more regionalized, integrated, dynamic and crisis wary world (Goh et al 2008; 2010). This new world will provide hazards for even the most experienced managers, as regulatory and credit limitations are impacting on their engineering world. Engineering managers in the 21st Century must be prepared to operate in a very different environment to that of the 20th Century' on which engineering management education is mostly based (Goh et al 2008; 2010). In addition, the nature of the modern workplace in Australia has encouraged a number of engineering graduates to follow management paths early in their career. 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 (EEA 2010). In addition, there is the EEA's Experienced Engineer Program (EEP) and the Engineering Leadership Program (ELP) specifically targeting existing and aspiring engineering managers (EEA 2010).

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 (except mining employers) to fund professional development in recent years because of the GFC 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 a structured life-long learning journey. Professional masters-level programs that address personal, professional, and educational development needs should fulfil this demand. Inspired by similar programs developed by other professions such as accounting and law for attainment of professional status, the authors have initiated a journey to propose an accredited postgraduate program to address a perceived market need.

## Literature Review

Educators must question if advances in engineering management education have made progress towards adequately equipping their graduates. The main research question that we may have to ask post GFC is if any of the influencing factors, operating environment or attribute requirements changed? How can leadership development play a part in enhancing this learning journey? Another area of interest is in the debate around climate change and the global initiatives to address it and how outcomes may impact on engineering world post Copenhagen (2009 United Nations Climate Change Conference)?

Recent drivers for change post GFC and Copenhagen are the need for the engineering world to be more sustainable; particularly solving the challenges of population growth and the demand for infrastructure, energy, water and food. This sustainability platform refers not only to financial and technological components, but also to the social and ecological components in engineering (Dunphy et al 2000). Head (2008) states that society's globalizing economic system is destabilizing the planet's life support systems and is rapidly becoming unsustainable. Head (2008) calls on the engineering profession to train and motivate young people to join this ecological challenge. Head (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 (2008; 2010) and Galloway (2008) argues 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 (both authors proposes a new Master's degree in Professional Engineering Management). 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**). The facilitation and teaching of these new 21st century "curriculum" are often outside the traditional technical curricula often delivered in "service" courses. For the learning to be authentic and effective, it needs to be "out of mind" as proposed by Robinson (2007). He argued that one of the fundamental problems for the human mind to be "creative" is the very process which is meant to be developing our natural abilities and minds – "education". The problematic "education" Robinson was referring to is the existing traditional curriculum that exists in schools and universities. Robinson (2007) goes further to propose individualized learning journeys.

To Human Resource (HR) managers and Learning & Development professionals, learning is much more than just creating courses, it is also about managing the people. Corporate education programs such as the ones offered by EEA enable companies to link the development of their employees to business goals and performance. 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 (Kirkbride 2008). Most HR professionals refer to this view as the "70-20-10" approach of leadership development (Lominger & Eichinger 2002). Though EEA is actively looking at developing the 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 about how we can provide recognition and articulation of informal learning. One such method is the student-centric **Work-Integrated Learning** (WIL).

There has been a call for reform and increased collaboration between academia, industry and governments in engineering education from Australian engineering employers for some time (King 2008; Goh & Bullen 2010). Engineering education should be about alignment to the needs of the profession and their organizations with the focus being on bringing the employee visions and values into line with those of the organization (Gannon 2008; Ryan 2008; Efrat 2008). Siller et al (2009) and Sheppard et al (2009) both support calls for changes in the methods used for educating future engineers in the face of a rapid changing world. Fox et al (2008) encapsulated this proposition by linking university and industry to develop cooperative learning experiences for students. Tomkinson et al (2009) introduced a course on sustainable development available to students from a range of engineering and science disciplines. The specific application is in an inter-disciplinary single semester course on Sustainable Development for Engineers and Scientists. This poses the question "should engineering management be taught within a discipline-specific or **inter-disciplinary environment**?"

At an anecdotal level, many engineering faculties around Australia are investigating King's (2008) recommendations for engineering curriculum renewal at the undergraduate level. Though these developments are still flowing through the publication pipelines in terms of the innovations and renewal in curriculum development, it is hard to envisage any fundamental shift in engineering education paradigm, in particular, engineering management education. One would suggest this area should be under the stewardship of management and leadership, hence the business faculties. That may be so but what of the engineering context? Is it relevant in management and leadership studies?

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 that arises from this is "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. The reader is referred to publications by King (2008), National Science Board (2007), National Academy of Engineering (2004; 2005), Royal Academy of Engineering (2007) for further recent literature on the call for engineering curriculum reform.

## Establishing a Curriculum Model

Earlier works by Goh et al (2008, 2010) and Goh (2007) concluded that 'Integrity' and 'Leadership' are essential elements of engineering management education. Other important areas were 'communication', 'business acumen', 'strategic planning', and 'financial management'. **Adaptability** and **agility** were also identified as important areas, citing recent business paradigm changes. This observation is well supported by the two recent IBM reports (IBM 2008a; 2008b) 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. In some ways, the shift in "management" emphasis satisfies the ongoing debate between leadership and management (Taylor 2006; Re 2005). The shift support the view that both **management and leadership skills** are paramount to manage the ever increasing complexity of the engineering world.

Engineering managers 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 (Henry 2008; Burrowes 2009). **Diversity** will be a large component of the learning

journey (Goh et al 2008, 2010; Goh 2007). The new program should also have mechanisms to nurture **emotional intelligence** (Goh et al 2008, 2010; Goh 2007). Another aspect that needs to be considered is developing confidence (Dent 2009). Mortimer (Dent 2009) 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." Burton (D'Angelo Fisher 2009a) also says "It prepares you remarkably well. It's an intangible, but a direct benefit of doing the MBA, as much as anything else, has been confidence."

