

Transforming the Monologue – Engineering Management into Practice

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***Abstract:** Engineering Management and Professional Practice is a compulsory final year course taught in The School of Mechanical Engineering at the University of Adelaide. It covers, what may best be described as, the ‘essential non-engineering’ subjects of an engineer’s professional practice and includes topics such as law, risk analysis, marketing and project management. However, student feedback revealed that the lectures (presented by industry experts) were, on the whole, perceived by students to be dull, uninspiring and were consequently very poorly attended. The delivery of the course was therefore radically changed to a project based learning format that offered a clear engineering and vocational relevance to the students. An imaginary large-scale industrial project, with strong and very obvious similarities to a local high-profile company, was described to the students in precise detail. The script of project was deliberately rife with problems that related to industrial law, risk analysis, marketing and project management. Student teams role played and the recommended approaches for solving these problems became the focus of the visiting experts’ revised interactive lectures. It became immediately apparent that interest in the course had increased dramatically. While these convincing initial observations are only qualitative, an ongoing study aims to provide a more quantitative and comprehensive evaluation of the improvement in the students’ learning outcomes.*

***Keywords:** PBL, Project based learning, Role play.*

Introduction

In addition to an engineering graduates’ practical skills and theoretical knowledge, there are many non-technical, business aspects that potential employers expect them to understand. Engineering Management and Professional Practice is therefore a compulsory final year course, taught in The School of Mechanical Engineering at the University of Adelaide, which includes topics such as ethics, industrial law, risk analysis, marketing and project management. The course includes approximately 250 Australian and International students from Mechanical and Electrical & Electronic Engineering. The objective of the course was to develop the following graduate attributes, which would be assessed via assignment and workshop interactions:

- The ability to undertake problem identification, formulation and solution;
- The ability to function effectively as an individual and in multi-disciplinary and multicultural teams, with the capacity to be a leader, a manager or an effective team member;
- The ability to communicate effectively, not only with engineers but with related disciplines and with the community at large;
- An understanding of the social, cultural, global and environmental responsibilities of the professional engineer, and the need for sustainable development;

- An understanding of professional and ethical responsibilities and a commitment to them.

However, through a variety of student feedback methods that included special focus groups, student evaluations of teaching and learning (SELT) and via student representatives, it became very clear that most students were extremely disappointed with the delivery of the course (Kestell 2006, University of Adelaide 2006 and University of Adelaide 2007). This feedback led to a significant restructuring of the course towards improving the learning outcomes of the students.

Original Course Structure

The original course structure included weekly lectures from a variety of guest speakers, all of whom were experts in their own field, and covered the following topics (in order of their presentation):

- People management
 - Interpersonal behaviour
 - Management structures
 - General management topics
- Risk
 - Introduction to risk management
 - Safety and environmental risk management
 - Technical risk management
 - Economic and financial risk management
- Business engineering
 - Entrepreneurship and innovation
 - Business management
 - Company structure
 - Insurance
 - Suppliers
 - Union interaction
 - Impact of government regulations
- Marketing
 - Consumers
 - Competition
 - Promotion
 - Patents
 - Social responsibility
- Ethics
- Legal aspects
 - The Australian legal system
 - Tort of negligence
 - Copyright, patent, design and trade marks
 - The employment relationship
- Project management
 - What is it?
 - How is it done?
 - Software tools

Each subject area was delivered by an expert guest lecturer in a sermon type monologue which, in hindsight, focused simply on the delivery of the curriculum rather than on the learning outcomes of the course. Each lecturer independently developed the curriculum of their own segment without reference to the other parts, which sometimes resulted in duplication of material. From a curriculum committee (management) perspective, the outline of the course appeared to be very coherent and relevant, but in reality (as observed through feedback and hence the viewpoint of the student) was actually extremely segmented, thus making it very difficult for students to visualise how all of the aspects holistically combine in a typical engineering business. The segmentation and off-campus expertise also resulted in no broad-based continual assessment of the learning outcomes and the vast majority of the course (with the exception of the legal topic in which students completed an assignment) was therefore assessed by a final exam. Despite the diverse and apparently interesting content of the course, the

presence of the exam and the professional standing of the guest lecturers, students revealed that they absorbed little information from the “*very dry and boring delivery*” of the course with rhetorical evidence of many boasting that “*I didn’t need to attend any of the lectures to pass the exam*” (University of Adelaide 2006, 2007). Subsequent (staff) peer evaluations of teaching confirmed that the lectures were poorly attended and that the expert views of the presenters were, on the whole, unappreciated.

Revised Course Structure

The monologue lecture style of delivery was therefore radically restructured to a far more interactive project-based-learning experience, designed to offer a realistic example of typical engineering business issues and thus provide a perception of real vocational value to the students. Students were required to apply the knowledge that they acquired in the course to the problems of a realistic business case.

An imaginary industrial scenario with a strong engineering focus was described to the students in detail, to set a scene that was rife with problems relating to law, risk analysis, marketing, human resources and project management. The project, although imaginary, was realistically based on the operation of a major South Australian company (the Australian Submarine Corporation) so that the students could easily relate to all of the issues and problems to create an element of vocational authenticity. Students were divided into teams, each supposedly part of this imaginary scenario in which their company had recently secured a government contract to build *Fast Response Interceptor Ships*. The students were not tasked with the design of the ship, but rather how to address a multitude of non-technical issues that are typically faced by engineering companies (such as sexual discrimination, harassment or job applications for example). Once the students were introduced to the project, they were briefed on what was expected of them throughout the duration of the course and were advised of the assessment structure. Their tasks included the need to develop:

- A project management plan and a project schedule;
- Definitions of position descriptions and the evaluation of job applications for these positions (from other teams – also providing an opportunity for peer assessment);
- Solutions to imaginary (yet realistically probable) risk management issues, business ethics issues and contract management and negligence issues.

