Introduction

A significant proportion of engineers manage projects, and at the professional engineering level, professional engineering organisations tend to link the skills of engineering and those of project management. For example, Engineers Australia requires graduate engineers to ensure that all aspects of a project are soundly based in theory and fundamental principle (Engineers Australia, 2013). Certified Practising Engineers are required to ensure that the engineering contribution is properly integrated into a project, program, or process; and to ensure that costs, risks and limitations are properly understood in the context of desirable outcomes (Engineers Australia, 2012).

The Advanced Engineering Project Management course was developed by the University of Southern Queensland to assist engineers to better address these requirements and enhance their knowledge and skills in project management. It is a core or major course in a number of postgraduate engineering and built environment programs, such as the Master of Engineering Science, at the University of Southern Queensland (University of Southern Queensland, 2015a). This course was developed and delivered for the first time in Semester 1, 2014 by distance education to a small group of learners enrolled by studies external to the University. The 2015 offer had enrolments of 80 learners, most of whom studied on-campus.

While this course was primarily designed to aid practising engineers to meet professional requirements, such as those of Engineers Australia (2012), it is also able to be studied by engineering technologists undertaking a postgraduate coursework program (such as the Master of Master of Engineering Science) to meet Stage 1 competencies of Engineers Australia (2013), and thereby qualify to practice as graduate engineers. It has a strong professional focus, and aims to add value to engineering qualifications through not only teaching project management, but also challenging engineers to consider the wider portfolio and program management environment, have a strong focus on sustainability, and consider a range of contemporary and emerging issues in project management. As well, this course is designed to achieve good teaching practice, such as student centred learning, reflective practice, authentic assessment and learning that is as experiential as possible. These concepts are embodied in careful design, regular review and updating of course materials, and development of assessment designed to reflect real practice.

This paper discusses the background to the development of this course, then discusses the course and its objectives, its development by a team of academics with industry experience, and its subsequent delivery, reflections on the success of the course delivery process, lessons learnt, and resulting planned and future enhancements to the course. There is a strong focus on the challenges in the course development and delivery process, how well the course prepares learners for contemporary project management, and well it has met its objectives and future directions of the course.

Considerations in development of this course

Engineers use project management skills throughout their career. They are required to plan, organise and complete projects to specifications within time, cost and quality constraints in what is often an uncertain management environment (Trevalyn, 2014, pp. 321-369). In addition, engineers may be required to ethically negotiate a range of sustainability issues (environmental, economic, social and governance) with stakeholders, and consider their needs and the impacts of engineering programs and projects on them and their environment (Trevalyn, 2014, pp. 418-459). Failure to take into account these wider issues has the potential to lead to project failure and significant cost to the engineer's organisation. For these reasons, it is desirable to teach the advanced knowledge and skills that assist engineers to deliver well planned, executed and completed projects at minimum risks to clients. Such teaching should meet the requirements of professional organisations, deliver

high quality engineering programs and projects that align closely with organisational goals and direction, and take account of the uncertain project operating environment.

The Advanced Engineering Project Management course has aimed at aiding engineers achieve such higher level skills. As graduate engineers tended to possess skills in project scheduling and control, it was considered that a course that best fitted the requirements of the practising professional should be focused at a strategic, organisationally focused level. To enhance the relevance of such a course to the practising engineer operating in an uncertain environment, it was also important to consider contemporary issues, such as sustainability, innovation management, stakeholder management and the requirements to manage both programs (groups of projects) and portfolios (groups of programs and projects). Human factors like the attributes of a good project manager were also a significant consideration this course, as were emerging issues in project management.

Another factor in planning this course was that it should be written in a way that engineers in all disciplines, plus related professions like surveyors, town planners and constructors could benefit from studying it. Therefore, the course was developed to have a multi-disciplinary engineering focus, with examples being drawn from engineering projects and programs from all disciplines, while having broader relevance to related professions.

Objectives and content of the course

In the course planning and development process, a number of existing project management courses were reviewed, and principles drawn from them. An example of such courses was the Advanced Engineering Project Management course offered at Florida International University (Chin-Seng Chen, 2015). This course considers project management from an organisational viewpoint, discusses the main principles in project management, and considers aspects like leadership, outsourcing and project closure. However, it uses team projects, while the main requirement for the University of Southern Queensland is to address the individual learner, primarily because of the large external studies cohort of learners in the University's courses. This course was also not as strategically focused as the proposed course.

The Advanced Engineering Project Management course primarily utilises, and extends, well-known concepts of projects and project management, such as the Project Management Body of Knowledge, or PMBOK (Project Management Institute, 2013), and to a lesser extent, those in the United Kingdom based PRINCE2 (Projects in a Controlled Environment) (Stationery Office, 2009). It also draws extensively on other literature. An example of this approach is the way in which this course considers the definition of a project, which is described slightly differently by each of the two major project management standards. The definition of a project developed for this course recognises the PMBOK focus on the uniqueness of a project, the business focus of a project in PRINCE2, the temporary nature of a project recognised in both of these approaches, and input from other literature. It is:

A project is a temporary activity with a defined life span that aims to product a unique result. It also typically requires participation from across the organisation, and typically requires completion to a scope, with defined time, cost and quality constraints and has a number of risks associated with it (University of Southern Queensland, 2015b).