An under-rated component of leadership development is in **intelligence leadership**. Aspiring engineering managers would be advised to take their study seriously as a survey showed that 19% of S&P/ASX100 leaders achieved honors in their undergraduate degree, 25% have an MBA, and 7% have no tertiary qualifications (Dent 2009). This observation is well supported by the authors' own study on CEOs who have an engineering degree (Goh et al 2008). 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. It is also interesting to note that there is little correlation between higher educational attainments at prestigious schools and better managerial qualities (Gottesman & Morey 2005); ie. will be more adaptive and innovative, and more likely to possess characteristics that may improve firm performance.

Graham (2009) provided a snapshot review of the international good practice in developing future engineering leaders. Programs such as Gordon-MIT Engineering Leadership program, Penn State's Engineering Leadership Development Minor, Uni of Michigan's Engineering Global Leadership Honours Program, Purdue's Global Engineering Program are all highly rated US-based programs of which the key theme 'student empowerment in their own leadership development'. It was found that leadership education sits uncomfortably within engineering programs in European institutions (Graham 2009), however, they have advanced in sustainability education (Tomkinson 2009). In saying this, while not labelled as engineering leadership, there are a large number of successful programs operating in Australia (eg. Monash) and Europe that subscribe to student learning outcomes almost identical to those found in US engineering leadership programs. Most programs are keen to equip their students for the global context of engineering practice for the 21st century. In addition, most programs have been developed in the last 5 years and are managed on very small budgets and project teams, often **operating outside the formal curriculum**. One may conclude that engineering leadership is currently in its infancy but developing as an important part of an engineer's learning journey.

## A Proposed Learning Journey

The future environment requires engineering managers that are leaders who possess (Goh et al 2010):

- 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. While it is possible to complete the learning journey in an intensive 3 year timeframe, a more realistic 5 year timeframe is recommended as most graduates take the step to management after 6 years of work experience (Goh et al 2008). 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 the figure below.

<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 engineering management program**

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 (Goh 2008), into the engineering management 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".

The model, mechanisms, and methodologies proposed in this paper are currently being refined and developed as part of the current work in a 2010 USQ Senior Learning & Teaching Fellowship. Though the authors acknowledge that there are external accreditation drivers for an outcome-driven approach in engineering education, it is essential that academics and professional authorities reflect on and challenge existing paradigms. For example, what do we want prospective engineers to "know" about

leadership and sustainability? Should they "explore" leadership and sustainability, determine what it "means" to them, and learn "how" to adapt and exercise it? Engineering educators or academics will need to take a life-long learning perspective to their client, in this case, the aspiring engineering managers. 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 of our aspiring engineering managers. This framework can be replicated for postgraduate engineering coursework programs with specialised technical contents.

## EA Engagement Process

A study is to be undertaken to identify how the distance education strengths of USQ can be used to deliver a Masters program for a diverse cohort of engineering practitioners with the aim of facilitating progression to chartered status with Engineers Australia while also promoting engineering management and leadership (Jokic 2010). The study is intended to be run as a project within the Faculty of Engineering and Surveying at USQ with delivery of the final outcomes in 2010.

This project will document:

- course/content requirements for a Masters program facilitating engineering practitioners' progression to Chartered status,
- course/content content requirements for a Masters program that enhances postgraduate engineers' knowledge and skills in engineering management and leadership,
- appropriate modes for delivering course content, including distance education courses, residential components and work-based activities,
- identified risks and issues for USQ to develop and deliver a Masters program,
- schedule and resources required for the development of the Masters program,
- the overall feasibility of USQ establishing the new Masters program.

This activity will be undertaken by USQ Faculty of Engineering and Surveying staff The primary communication mechanisms for USQ staff will be monthly meetings (face-to-face and teleconference) and the project community portal (http://community.usq.edu.au). Stakeholders will be encouraged to participate in both communication mediums. Stakeholder engagement is essential for establishing the appropriate course requirements and identifying the risks and issues. Possible stakeholder engagement includes:

- Engineers Australia (at least once per month) – 1) to identify how the proposed course can complement existing professional development programs, 2) to establish if a course can indeed be created and satisfy requirements for Chartered status and 3) for reviewing the final deliverables.
- Engineering employers (including local government and defence) – 1) to help identify a market for the proposed Masters program and 2) for establishing course delivery requirements

The product of this engagement process is envisaged to be a new USQ engineering Masters program designed to support a wide range of engineering practitioners in the pursuit of Chartered status and excellence in engineering management and leadership.

The engagement was initiated around March 2009 and continued since then. It is observed that even though there was some agreement on the engagement process, the external committee looking into this project desires a 'product' to evaluate rather than working through the process of collaboratively developing the program. It can be argued that this may because of entrenched behaviours in their previous engagement with tertiary institutions.

### Conclusion

The engineering management education fraternity appears to be at the start of a new journey, initiated by the changing environment for engineering managers that has been gathering momentum over the last few years; in particular, the drive for graduate engineers to pursue chartered status. The fluid and dynamic nature of management education has introduced many new influencing factors but also presents opportunities for engineering faculties to exploit. There is a need for future transformative,

highly skilled and adaptive engineering managers, in particular, those who exhibit strong leadership and sustainability attributes. This paper examined the requirements for a reformed curriculum and suggested a conceptual learning journey for which to engage the engineering profession in a collaborative effort to address a market need.

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