Best Practice Guidelines for Effective Industry Engagement in Australian Engineering Degrees

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Preamble

These best practice guidelines are an outcome of the project 'Enhancing Industry Engagement in Engineering Degrees' led by the Australian Council of Engineering Deans, with a grant from the Australian Government through the National Resources Sector Workforce Strategy. The project has 12 partner universities and also industry partners: Engineers Australia; Minerals Council of Australia; Australian Mines and Metals Association; Consult Australia; Australian Constructors Association; and the Australian Petroleum, Production & Exploration Association.

The guidelines apply to 'formative' degree programs that prepare graduates to enter engineering practice as professional engineers or engineering technologists. The relevant qualification for professional engineers is a four-year Bachelor of Engineering degree, although some universities are now offering formative Master of Engineering degrees. Engineering technologists graduate from three-year Bachelor of Engineering Technology programs. Programs are accredited by Engineers Australia if they deliver graduates with the Stage 1 competencies for the corresponding occupation and are compliant with other accreditation criteria. One of these criteria is that within their program, graduates have 'exposure to engineering practice'.

The guidelines are informed by literature, consultation with Engineers Australia, a survey of the 12 partner universities and five additional universities, and interviews or focus groups with over 80 participants including academics, industry members, and students. The guidelines have been revised following review by 149 industry members and academics at five forums in Sydney, Melbourne, Brisbane, Adelaide and Perth in June 2013, and a participants' forum in April 2014. Recommendations have been trialled in second semester 2013 and first semester 2014.

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Contents

Introduction

Problem

The original conception of this project arose during a skills shortage in engineering in Australia (The Senate, 2012). Since then, the characteristically cyclical nature of engineering employment has become evident, with increasing unemployment of experienced engineers and graduates during 2013–14. These cycles and trends pose challenges to the tertiary education sector, as well as to employers. Engineering graduates who are unable to gain employment soon after graduation may go overseas, or take up other careers—they are not necessarily available to enter engineering roles when the engineering economy picks up. Employers mostly need experienced engineers to fulfil their needs. Companies' willingness and ability to train graduates in engineering roles, and support them to gain experience prior to being recognised as skilled and independent engineering practitioners, will also vary over the economic cycle.

For engineering faculties, the imperative is to retain and graduate as many of their students as possible. Graduates must, of course, meet the required program educational requirements which, for programs accredited by Engineers Australia, are referenced to the national Stage 1 competency standard. The average graduation rate of students who commence study in engineering bachelor degrees in Australian universities is about 65% (Godfrey & King, 2011), a figure that suggests scope for improvement. Furthermore, those student engineers who do graduate have significant gaps between their capabilities and those required by engineers in practice (Male, 2010b). Finally, many engineering graduates choose not to work in engineering-related roles, which further exacerbates the issue of engineering skills shortage (Tilli & Trevelyan, 2010).

Background

This project is intended to contribute to reducing the engineering skills shortage and improve graduates' employment prospects, by acting on the proposition that improving students' engagement with engineering practice will increase graduation rates and graduate employability. Participants in this study resoundingly reported that exposure to engineering practice is transformative.

However, engineering practice is poorly understood (Trevelyan & Tilli, 2007) by both students and their academic teachers. At many Australian universities there are few academics with recent industry experience (Cameron & Reidsema, 2011). Despite the efforts of many educators, engineering education is largely shaped by a focus on engineering science (Sheppard, Macatangay, Colby, & Sullivan, 2009), rather than applications and practice. Consequently, before any substantial exposure to practice, students are expected to learn theory without context or relevance. Many students find this difficult and not highly motivating to their learning. Furthermore, this approach does not reinforce the breadth of capabilities necessary for engineering practice, particularly its critical socio-technical dimensions (Faulkner, 2007; Fletcher, 1999). As a result, students are likely to have misperceptions about engineering practice, and develop professional identities that are inconsistent with practice.

