

Diversification of engineering management studies in enriching the learning experience for the 21st century global engineer

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***Abstract:** This paper examines the engrained practice of contextualising engineering management studies within a technical context. The author argues that this practice has attributed to a generation of graduates that are well focused and technically competent but lack the creativity and professional skills needed to operate as a global engineer in the 21st century. The world is moving rapidly and an adaptive workforce is part of the success formula now and into the future. In the future world of mega projects, cross-cultural diversity, intellectual mobility, multiple stakeholders and increasingly complex operating frameworks for engineers, one would argue the current curriculum of training engineers within disciplines to be technical specialists is inherently outdated. This paper provides an initial scoping study for further work to be developed and proposes a diversification principle in the reform of curriculum design in engineering management programs.*

Introduction

As world leaders continue to navigate around the global financial crisis and potential global recession, future engineers aspiring to management will need to rethink their learning journey and pathway planning to management in order to be more prepared to tackle a more globalised, integrated, dynamic and ever-changing world. Engineering managers in the 21st Century must be prepared to operate in a very different environment to that of the 20th Century of which engineering management education is mostly based on. This paper is intended to initiate further discussion and research into this important area of the development of the future engineering leaders and nation builders of tomorrow.

Literature Review

A Call to Collaborate

There has been a call for reform and collaboration in engineering education, particularly from industry for some time (King 2008). In Australia, this has been accentuated by the engineering skilled labour shortage currently being experienced. This is reinforced by “Big Issues Roundtable” coordinated by the Committee for Economic Development of Australia (Sibillin 2008). Simons of The Smith Family (Sibillin 2008) was quoted, “With educational transformation there is need for greater integration and porosity among walls, systems and sectors.” and “Business council of Australia expressed a concern about how business can come to the table in enhancing and driving change effectively in the education sector both in terms of design and strategy, programs that are effective in the marshalling of evidence that will bring about improved practice.”

This is further highlighted by the KPMG’s “Embracing Change? Global Construction Survey 2008” Report, “On a global level, there has historically been little or no collaboration between stakeholders

such as companies, universities and governments” (KPMG 2008). One example of this collaboration is the establishment of Mining Education Australia, where collaboration from universities and the mining industry saw the emergence of new capabilities and capacity to train mining engineering graduates. The message for the future is clear; collaboration is required from universities, industries and governments.

A Call to Consolidate

An environmental scan performed by the author (Goh 2007) highlighted that management education for engineers is already undergoing a transformation. There is evidence that indicates an increase in customization of curriculum and delivery, increased corporatization of education, and a proliferation of short-courses and workshops. Some examples that illustrate this shift are Engineers Australia’s EEA and Graduate Development Program, engineering professional organization’s partnerships with Melbourne Business School and Chifley Business School, and in-house leadership development operations such as GHD Business Schools, SKM and Qantas Engineering. However, there is also some evidence that these activities are causing congestion in the market place, and increasingly there is a call from the engineering profession to consolidate this professional development market (Goh 2008).

A Call to Revitalize

Recent literature initiated by the Commonwealth of Australia, Innovation & Business Skills Australia, Australian Institute of Management, and Engineers Australia (Goh 2007), has indicated that engineering managers of the 21st century need to operate in a global and often mobile environment, encounter complex and often conflicting issues, need to be culturally aware, have to deal with multiple stakeholders, technology driven and possess strong team leading skills and interpersonal skills. They may also find work-life balance difficult, and most of all, must possess strong technical acumen in the relevant industry. This is further supported by recent research on some Australian CEOs who have an engineering degree in Australia (Goh et al 2008).

One of the reasons for this change in training preference is mainly as a result of the curriculum gap in the existing training of engineers as the operating engineering environment evolved. This is indirectly highlighted and addressed in the ALTC Review of Engineering Education led by King (2008). This observation is further supported by Trevelyan (2008) of UWA that engineering educators often have a narrow view of what constitutes “real” engineering and neglect the “human” side of engineering in the curriculum.

