AN INTEGRATED PROFESSIONAL PRACTICE AND EMPLOYABILITY INITIATIVE IN AN ENGINEERING UNDERGRADUATE PROGRAM

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ABSTRACT

To attain accreditation, Engineering programmes in Australia must meet Engineers Australia's Stage 1 Competency Standards. In addition to the academic criteria, there is an expectation that students meet professional practice requirements. In the School of Engineering and Built Environment at Griffith University, the professional practice requirement is that students "must complete a minimum of 12 weeks (60 days) of approved experience in an engineering practice environment (or a satisfactory alternative) during their degree studies." While there have been several opportunities for scaffolded student-industry interaction in earlier years of the programme, the opportunities were not integrated into the programme, were inconsistent across the disciplines, and not coherently articulated as professional practice and employability opportunities for students. The result was that some students entered the final year of the programme without sufficient industry internship experience, or exposure to industry professionals, or a lack of understanding of professional expectations and practice. The paper discusses the introduction and implementation of an integrated Professional Practice and Employability Skills stream within the programme to improve graduate employability and better support students as they develop into engineering professionals. The paper also describes a method for monitoring and assessing professional practice supported by a reflective ePortfolio.

KEYWORDS

Professional Practice, Employability, Engineering Curriculum, ePortfolio, Standards: 3, 4

INTRODUCTION

For Australian Engineering programmes to be accredited, they must meet Engineers Australia's Stage 1 Competency Standards (Engineers Australia [EA], 2011). These standards group the competencies into three broad areas: knowledge and skill base, engineering application ability, and professional and personal attributes. Griffith University engineering programs and the individual courses are mapped to the EA standards and also to the Griffith Graduate Attributes (Griffith University, 2016). Previous researchers (Campbell, Dawes, Beck & Wallace, 2009; Popp & Levy, 2009) have described mapping the initial version of the CDIO syllabus (Crawley, Malmqvist, Ostlund, & Brodeur, 2007) to the Australian university context. The revised CDIO standards and syllabus (Crawley, Malmqvist, Östlund, Brodeur, & Edström, 2014) have been useful in framing a 2017 redesign of Griffith Engineering programs to improve graduate outcomes and the overall quality of the programmes. In line with the CDIO call for "a systematic approach to teaching professional engineering skills, also referred to as personal and interpersonal skills" (Crawley et al., 2014, p. 114), this paper will focus on the introduction and implementation of a Professional Practice and Employability Skills (PPES) stream into an undergraduate Engineering programme, and a method for monitoring and assessing professional practice supported by a reflective ePortfolio.

THE NEED FOR CHANGE TO PROFESSIONAL PRACTICE AT GRIFFITH

Griffith University is a multicampus university spread across Brisbane and the Gold Coast with engineering programmes available at the Nathan and Gold Coast campuses. Students can choose to major in Civil, Mechanical, Electrical, Electronic, Environmental, and Software Engineering, with the range of majors varying depending on the campus. In 2018, there were around 1350 undergraduate students enrolled in the School of Engineering and Built Environment.

All Engineering students complete a work placement in their final year as part of the Industry Affiliates Program (IAP). The IAP office has since been renamed the Work Integrated Learning office, but still assists in linking engineering students with suitable projects with different industry partners. Students also take a Professional Practice course (6008ENG IAP - Professional Practice) concurrently with their final year thesis and work placement with an industry partner (6007ENG IAP - Thesis). The thesis is usually linked to the student's industry placement, with some students doing an internal project when a suitable external project is unable to be sourced. Many students concentrating on their work placement and thesis often struggle to see the relevance of the professional practice course (6008ENG) to their degree and engineering career, as evidenced by some of the following comments from student evaluation forms:

> *It is a useless course that just takes time away from IAP projects. I learnt nothing during the course.*
>
> *It saps a lot of time out of the IAP thesis course which is the more important course.*

In addition to some negative perceptions of the final year professional practice course itself, students sometimes reached the final year of the engineering programme without sufficient industry internship experience, exposure to industry professionals, or a lack of understanding of professional expectations and practice. While there have been several opportunities for scaffolded student-industry interaction in earlier years of the programme, the opportunities were not integrated into the programme, were inconsistent across the disciplines, and not coherently articulated as professional practice and employability opportunities for students. Changes clearly needed to be made.

