Engineering Learning and Practice - a Brunei Perspective

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Abstract: *This paper discusses the findings of preliminary data analysis on the engineering work conducted in Brunei. One might assume that an undergraduate embarks on an engineering course with a clear picture of the future work and responsibilities involved. From this study, however, it was found not to be a valid assumption for Bruneian engineering students. There is a mismatch between engineering education and engineering practice with regards to the appropriate skills and knowledge required upon entering the engineering workplace.*

Brief Introduction

Brunei Darussalam, with an estimated population of 390,000 people, is located in the north-west corner of the island of Borneo. For the engineering education system to be effective, one has to first understand the work of an engineer. This will help with better planning and design of the engineering course, with the assurance that appropriate skills and knowledge are imparted. There are few reliable research reports on engineering practice (Domal & Trevelyan, 2008; Trevelyan, 2007, 2008; Trevelyan & Tilli, 2007).

This paper reviews the literature on engineering practice and presents initial results from an empirical study to gain an insight into engineering practice in Brunei. This research is part of a wider on-going study of engineering learning and practice, conducted in School of Mechanical Engineering at the University of Western Australia.

Literature Review

Engineering institutions in many countries have their own definition of engineering practice. However, this is not the case for some South East Asian countries, except for Singapore, Thailand, Philippines and Malaysia (Bhumibhol Adulyadej, November 19, 1999; Malaysia Board of Engineers, 2007; Republic of the Philippines, February 12, 1998; Singapore Professional Engineers Board, 2005). While the majority of definitions of the engineering practice include planning and designing, some include analysis, organisation, supervision, management and administration, whereas others are relatively more comprehensive, even taking into account liabilities and environment relationships (Meisen, 1996, p. 16; The Institution of Engineers Australia, n.d; The Institution of Engineers Singapore, n.d; The Korea Engineering & Consulting Association, n.d; Trevelyan & Tilli, 2007).

The literature shows that there are misconceptions as to what an engineer actually does (Lam, 1996; Marshall, McClymont, & Joyce, 2007; Wilde, 1983). An engineer has been defined in numerous ways by the various engineering institutions or associations (The American Heritage Dictionary of the English Language, 2000; The Institution of Engineers Australia, n.d; The Institution of Engineers Malaysia (IEM), n.d; The Institutions of Electronics and Telecommunication Engineers (IETE), 2004;

The Society of Professional Engineers United Kingdom, n.d). This difference in definition contributes to conflicting views between professional engineering associations and the general public when it comes to what the term 'engineer' represents. The majority of the general public have little idea of what engineers do beyond being involved in the construction of machines and buildings. It is claimed this ambiguity results in engineers being unfairly blamed for 'failures' which have taken place around the world (Steinhauer & Cieply, 2008). This may result in a decrease of students entering engineering courses, inadvertently leading to a shortage of engineers (Beder, 1999, p. 13; Brown, 1998, p. 45; Committee of Inquiry into the Engineering Profession, 1980; Lam, 1996, p. 184; Wilde, 1983, p. 22; Wilson, 1987; Yates, 2001).

Lichtenstein et al (2007) found that majority of the students had limited exposure to engineering prior to commencing their engineering education, in which the authors classified as low, moderate or high exposure. By having a clear understanding of their chosen field, engineering students can avoid disappointment and develop in areas about which they are passionate.

Besides the technical know-how, engineers should also posses other skills such as communication skills, strategic planning skills, finance skills, and project management skills (Cao & Ramesh, 2008, p. 444 & 448; Jonassen, Strobel, & Chwee, 2006, p. 146; Solomon & Holt, 1993; Trevelyan, 2007, p. 196). Did engineers in Brunei acquire these skills through work experiences, work-related workshops or during their engineering studies?