In this course, it is recognised that project management is becoming a standard approach to undertaking business, and is likely to increasingly play a role in the development of the strategic direction of business as a result of a number of factors like shortening of the product life cycle, increasing project complexity, a stronger focus on sustainability, the pressures of corporate downsizing and an increased customer focus (Larson and Gray, 2011).

In order to address the project management requirements for professional engineers, the contents of the course have been designed to achieve the following main objectives:

- Know and understand the project management life cycle and knowledge areas.

- Understand and assess the environment and context in which projects are delivered.
- Apply the project management process to the delivery of an engineering project.
- Evaluate the effectiveness of project management to delivery of project outcomes.
- Understand the challenges of complex projects.
- Develop, deliver and evaluate the delivery of a program of engineering projects.
- Understand special focus areas in project management and know how to apply them.

Except for purposes of revision of the fundamentals of project management, the course did not revisit basic project management methodologies and the use of project management software, which are normally taught at an undergraduate level.

Organisation of the Course

As shown in Table 1, this course is divided into 12 topics, delivered over one semester.

Table 1: Advanced Engineering Project Management – List of Modules

Topic Number	**Title**	**Percentage of Course**
1	Historical development of engineering project management	5%
2	The engineering project management challenge	5%
3	The engineering project life cycle	10%
4	Engineering project integration, scope, time, cost and quality management	15%
5	Engineering project human resource, communications and procurement management	15%
6	Engineering project risk management	5%
7	Engineering project stakeholder management	5%
8	Management of sustainability	5%
9	Attributes of an effective engineering project manager	10%
10	Managing complex engineering projects	5%
11	Engineering program management	10%
12	Current and future issues in engineering project management	10%

Assessment for this course is by two assignments – one aimed at rectifying issues at the project level (worth 40%) and the second primarily focusing on a next step of developing a strategy to align a program of projects with corporate strategic direction (60%) – designed to test the learner's understanding of course material, assess its application to professional practice, and evaluate and comment on options.

Challenges in the development of the course

Because of the strong relevance of this course to professional practice, a significant challenge in course development was the achievement of assessment that matched, as

closely as possible, situations that professional engineers would encounter in practice. Therefore, it was desirable that assessment should mirror real world situations as much as possible, prompt learning (Boud, 1998), meet the principles of constructive alignment (Biggs, 1999; Gulikers et al., 2004), and challenge learners in their professional engineering and project management roles. The assessment process also utilised authentic assessment principles (Gulikers et al. 2004) as modified by Thorpe (2013) to include professional skills.

Development of the course, which used the outline shown in Table 1, was undertaken by a team of three academics, two of whom were full-time and one of whom worked part-time, each of whom had practical engineering and construction management experience. This approach brought to the course development process a combination of academic rigour, industry knowledge, and an understanding of the high standards expected by professionals.

One of the major challenges in developing this course was that there were significant time constraints imposed on the development process. This challenge was overcome through using the experience of the development team to focus on meeting deadlines and achieve a high standard of quality through peer review of material. Learner feedback aided the development process and assisted to keep it student focused.

The course material development process was designed to meet a combination of academic, learner and industry needs. It was accordingly aimed at promoting deeper learning, through using student-centred learning principles (Biggs, 2001), designed with experienced professionals in mind, and focused on achieving in learners the higher level objectives in the cognitive domain of Bloom's taxonomy of educational objectives (Isaacs, 1996). An example of the application of these principles included reflective exercises to encourage learners to extend their knowledge, think in depth about and challenge course material, and apply their learnings to more strategic concepts like portfolio and program management.

A challenge in course development was to address the Stage 2 competencies of Engineers Australia (2012), and in particular ensure that the contribution of engineers to projects was properly integrated into a project, program, or process. Achieving this goal required delivery of quality outputs and outcomes to meet stakeholder requirements, achievement of the project delivery requirements of Trevalyn (2014), and an understanding of project risk and sustainability requirements (Brundtland, 1987). These challenges were addressed through detailed course planning, a team approach to course development, close attention to course material, and observance of sound learning and teaching principles. Extensive use of examples was made to make the material relevant to practising engineers.

Challenges in implementation of the course

One of the challenges in delivering the course was to design its assignments to challenge learners at an advanced level of engineering competency, and also to achieve, as far as possible in an academic course, authentic assessment. To achieve these objectives, the first assignment places the learner in the role of a new project manager who has taken over an engineering project that is lagging behind the required rate of progress, and is not meeting other targets such as cost and quality. Learners nominate a project within a set of parameters, develop a project plan to achieve project requirements in a set delivery time, and write a report on their plan to company management. Achieving the objectives of this assignment requires an understanding of the project planning process, the project life cycle, and several project management knowledge areas.