INTEGRATING PROFESSIONAL PRACTICE AND EMPLOYABILITY SKILLS

In line with section 3 of the EA Stage 1 competencies (EA, 2011), and CDIO Standard 3 requiring integration of professional skills (Crawley et al., 2014), the PPES stream is systematically integrated into the programme across all disciplines to assist students to develop their professional and personal attributes. Table 1 shows some broad similarities between section 3 of the EA Stage 1 competencies and the CDIO Syllabus V2.0. Some EA competencies such as *3.3 Creative, innovative and pro-active demeanour* and *3.4 Professional use and management of information* appear to only match some aspects of the CDIO Syllabus as indicated in the table.

Table 1: EA Standards (Professional and Personal Attributes) and CDIO equivalents

Engineering Stage 1 Competency	CDIO Syllabus v2.0 equivalent
3.1 Ethical conduct and professional accountability.	2.5 Ethics, Equity and Other Responsibilities
3.2. Effective oral and written communication in professional and lay domains.	3.2 Communications
3.3. Creative, innovative and pro-active demeanour	Partial match to 4.7 Leading Endeavours (4.7.1 - 4.7.4)
3.4. Professional use and management of information	Partial match to 2.2 Experimentation, Investigation and Knowledge Discovery (2.2.2)
3.5. Orderly management of self, and professional conduct.	2.4 Attitudes, Thought and Learning
3.6. Effective team membership and team leadership.	3.1 Teamwork

Griffith University has a 12-week trimester system, with the majority of Engineering courses being offered in trimester 1 (T1) and trimester 2 (T2). A number of first year Engineering courses are offered in trimester 3 (T3) for students needing to repeat T1 courses, or for those who commenced in T2. The PPES stream starts in T1 first year, and continues each trimester over the first three years, culminating in the final year Professional Practice capstone course (6008ENG). The aim is for every student to participate in an assessable, integrated component of the PPES stream each trimester over the first 3 years of the program. To ensure this happens, one course each term is designated to be a 'Professional Practice and Employability Skills Partner' (PPESP) course.

The PPES stream elements are part of the assessment schedule for these designated PPESP courses, and will generally be worth a minimum of 10% of the marks for the course. Where practicable, common core courses have been designated as the PPESP courses. When this is not possible, each major has a designated PPESP course. It is worth noting that designating one course each trimester as a PPESP course to be a formal component of the PPES stream does not preclude other courses from including PPES elements. Indeed, all course convenors will be encouraged to include PPES elements, with the PPESP courses ensuring all students have sufficient exposure to Professional Practice to meet the EA Stage 1 Competencies.

The PPES stream is to be one segment of larger intent aimed to ensure that Griffith graduates are job ready, not just in their technical knowledge but in the full range of professional competencies. The overall process involves:

- An industry informed curriculum including engagement in curriculum design directly through the discipline specific Industry Reference Groups and overall through the School Advisory Board, and indirectly by staff-industry interactions; and involvement in curriculum delivery through guest lectures, material delivery, and industry-based projects;
- Students developing their professional engineering identity through their reflective professional portfolio; and
- Students enhancing their employability through their personal skill development

Three common core courses, 1701ENG Creative Engineering (Year 1, T1), 1022ENG Engineering Design Practice (Year 1, T2), and 3004ENG Project Management Principles (Year 3, T2) are designated as PPESP courses. The final year core course 6008ENG IAP – Professional Practice will act as a professional practice capstone for all majors. This leaves 3 PPESP courses, one in each of Year 2 T1, Year 2 T2 and Year 3 T1, to be designated for each major as shown in Table 2. Where practicable, these are courses that are shared between majors to minimise the number of formally designated PPESP courses.

Table 2. Professional Practice and Employability Skills Partner Courses

Year	Trimester 1	Trimester 2
1	1701ENG Creative Engineering	1022ENG Engineering Design Practice
2	Designated major PPESP course	Designated major PPESP course
3	Designated major PPESP course	3004ENG Project Management Principles
4	6008ENG IAP – Professional Practice	

PPES ACTIVITY OVERVIEW

Table 3 gives an overview of the completed activities at the time of writing, and the following section will describe the PPES activities in more detail.