Amidst this team-based role playing scenario, the course content (once again presented by experts from industry¹) was restructured to compliment the scope of the project so that the chronological delivery of the course allowed students to incrementally build upon their case study and develop solutions to the described problems. Lectures material provided timely solutions to the unravelling script of the project. Simple one-way lecturing was discouraged, while questions and answer interaction pertaining to the immediate and longer term issues, strongly encouraged. The central story-line provided far more flow, there was increased cohesion between topics and, more importantly, students were able to visualise and anticipate how these non-technical issues (or soft skills) would need to be considered and dealt with in their future engineering vocations.

The learning outcomes were assessed in a number of ways: One aspect of the brief was for students to apply for advertised job positions. The teams developed position descriptions and selection criteria and then canvassed for applicants (from other teams). The anonymous applications were evaluated and shortlisted thus peer-assessing the quality of the assignment. Detailed marking criteria for other specific elements of the project simplified the marking tasks for tutors, rather than the need to rely upon the guest lecturers who were kept busy by their regular jobs.

A co-ordinator attended all of the lectures and workshops and also met with lecturers and tutors prior to the sessions to ensure that the course flowed. The two-hour interactive lecture was followed (later in the week) by a two workshops in which tutors facilitated the teams while they studied the unfolding problems of project. Lecturers attended their relevant workshop and a strong teaching team

¹ Not all of guest experts were the same as those who lectured previously, because it was evident that some were not comfortable with the proposed revamp, particularly with respect to the more interactive style of teaching.

environment of tutors, lecturers and the co-ordinator) was established with all sharing a common view of expectations and learning outcomes.

Discussion

The original concept for the course Engineering Management and Professional Practice was to ensure that students developed essential ‘non-technical’ soft-skills. However, while on-paper it appeared to deliver the required information, it failed in developing the required attributes amongst the enrolled student cohort (Kestell, 2006). They reported a lack of engagement with the course, an inability to understand why the course was even being offered and that the lecture/exam style of delivery and assessment was seen as boring, unengaging and did not facilitate deep learning of the content. Typical comments included:

- *“I don’t see the point of this subject, why make us do it?”*
- *“This is a waste of my time, especially the exam, which only requires common sense to pass”*
(University of Adelaide, 2006).
- *“While an easy subject to pass, it is a pointless waste of time that prevents me from choosing a preferred elective”* (University of Adelaide, 2007).

Subsequent to the restructuring of the course, the feedback of a recent student evaluation of learning and teaching (SELT) questionnaire was reviewed (University of Adelaide, 2008). Overall, the reworked course was extremely well received. The use of a single project brief for all of the assignments to build on was well received. The students thought it gave the course a more ‘real life’ feel. Their feedback on the quality and outcomes of the course was far more positive than feedback received during the old course structure. Students identified several things that they considered to be the best aspects of the course. They recognised that the course was providing vital tools for their next step into business and that the topics gave them a broad exposure to non-engineering topics. The variety of expert lecturers was more fully appreciated and the experience that they brought to the students was recognised.

The use of project-based learning methods is now widely advocated as a useful teaching tool and accepted as an improvement to lecture-centric (‘chalk and talk’) programs that have dominated engineering education for so long (Mills and Treagust, 2003). Students’ achievement in complex and content-dense material is improved if they remain an active part of the learning process (rather than passive receptacles in traditional lecture). Team work and peer support in project based learning enables such active learning (Smith et al, 2005). Role playing in realistic yet imaginary situations has been demonstrated to develop a wide range of generic skills expected of today’s engineers” and can prepare students for work in multidisciplinary and international environments’ (Maier 2007). These scenarios help students to visualise engineering projects from multiple perspectives while helping them to gain an understanding of a multidisciplinary (and ‘soft’) skills. Relevant realistic imaginary scenarios therefore provide a simulated vocational experience and a cohesive link between what may otherwise be perceived as ‘unrelated’ disciplines.

The most immediate and obvious effect (as observed by the lecturers, the coordinator and the tutors) was that the class attendance and interactive participation increased dramatically when compared to previous years. The level of satisfaction from all participants (staff and students alike) also improved significantly. Typical student comments included:

- *“It is interesting to see how legal issues can directly affect the daily routine of an engineer”*
- *“I didn’t realise how many things we need to be EXTREMELY careful about”*
- *“One or two in my team were a little lazy, but I guess that is a life- lesson in itself”*
- *“The potential challenging issues have encouraged me to follow a managerial career”*
(University of Adelaide, 2007).

Conclusion

Engineering Management and Professional Practice is a final year course in the School of Mechanical Engineering at the University of Adelaide. The objective of the course was to provide students with the ‘soft skills’ of engineering practice in addition to the practical skills and theoretical knowledge that they acquired in the technical courses of their program. However, the course which utilised traditional lecturing techniques was uninspiring (often boring) to the point that students gained little benefit from it. A thorough restructuring of the course using what are now widely recognised as more effective teaching practices resulted in a project-based-learning focus in which students role played a team in a fictitious engineering company. Exposing students to typical non-technical problems in this scenario provided a cohesive structure in which human resource, ethical, marketing, legal, risk analysis and project management issues could be commonly addressed along a core theme. Feedback from students and staff strongly indicate that the restructure and change of teaching style has been a huge and dramatic success. While qualitative evidence of this has been provided in this paper, further analysis and continual improvement of the course is ongoing. Data will continue to be accumulated to quantitatively support the evidence to date and to provide guidance for additional course improvements.

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