To date, no research appears to have reported on either engineering practice or framework of engineering roles in Brunei. A comprehensive framework of eighty five different aspects of engineering practice, supported by thirty five areas of specialised knowledge, was developed by Trevelyan (2008), using empirical research on engineering practice based on interviews and field observations. From the empirical study carried out by Domal and Trevelyan (2008) on the work of engineers in South Asia and in the empirical ethnographic survey of engineers in Australia conducted by Trevelyan(2007), it was found that coordinating the work of others and acquiring their cooperation are major aspects of engineering practice. Lam (1996) also found similar findings in the empirical study of British and Japanese engineers.

Research Methods and Participants

Qualitative data for this paper include semi-structured interviews and informal dialogue with a targeted sample of engineers (N=15), and is complemented by survey data from a larger cohort of engineering students (N=104). The sample of engineers comprises of twelve men and three women in various disciplines; six Telecommunication engineers, two Military engineers, two Electrical engineers, two Mechanical & Electrical (M&E) engineers, one Sales engineer, one Oil & Gas engineer, and one Radio & Broadcasting engineer. The samples of engineering students were from three engineering Institutions in Brunei.

The survey questions for the engineering students were on their current engineering courses, how their interest in engineering evolved, skills, curricula, and understanding in the work of an engineer. The engineers were interviewed on their engineering studies experiences, continuing education or training and to elaborate in detail on their existing and past work experiences. Data were collected by digitally recorded interviews, which range between one and one and a half hour long. The digital audio files were transcribed into text, and converted into Rich Text Format (.rtf) files. A software program frequently used in qualitative research, ATLAS.ti version 5.5, was used to analyse the interview transcripts. An initial selected number of interviews were chosen for labelling of descriptors, followed by coding to reveal coding descriptors and grouping them into categories.

In Brunei, the use of different languages, such as English, Bahasa Melayu (Brunei national language) and Chinese (dialects such as Hokkien and Mandarin) or a combination of all three languages was used by the engineers, need to be taken into account. Fortunately, the first author is fluent in all the three languages. This was indispensable during transcribing of the interview data. Engineering discourse was translated from Bahasa Melayu and Chinese into equivalent English.

Discussions

From the survey questionnaires carried out among the engineering students, suggestions were made to include more field trips, work attachments, up-to-date equipment, improving teaching skills of lecturers and updating the course curriculum. Many students felt that problem solving, trouble shooting, designing, programming and information technology should be taught in their engineering studies. Just over half of the respondents suggested having more hands-on (practical) skills in their engineering courses. Literature showed that majority of engineering graduates did not actually need to learn more practical skills since the technical skills acquired were sufficient (Cao & Ramesh, 2008; Lang, Cruse, McVey, & McMasters, 1999; Lee, 1994; Riemer, 2002; Wood & Reid, 2005). Instead it would be more useful to possess the essential 'non-technical' skills they need when they start working. Out of 104 respondents, only four mentioned the need for other 'non technical' skills such as communication skills.

The need for non-technical skills was mentioned by some of the participants during the interviews. A graduate engineer quoted;

> *In the University, we were not taught how to manage and give orders to other people or how to work with subordinates and superiors - supervising and negotiating skills.*

Most participants interviewed found attending relevant workshops and seminars helped them to cope with the so called "non-technical" challenges, when they have to work with 'people', instead of 'nuts and bolts'. A graduate engineer commented on how challenging it is to deal with 'people'.

> *I hope that it can change the attitude of my staff whom I found very difficult to motivate, especially those senior technicians who are much older than myself*

Another participant with twenty three years' of experience quoted;

> *I went to the workshop called "Recognising your inner self". After that I realised the importance of teamwork and that being egoistic will not solve any problem. We were asked to apply the 'Zero minds' concept, to bring people together as a working team.*

He illustrated the 'Zero minds' concept where a group of people had to stand in a 'small square box'. In order to accommodate them all, various suggestions were made. In the end, the stronger person has to carry another less-able person. Symbolically, the former could be a senior engineer of high managerial position whereas the latter could be a clerk, technician or cleaner. The underlying key point was that without teamwork, these tasks cannot be successfully completed.