Industry engagement within engineering education offers the potential to help students prepare for and transition into graduate employment. Specifically, stronger industry engagement will assist students to:
- Develop a more comprehensive and accurate understanding of engineering practice as a socio-technical activity.
- Increase their motivation for learning, due to recognition of the relevance of the engineering program and the value of engineering.
- Improve learning through understanding context and connections.

- Learn reflective practice skills to improve learning and support lifelong learning.
- Develop comprehensive socio-technical capabilities.
- Cultivate a sense of belonging to the faculty and the profession.
- Build networks with peers and professionals within the industry.

Industry participants in this study reported that by engaging with engineering education they have experienced the following benefits:
- Greater visibility and loyalty among students and graduates, who become their future employees, clients, contractors and alliance partners.
- Enhancement of their organisation's brand among these future engineers.
- Improved accuracy of perceptions about working for the organisation held by prospective graduate recruits, thereby improving their retention.
- Opportunities to work with future graduates, identify potential graduate recruits, and influence the capabilities of future graduates.
- Opportunities for professional development for staff through the experience of engaging with students.
- Personal satisfaction for those engaged in working with students.
- Appeal to the organisation's employees.
- Social licence for the organisation.
- Development of relationships with university researchers leading to future collaborations.
- Access to university resources such as laboratories, libraries, and experts.

These guidelines are intended to strengthen the culture of industry engagement in engineering education in Australia. They have been designed with an acute awareness of the diversity of all aspects of engagement. The engineering faculties and schools in the 35 Australian universities that provide formative engineering degrees are diverse in size, focus, and student and academic demographics. Furthermore, these change with time. Additionally, the scope of 'industry' engaging with engineering education can include government, private, government business, research, and charity organisations; large, small and medium organisations; professional societies and organisations; and individuals. Industry partners are very diverse and have changing needs. Many are 'resource light' in terms of their ability to run comprehensive human resource departments or 'talent management' programs. Amongst the 35 universities are features of effective models of industry engagement, including high levels of staff with industry experience and well-established internship schemes.

Aims and scope

These guidelines are aimed at supporting engineering schools to provide improved industry engagement for *all* student engineers in a formative degree program. Thus, these guidelines are intended to promote existing good practice across the system as a whole; they are consistent with—and effectively expand upon—the current expectations of Engineers Australia, in program accreditation (Engineers Australia, 2013). The full adoption of these guidelines will represent more significant change in some universities than others. Recognising that the environments in which universities operate can limit capacity to achieve desirable goals, the guidelines present opportunities for universities to differentiate themselves by focusing on the adoption of particular areas of the recommendations. The guidelines are also based on the underlying assumptions that much can be learnt about practice while at university and that successful graduates will continue to learn throughout their careers.

Vision

Engineering education provides students with the best possible opportunities to develop competencies (knowledge, skills, attitudes), as well as opportunities to underpin successful lives as engineers contributing to a well-functioning society ((Rychen & Salganik, 2003) adapted by Male (2010a)). Engineering graduates will contribute to the economy and to improving workplaces, industry, the environment and the general well-being of society, both locally and globally.

This project and its resulting guidelines will contribute to this vision by establishing industry engagement in formative engineering degrees, as a key element of the culture of all engineering faculties and their partnerships with employers. This will support students to progress through their programs and prepare them for their transition to engineering practice.

By engaging in authentic engineering problems, solutions, practices and roles, students will be more highly motivated to their studies, and will:
1. Improve their understanding of the concepts, tools and applications of engineering science and fundamental mathematics and sciences.
2. Comprehend the relevance of socio-technical competencies.
3. Develop the desired attitudes for engineering practice.
4. Develop their identities as student engineers, and develop self-efficacy to achieve their goals.
5. Develop accurate perceptions of engineering practice, in preparation for the transition to practice.