Table 3: Overview of PPES Courses and Activity Focus

Trimester	PPESP Course	PPES Focus
T1, 2017	1701ENG Creative Engineering	Raise awareness of skills needed in the profession Part of milestones assessment (10%)
T2, 2017	1022ENG Engineering Design Practice	Employability week - assessed site visit and development of CV (20%)
T3, 2017	1701ENG Creative Engineering	Video interview highlighting skills developed through the projects in the course (10%)
T1, 2018	Designated PPESP Courses: Construction Materials Digital Electronics Mechanical Engineering Design Environmental Microbiology and Ecology	Assessed reflection on industry guest speaker presentation. Students will be required to reflect on content of the presentation, and link the guest speaker's comments to the EA Stage 1 Competencies (10%)

Creative Engineering

The first PPESP course, 1701ENG Creative Engineering, is taken by both Engineering and Industrial Design students and is available in trimester 1 and 3. Creative Engineering is a project-learning based course where students are asked to work in teams to design creative solutions for selected problems. This is in line with CDIO standard 4 which requires a core

first year course which functions as an introduction to engineering practice and the professional skills required to be successful in the field (Crawley et al., 2014). In trimester 1, 2017, the aim of the PPES assessment item was to highlight the importance of communication skills and teamwork in engineering practice. Engineering students were asked to read and write a reflection on a conference paper by Male, Bush, & Chapman (2009) which highlights the competencies required by engineers graduating in Australia. In a similar manner, Industrial Design students were asked to read and write a reflection on chapter 6 of Design Education and Beyond (Rodgers & Milton, 2011).

The trimester 1, 2017 offering of Creative Engineering was modified version of a course previously taken only by industrial designers. While there was some positive student feedback on the aims of course, the course suffered from a major last-minute staff change prior to the start of the term which impacted on the organisation of the course. There were also some difficulties in meeting the differing needs and expectations of both the engineering and the industrial design students, as well as trying to expose students to open-ended projects with conflicting feedback from teaching staff. The following positive comments from the student evaluation of course forms showed some awareness of the aims of the course:

> *I think the concept behind the course is admirable; that is, a course that encourages engineers and industrial designers to think creatively, critically, and with a whole of systems approach could be quite helpful, if executed properly.*
>
> *It showed many different aspects of design that are very important, rather than just drawing parts for things. It really emphasized elements of marketing that often seem to be ignored by engineers. It encouraged students to actually do research into the target market and their problems. It also encouraged students to imagine having to actually build or use the products we designed.*

Creative Engineering and its PPES assessment item were extensively redesigned for Trimester 3. In the revised PPES assessment item, each student is required to submit a 5 minute video, aimed towards an employer, where students describe the skills they have developed through completing their design project.

Employability Week

A crucial part of the PPES stream implementation led to a major change in the Engineering program structure, with week 7 of Trimester 2 designated as “Professional Practice and Employability Week”. During Employability week, normal teaching activities are suspended for the majority of Engineering courses, and the week is reserved for a program of site visits, industry talks and employability enhancement activities. In previous years, it had been very difficult to hold such activities during normal teaching weeks, or vacations, at times that are suitable for all students.

By embedding a dedicated non-teaching week into the first three years of the programme, time is created for these events, both for activities aligned with the T2 PPESP courses, and for other extracurricular activities. Teaching staff also become available to assist with leading visits. The week will be rolled out through the program year by year, and by 2019, Employability week will be embedded across the first three years of the programme. The introduction of employability week and the loss of a teaching week in the term required first year courses to be redesigned for 2017, and second year courses are currently being redesigned for 2018. There will be a similar impact on third year courses in 2019. Employability week will not require timetable

changes in the final year as the majority of the students are off campus for their work placements.