Galloway (2008) in her book titled “21st Century Engineer: A Proposal for Engineering Education Reform” 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. These soft “fundamental capacities”, she believes, are still not being taught at either undergraduate or postgraduate levels, and proposes a new Master’s degree in Professional Engineering Management. Galloway paints the new global landscape where mega projects, sustainability, infrastructure security, and multicultural work teams pose challenges for which engineers may be unprepared. She lays out non-technical areas in which engineers must become proficient: globalization, communication, ethics and professionalism, diversity, and leadership (ie. 21st Century Skills Set). She summarized the case for radical curriculum renewal with, “an engineering educational system that has not kept pace with the demands of the marketplace”. The message states that revitalization of the curriculum and delivery is long overdue.

A Call to Recognize and Articulate

Management education is often about aligning the needs of the organization, the focus on bringing the employee visions and values into line with those of the organization and their development is linked to the wider corporate strategy (Gannon 2008; Ryan 2008; Efrat 2008). To Human Resource managers and Learning & Development professionals, learning is much more than just creating courses, it’s about managing the people. Corporate education programs enable companies to link the development of their employees to business goals and performance. Training courses are not the core requirement

of leadership development and need to be integrated into wider process of feedback and structured experience.

Within the HR profession, there is a growing recognition that formal training accounts for only a fraction of organizational learning (Kirkbride 2008). Disseminating knowledge in a formal classroom is both very expensive and inefficient, and most HR professional have a “70-20-10” approach to leadership development (Lominger & Eichinger 2002). That is, learning is broken up into 70% on the job, 20% as feedback and learning from others through mentoring and coaching, and the last 10% through learning programs. In some ways EA’s Professional Development Program recognizes this trend by progressing graduates to chartered status using Career Episode Reports with opportunities for mentoring within the program. Therefore, the question arises on how to provide recognition and articulation of informal learning at the management level.

There is also the ongoing debate over what type of training and development is required; Management vs Leadership debate (Taylor 2006; Re 2005) and the Team Oriented Leadership vs Individualized Leadership. Finally, there are senior engineers and managers acting as mentors for graduates, however, it must be asked who is supporting and mentoring the mentors and whether this is necessary. Would an “Engineering Leader Support Network” be an avenue for peer support and networking?

The foreseeable changes in the dynamics of the working environment of engineering managers of the year 2020 will also likely contribute to another significant environmental shift in the management education market place. In a near future world where products such as “Facebook”, “Wikipedia” and Web 2.0 will dominate, the question is posed, “What is the next paradigm in personal development, professional development and postgraduate education delivery and curriculum for the engineering managers of the 21st century. Equally important is how can universities position themselves to strategically benefit from this opportunity?” The authors propose that the new paradigm for educators is a matter of role transformation from a teaching perspective to one of “a coach, a mentor and facilitator of learning rather than purely as educators”.

Transformative Paradigm

From an earlier study (Goh et al 2008) conducted by the authors on CEO attributes who have an engineering degree, it was noted that the most important attribute required by CEOs, identified in the study was “Integrity”. From the published results, integrity had the highest average importance compared to the next highest for leadership. Leadership and integrity thus are of major focus in this paper. Other important areas were communication, business acumen, strategic planning, and financial management. However, unsurprisingly, integrity was not seen as requiring training, and a large extent considered to be an inherent character trait rather than something that could be ‘taught’. However, this paper proposes that educators can nurture and facilitate this “learning” of integrity by introducing an accelerated personal ethically journey. This can be manifested in the form of philanthropic activities by (say) placing engineering executives into charities during their learning journey. For example, Qantas aircraft engineering and maintenance services senior management team participates in the “Executive Leadership Development” program that aligned leadership development with corporate social responsibility by placing them in a charity called “Foodbank” (D’Angelo Fisher 2008). Beside the ability to identify and resolve business issues, strategic and commercial skills, cross-functional communications, and leadership attribute, Qantas identified that adaptability and agility are key factors to business in the future.