There is much evidence in the literature pointing to the importance of teamwork in achieving a common goal. Engineers rarely work alone (Beder, 1991; Jonassen et al., 2006). Although some authors found that British engineers preferred to work alone, compared to Japanese engineers, (Lam, 1997; Lynn, 2002) other authors through qualitative research found engineers spent most of their time working in teams (Sheard, 1996; Sheppard, Pellegrino, & Olds, 2008; Trevelyan, 2007; Zussman, 1985). From our qualitative research, we had similar findings - where all the fifteen engineers interviewed work in teams to achieve common goals at their workplaces. Many of them found working in a team challenging because they were not exposed to teamwork during their engineering studies nor did they expect teamwork to be part of their job.

Another important finding was that from the fifteen engineers interviewed, thirteen have managerial responsibilities. One participant who's in management explained what managerial work is.

> *Managerial work are mostly not engineering work, for example delegation, checking performance of individual, managing and maintaining the unit*

Clearly this is a misperception that upon entering into management, there is no further need for technical application, but detail analysis shows that this is not true. Senior engineers in management positions still need their technical expertise whilst managing, delegating, negotiating, discussing and even maintaining project (Bailey & Gainsburg, 2009; Lynn, 2002; Solomon & Holt, 1993; Yun, 1991; Zussman, 1985).

It was found that some of the participants are also entrusted with heavy financial responsibilities. This is somewhat different from the finding by Domal & Trevelyan (2008) where little or no understanding of financial issues were found with the engineers in their study. One of the participant's in our study with more than twenty five years' of experience highlighted that;

> *... the first goal is to ensure that the company is making money. I am currently handling about $x million of Singapore Dollars.*

Another participant with twenty three years' of experience quoted;

> *It is not enjoyable when you are given the responsibility to achieve a certain target, say $x million. You will need to provide an acceptable answer if the target is not met.*

Despite the stress and burden in ensuring making profit for the company, most senior engineers view being in the management position as a major promotion; something they look forward to.

Future work

This study found that some participants, especially new or junior engineers, were reluctant to express dissatisfaction or raise controversial issues openly, even during one-to-one in-depth interview. It is probably fair to assume that issues relating to social issues and hierarchy may manifest themselves in the form of work politics or culture in the Brunei workplace. Some found it frustrating dealing with their boss. The frustration faced by one of the participants resulted in the individual's resigning from the company:

> *...although the client was not forthcoming with payment of fees, I objected to issuing letters in pursuing the payments...the boss went ahead despite my refusal to sign the letter. I received the flag from the client, who was very angry. To complicate matters, the boss had copied the letter to a higher authority...*

Observation may be a better method to monitor social patterns, communication, behaviour and interactions. The next step of the research would involve shadowing a number of engineers to triangulate the interview data and to develop a deeper understanding into the work of engineers in Brunei. A comparative study will be carried out in Australia where major differences between Australia and Brunei will be identified.

Conclusion

From the interviews, several engineers highlighted that they often develop templates for evaluation, report and other documents as part of their engineering work. These templates may subsequently be used by their successors. On one hand, it is made more convenient for the successor to revise and use a pre-existing template but the margin of error is high if inappropriately modified and at times may be used blindly as pointed out by a participant,

> *Some engineers are commercially oriented ... because some engineers practise the cut, copy and paste method... Drawings are inaccurate and imprecise because designs for projects are not individually drawn up...*

Is this an accepted engineering practice? It is important for engineers to maintain their professionalism and have good ethical engineering practice. 'Unhealthy' practices may jeopardise the profession and adversely affecting the status of engineers.

The unclear professional boundaries, the lack of coherence and conflicting occupational identities of engineers are likely to undermine a coherent approach to lowering the status of professional engineers as well as social issues in engineering practice may be contributing to the existing gap between engineering education and practice. This study is a first attempt to understand what engineers in Brunei do before further steps can be taken to improve the quality of engineering education, bringing it closer to engineering practice.

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