In support of the Employability week initiative, Teaching and Learning Development Funding from the Group Dean (Learning & Teaching) was obtained to trial a Site Visit program at the Gold Coast campus during week 7 of second semester, 2016. During the trial, timetables were unable to be altered and all lectures, tutorials and laboratories had been scheduled as normal. A program of 14 site visits was arranged with local industry and offered initially to first year students. Later year level students were also able to participate where space permitted. Industry feedback was very positive with almost all potential partners offering future site visit opportunities. Given the restrictions imposed on attendance by class timetables, the student response rate was good, with those that participated very enthusiastic about their experience. As a result of the trial response, further funding was obtained and used to purchase protective gear such as hard hats, high visibility vests, and safety glasses for student use, as well as to provide transport to site locations as required. Students visiting construction sites were required to provide their own steel-capped boots. In the longer term, the intention is to obtain funding from industry sources to support employability week activities.

First year students commencing during 2017 were the first to experience Employability week in a T2, 2017 course: 1022ENG Engineering Design Practice, and around 350 students across both campuses were required to visit at least one site. Students could select a site from 15 different partner organisations across the range of majors, with some organisations hosting multiple visits. As part of the course assessment (20%), students were required to do some preliminary research into the site, or organisation responsible for the site, take notes during the visit, write a reflection after the visit, and also submit a CV targeted towards the organisation responsible for the site. Student feedback on the employability week and site visits was positive as in the following comments from student evaluation forms:

> *I found it particularly good when it came to setting the students up to experience how an engineering company works. I loved getting to* [*sic*] *opportunity to do company visits*
>
> *I found the site visit and resume project particularly useful to my career pathway and* [it] *helped me prepare for my future.*

Employability week activities for later years are currently under development, and Table 4 shows examples of proposed activities tailored specifically for each level of the program. Although students from all levels will be able to attend any activity, preference will be given to students from the targeted year level where space is limited.

Table 4. Proposed Employability Week Activities

Year Level	Proposed Targeted Activities
1	Series of general site visits not necessarily related to a particular major Series of guest speakers from industry are planned to talk about possible careers
2	CV building and letters of application to assist students with seeking paid approved engineering work experience, Course specific site visits
3	Course Specific Site visits, IAP preparation program will be offered to help students be “shovel ready” for their IAP project by week 1 of T1, Employment Fair

GRADUATION AND PROFESSIONAL PRACTICE REQUIREMENTS

Coupled with the completing the academic requirements of the BEng(Hons) program, a student must also complete a minimum of 12 weeks (60 days) of approved experience in an engineering practice environment (or a satisfactory alternative) during their degree studies to be able to graduate. The 60 days of approved experience requirement is currently incorporated into a core course in the final year of all engineering programs, 6008ENG IAP – Professional Practice, with the course convenor managing the approval of a student's professional practice. The satisfactory alternative is interpreted as requiring students to complete a minimum of 60 points of approved professional practice collected as per Table 5.

Table 5. Overview of Professional Practice Categories and Requirements

Category	Professional Practice Description	Points
A	At least 30 points of junior professional or senior para-professional engineering practice within a professional engineering context.	1 point per day of approved work experience
B	No more than 20 points of independent university based engineering research as approved by the course convenor.	1 point per day of approved engineering research
C	No more than 20 points of junior para-professional engineering practice within a professional engineering context.	1 point per day of approved work experience
D	No more than 10 points of work experience outside of an engineering context.	1 point per day of approved work experience
E	No more than 5 points of engineering tutoring and/or teaching within University level courses.	1 point per 3 hours of approved teaching experience. 1 point per 6 hours of approved tutoring/lab demonstration experience
F	No more than 5 points of field trips to engineering related projects.	½ point per approved field trip which includes an assessed report
G	No more than 5 points of attendance at guest lectures by practicing professional engineers.	¼ point per approved guest lecture attended at the University ½ point per approved guest lecture attended at a professional engineering association

At present, the majority of the students are able to complete the 60 days professional practice requirements and graduate on time, although many of the students tend to accumulate the required professional practice points purely from their final year work placement (Category A). There are also small numbers of students each year that are unable to graduate due to not meeting the professional practice requirements. The introduction of the integrated PPES stream aims to address this issue and improve overall employability by exposure to engineering practice throughout the program. Students will also be required to evidence their professional practice by collecting points across a wider range of categories, not just from Category A.