This observation is well supported by the recent IBM report “The Global Human Capital Study 2008: Unlocking the DNA of the adaptable workforce” (IBM 2008a) in that an adaptive workforce is required to respond to competitive and quickly shifting global markets, a precursor for future organizational success, however, workforce adaptability remains elusive to many. 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), that indeed management skills is important in engineering,

leadership skills are paramount.

According to the Economist Intelligence Unit (2006)'s "Foresight 2020" report, globalization and networking technologies will enable firms to use the world as their supply base for talent and materials. As a result, effective collaboration will become very important. The boundaries between different functions, organizations and even industries will blur. It adds that running an efficient organization is no easy task, but even success there will unlikely to offer any lasting competitive advantage, where personal chemistry or creative insight matter more than rules or processes. Engineering managers of tomorrow will have to lead an adaptive workforce.

In addition, engineering managers will face the prospect 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. Damain Burton of Asciano Group who completed an EMBA at Melbourne Business School with 25 other students (D'Angelo Fisher 2009a) says of his cohort, "There were lawyers, IBM executives, KPMG partners – it was fantastic to get that exposure. You discover a whole range of things about them and yourself." Doug Roem, an electrical engineer by training, now CEO and managing director of scrap-metal company, Metals Trading completed his MBA at INSEAD business school in Fontainebleau of France (D'Angelo Fisher 2009b). He says "The key attraction of INSEAD was its diversity. US business schools are much less diverse. INSEAD offered cultural and ethnic diversity, but also a huge amount of professional diversity." Dr. Paul Kroon, of University of Queensland has an international reputation for his research in molecular genetics, and has completed a one-year intensive MBA with his own university. He says that an important factor was the opportunity to study with students from around the world. A third of his fellow students were from overseas, including US, Indonesia, Singapore and India (D'Angelo Fisher 2009c).

Though Engineers Australia (professional body for engineering in Australia) is actively looking at developing the leadership aspects of 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.

Boston Consulting Group's report "Vision 2020" (Goh 2007) noted that managers of the year 2020 should have the following attributes and skills:

- Able to manage a global workforce and diversity in the workplace, and high adaptation to various cultures,
- Possess intellectual grunt, highly analytical and decision making skills, and a deep knowledge of the industry or enterprise,
- Possess high emotional intelligence and strong inter-personal and leadership skills,
- Possess a life-long learning and explorative attributes, and
- The ability to balance work/life demand requiring high energy levels and resilience.

In a recent survey conducted by IBM, "The Global CEO Study: Enterprise of the Future" on 1130 CEOs and leaders of public and private institutions (IBM 2009b), it found that:

Organizations are bombarded by change and many leaders are struggling to keep up; 8 out of 10 CEOs see significant change ahead and the gap between expected change and their belief in their ability to manage it has almost tripled since the Global CEO study of 2006:

- CEOs view more demanding customers as an opportunity to differentiate;
- Most CEOs are adapting their business models, with two out of three implementing extensive innovations.
- The enterprise of the future was described as:

- Hungry for change, shaping and leading trends, comfortable with unpredictability, value and goals providing alignment and cohesion,
- Constantly surpassing customer demands and expectations,
- Strategically designed to access the best capabilities, knowledge and assets from wherever they reside in the world and apply them wherever needed,
- Disruptive by nature, shifting the value proposition, overturning traditional delivery approaches and reinventing itself and its entire industry, and
- Moving beyond philanthropy and compliance to reflect genuine concern for society in all actions and decisions.

Based on these descriptors, the enterprise of the future will be nimble, innovative and better at recognizing and facilitating faster and more extensive collaboration on a global scale. It will be adept at social networking and real-time collaboration to improve communication across its global organization to spread good ideas and solve problems faster. It must remain active at managing business while trying out bold business innovations. The message to engineering managers of the future is clear, instead of shrinking their focus and budgets around aspects such as R&D, marketing, HR, etc., they need to be investing in those things that will have the workforce ready for fluid transformation. It will require transformative leadership and genuine integrity combined with strong commercial and technical acumens.