The second assignment asks learners to assume the role of manager of a program of six projects, three of which have issues that require addressing. The three projects, nominated by learners within a set of parameters provided to them, are of quite different cost and type. Learners are asked to define the key characteristics of each project, review them with respect to their alignment with the principles of advanced project management, develop a plan to manage each project to achieve project objectives, and write a report on their

proposal to senior management. It also includes a question that asks learners to write a short essay to discuss issues that project managers may face in the next 50 years.

The purpose of this approach to assignment development has been to permit learners to construct their own problem and solution, within broad parameters, and thus develop a more constructive approach to learning (Biggs, 2001), achieve and meet the principles of constructive alignment through achieving the objectives of the course, and meet the principles of authentic assessment in all criteria (Gulikers et al. 2004; Thorpe, 2013).

Reflections on the success of the course in achieving its objectives

A postgraduate academic course should aim to be of high quality from the points of view of academic excellence, a positive learning experience for students, and meeting industry requirements. Achievement of a quality product also requires a commitment to continual improvement, as embodied in the International Quality Management system standards (Standards Australia 2008). These standards recognise the importance of customers, who include learners, employers and professional associations. While each customer has different objectives, all require a quality product. Accordingly, there is a commitment to review the course each time that it is offered, ensure that it maintains currency and make incremental improvements to it.

A number of lessons have been learnt in developing and managing the delivery of this course. In particular, it has been found that it is essential, when developing new courses, to have objectives stated clearly, seek input on them from others, and ensure that there is sufficient time to develop course material well. There was also a requirement, in course development, to deliver complex materials in a concise yet engaging manner, using current and challenging course material and well-constructed authentic assessment. This challenge was met through selection of a good development team from relevant backgrounds, who could work well in harmony with each other and give good peer reviews of each other's work.

The initial offer of the course in 2014, to a small group of learners studying through distance education, resulted in good grades for learners, but minimal feedback. In the 2015 offer of the course, learners achieved good grades on the whole. The 2015 learner cohort consisted of 23 learners external to the University who were studying by distance education and who tended to be fairly familiar with the basic principles of project management, and 57 on-campus learners studying at the Toowoomba, Queensland Campus of the University, a significant proportion of whom had minimal exposure to project management prior to their enrolment in the course.

The course was quite well received. Feedback from 21 learners (10 studying externally and 11 studying on campus) resulted in good evaluation scores in key dimensions like overall satisfaction with the course and satisfaction with how the course was taught, with learners studying on campus providing a higher ranking than those studying externally. There were both positive and negative comments. Examples of positive comments included one from a learner studying externally that the course was practical and the assessment gave the opportunity to apply theory and some positive comments from learners studying on campus about the tutorials. Negative comments included the desire for more real life case studies and more clarity in assignments.

A review of the course material and learner comments has found that the course could be further developed to better meet the requirements of learners and other stakeholders. For example, the course is likely to benefit from discussion of additional project management methodologies, such as the Agile methodology (Larson and Gray, 2011, pp. 582-601). Another area in which course can be improved is to enhance the discussion on sustainability in project management, including how good project management, in conjunction with Lean project delivery methodologies (Howell, 1999), can better enhance sustainable development and project management efficiency. Other areas for further consideration include further

discussion on the management of complex projects, elaboration of the material on program and portfolio management, and additional current and future issues in project management.

Proposed and future enhancements to the course

A number of improvements are being made to this course as a result of experience with teaching it and noting learner comments. One enhancement for 2016 will be an increased emphasis on project management principles to overcome the lack of knowledge of project management by some learners. There will also be increased emphasis on alternative project delivery methodologies and complex project management, and on current and emerging issues in project management, such as using knowledge management. A further enhancement is proposed to be made to assessment, and in particular include an experiential learning element (Kolb, 1984 as cited in James Cook University, 2015) that will give learners an opportunity to apply assignment feedback from the first assignment to the more complex second assignment.

The philosophy of continual improvement (Standards Australia, 2008) will continue to drive the development and enhancement of this course. One of the main steps in this process is expected to be the development of closer links with industry. Comments from learners during and at completion of delivery of the course for each semester in which it is offered are also being given strong consideration. Similarly, it is expected to develop closer links with professional organisations. It is envisaged that such linkages will consider both theoretical aspects of the course and how learners can apply the principles taught to real projects.

Conclusion

A number of lessons have been learnt from the course development and delivery process. It is recognised, for example, that the initial offer of the course was developed quickly, to meet a deadline. As a result, while the initial course was considered a good product, it now requires a number of enhancements to improve its quality. Other lessons have included the importance of clarity about course objectives, good constructive alignment in the course development process, good knowledge of existing and potential future learner skills and their requirements in developing and delivering new courses, the application of good teaching principles, a strong focus on continual review and building flexibility into courses to accommodate emerging issues and developing circumstances.

It is concluded that development of this course to date has been successful, with a number of challenges, including time and quality pressures, successfully met through a dedicated team development approach. At the same time, the learnings from developing this course will aid the development of future postgraduate engineering management courses through, from the point of view of good teaching practice, better identifying and assessing the challenges and issues in their development, delivery and revision.

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