DOCUMENTING PROFESSIONAL PRACTICE

The collection and management of students' professional practice development is not currently handled in a very efficient manner, and as part of the PPES stream rollout, an ePortfolio system will be used to streamline the process for both staff and students. Griffith University has recently selected the PebblePad ePortfolio platform (PebblePad, 2017) for use across the institution, with each student having their own PebblePad account. An advantage of an online portfolio system is that it allows students to collate and curate evidence of their learning experiences as they move through a degree program (Hallam & Creigh, 2010), and it can assist students in connecting their learning with the development of professional skills when appropriately scaffolded (Faulkner, Mahfuzul, Waye, & Smith, 2013).

All the PPES assessment items are required to be submitted and stored in PebblePad so students can monitor their own progress. Many of the other discipline specific courses will also require students to document their learning via their ePortfolios. When the 2017 starting cohort of students reach the capstone 4th year professional practice course in 2020, they will be required to articulate how they have met their professional practice requirements and the EA Stage 1 competencies by submitting evidence and suitable documentation collated throughout the program. This is similar to approaches where engineering students used an online portfolio to evidence progress towards graduate attributes (Palmer, Holt, Hall, & Ferguson, 2011), and Accreditation Board for Engineering and Technology (ABET) outcomes in the United States (Christy & Lima, 1998; Heinricher et al., 2002; Williams, 2002).

CONCLUSION

The CDIO standards are important in shaping the learning and teaching experience offered to our students. In addition, the implementation of an integrated Professional Practice and Employability Skills stream aims to ensure that Griffith Engineering graduates have a strong understanding of engineering practice, and are ready to perform to the best of their ability when they move into industry. Future research will be needed to evaluate the success of the initiative, and to monitor the students' development of professional and personal attributes as they reflect on their progression towards becoming engineering professionals.

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BIOGRAPHICAL INFORMATION

Simon Howell is the First Year Coordinator on the Gold Coast campus in the School of Engineering & Built Environment at Griffith University, Australia. He was previously a Student Success Advisor and has a background in student support, academic skills development and curriculum design. He is part of the teaching team for two core first year courses: Creative Engineering and Engineering Design Practice. Simon is particularly interested in curriculum renewal, project-based learning, and improving the development of professional skills in engineering programs.

Geoffrey Tansley is currently Professor of Engineering Design having just completed a five-year period as Head of School of Engineering & Built Environment at Griffith University, Australia. Geoff's previous engagements include: Professor and Head of Mechanical Engineering and Design at Aston University, UK, Associate Professor in Mechanical Engineering at Nottingham University, UK, Chief Mechanical Engineer at VentrAssist, Australia, Senior Lecturer in Biomedical Engineering at Flinders University of South Australia and Lecturer in Mechanical Engineering at Adelaide University, Australia. Geoff teaches in the areas of Design and Fluid Mechanics, and researches and consults widely in the design of cardiac medical devices.

Graham Jenkins is an engineer with over 10 years of experience in the water engineering industry and 25 years of academic experience. He was previously the Deputy Head (Learning and Teaching) in the Griffith School of Engineering & Built Environment, and was the academic lead in the Industry Affiliates Program. Graham developed the program to give students in Griffith Sciences the opportunity to undertake industry-based research as part of their degree studies. This has allowed students, industry and academia to form unique partnerships to move students into the workplace through a structured approach to work integrated learning. Graham currently teaches Creative Engineering and a humanitarian design elective focusing on providing sustainable water resources in developing countries.

Wayne Hall holds a PhD from the University of Warwick and a PGCert in Learning and Teaching from the University of Plymouth. He is a Corporate Member of the Institution of Mechanical Engineers (MIMechE) and a Chartered Engineer (CEng). He is currently Deputy Head (Learning and Teaching) in the School of Engineering and Built Environment at Griffith University. Wayne's research interests lie in the design and manufacture of lightweight and Fibre Reinforced Plastics (FRPs) and in engineering education related research. His interest in engineering education is focused on the development and implementation of successful teaching and learning strategies for on- and off-campus (distance education) students, and on the implementation of Project-Based Learning (PBL) in the engineering curriculum.

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