Another aspect that needs to be considered is developing confidence (Dent 2009). Confidence separates the true leader from the pretenders. Leighton Holdings and Australia Post chairman David Mortimer 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 of Asciano Group (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 showed that 19% of S&P/ASX100 leaders achieved honors in their undergraduate degree (Dent 2009). There is little consistency, at least at the undergraduate level, about what the leaders of the S&P/ASX100 companies studied. 18% studied commerce, 7% studied economics and 14% studied engineering while 17% have a bachelor of science. Only 3% studied law and 3% studied medicine. At the postgraduate level, 25% have an MBA, and 7% have no tertiary qualifications. This defies the myths that only individuals with commercial background succeed as managers. It is also interesting to note that there is little correlation between higher educational attainments at prestigious schools and better managerial qualities in a study by Gottesman & Morey (2005) of Lubin School of Business, Pace University; ie. will be more adaptive and innovative, and more likely to possess characteristics that may improve firm performance.

Mortimer (Dent 2009) who is chairman and director of a number of ASX listed boards stated that “There are 2 types of managers; those who are outstanding people-people, who combine that with high level of intelligence and are quite frequently visionary. And then there are those who, in my mind, are risk managers.” The Warren Centre for Advanced Engineering at the University of Sydney is establishing a new department of postgraduate teaching and research in engineering leadership (North 2008). It will offer Masters courses to the best engineering graduates in various disciplines from around Australia, many of whom would already have experience in industry. Students will learn how to analyse markets, how to gain an understanding of other fields of expertise and how to lead an engineering team. In addition to classroom learning, students will carry out field work in a company and write a thesis in industrial innovation or R&D program.

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.

The question must be also asked of the adequacy of MBA programs to provide the personal, professional and educational development of engineering managers. The answer so far hasn't been a "no", it is a "not yet but watch this space". There is an acknowledgment by business schools around the world of the need for transformative reform. Brailsford, head of UQ Business School, suggests radical changes to curriculum to focus on personal and ethical decision making, and to get back to fundamentals (Mathers 2009). He agrees with the feeling among MBA educators internationally that some significant decisions on content are required. Green, dean of business at University of Technology Sydney (Mathers 2009) says "The MBA will evolve because an MBA that stand still is a useless MBA ... People will challenge paradigms and provide new solutions and ideas." However, he says specialized masters will still have their place but the MBA will be particularly relevant because "it is the only degree that combines a comprehensive grounding in all the functional areas of management".

In the shadow of the last statement, what if it is possible to extract the best of an MBA, a research degree, work integrated learning, mentoring, professional network, external placements (outside engineering), and integrate it into the proposed diverse learning journey. It can be argued that the best candidates to host such programs are in the engineering faculties as they should possess the capacity to teach both technical and management curriculum for engineers and technical managers. The next few years will be an interesting one as we see universities react to the changing environment, and be agile and adaptive, and position themselves to exploit and new and exciting opportunities in engineering education.

Conclusion

The changing environment for future engineering managers demands a new paradigm and this paper proposes fresh views on reforming curriculum for personal, professional, and educational development especially in postgraduate education for engineers. It is acknowledged the works is in its infancy and require further work to refine the ideas into frameworks. The fluid nature of the management education market has introduced many new influencing factors and opportunities. This changing need in delivery and curriculum preference is as a result of the increasingly dynamic and integrated globalised world. It may require collaborative idealism from the stakeholders to achieve desired outcomes. There is a need for future transformative leaders in our engineering managers. This paper presented a new paradigm and proposals to reform the existing framework to achieve enhanced attributes of future engineering managers, and to provide a mechanism for sustainable curriculum reform in engineering management education. The authors recognize that this proposal may set a task that is too great, and politically, very sensitive to any individual champion (or university) to act on. Though history have shown that change is often a result of reactive actions, it is hopeful that foresight and vision may play a part in ensuring the future generation of engineering managers will be well positioned to exploit and excel their comparative advantage in the global stage of mega engineering projects, within fluid, diverse and integrated environments.

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