Curriculum Themes for Improved Exposure to Engineering Practice

To have the desired impact within the faculty, improved exposure to engineering practice needs to be fully integrated into authentic curriculum development and delivery, through adopting the following two broad themes in the design and delivery of the whole formative engineering education experience. Each theme will be realised by the adoption of the elements listed.

Theme 1. Engineering curriculum design and delivery incorporate the spectrum of local and global engineering practice
(a) Curriculum designers are informed by present and prospective engineering practice, including research in engineering practice, engineering applications and engineering science.
(b) All engineering students participate in a range of experiences of engineering practice, which position theory in its application contexts, by using industry-based examples and projects, and by site visits and guest lectures.
(c) Under mentoring and monitoring arrangements involving professional engineers, all students address authentic and substantive challenges requiring contextual understanding, thereby developing judgement, significant technical expertise, teamwork, initiative, and sound practice, which are assessed.
(d) All students experience socio-technical dimensions of the curriculum that demonstrate the integrated nature of engineering practice, where technology and people interact and engineering knowledge and skills are combined with others' professional and generic skills. For example, student teams work on technical problems in social contexts, and in at least one unit engineering students work with students from a non-engineering discipline that intersects with engineering practice.

(e) Work-based learning is integrated into the curriculum and assessed.
(f) Students use e-portfolios and/or reflective journals to track the development of their capabilities towards the Engineers Australia Stage 1 and Stage 2 competencies.
(g) Faculty leadership teams ensure that curriculum design and delivery are undertaken by academics who are recruited and rewarded by processes that acknowledge industry experience and engagement.

Theme 2. Engineering education incorporates the students' whole experience

(a) Students engage in a participatory experience, through which they develop into competent, motivated, professional graduates. Their development is influenced by experiences both within and outside the classroom, encouraged by faculty members and industry practitioners. The students' engineering education experience is framed by being and being treated as 'student engineers' (for example, Lindsay, Munt, Rogers, Scott, & Sullivan, 2008).
(b) Students engage in extra-curricular activities that have professional dimensions, for example, networking events, mentor schemes, careers expos and professional meetings.
(c) Student engineers develop their identities and self-efficacy through gaining confidence in the development of their knowledge and skills. This in turn requires an understanding of and confidence in achieving possible future roles.

Recommendations in these guidelines are presented separately for:
- Engineering faculties (F1. to F7.)
- Industry (I1. to I3.)
- Accreditors, Engineers Australia, and government (B1. To B6.).

The recommendations are presented as imperatives that when adopted, will enable realisation of the vision and themes outlines earlier. Brief descriptions of examples of effective practice are included with recommendations. More detailed descriptions of significant examples appear after the recommendations. The recommendations are completed with a list of ways that industry members can engage in engineering education degree programs (see Appendix B).

Definitions

In these recommendations, terms are used as follows.

Engineering practice
: The activities undertaken by professional engineers in the course of their work.

  While the outcomes of engineering generally have physical forms, the work of experienced professional engineers recognises the interaction between people and technology. Professional engineers may conduct research concerned with advancing the science of engineering and with developing new principles and technologies within a broad engineering discipline. Alternatively, they may contribute to the education of engineers, continual improvement in the practice of engineering and to devising and updating the codes and standards that govern it (Engineers Australia, 2012, p. 1).

Industry
: Companies, government, engineers, industry bodies/associations, and charities.

Internship
: Student employment, paid or unpaid in an engineering environment, for an extended period longer than three months and commonly six months, generally undertaken by students during one or more semesters of the engineering program.

Program
: A course of study from first year to degree completion.

Student employment
: Internships and/or vacation employment as defined above and below.

Unit
: A module of study usually taken over one semester. Others might call these 'papers', 'subjects' or 'courses'.

Vacation employment
: Engineering student employment, paid or unpaid outside class time in an engineering environment, commonly at least 12 weeks accumulated before graduation. This could be during vacations, or increasingly is undertaken by students on a part-time basis during semester, but is not allocated a semester during the engineering program.

Recommendations for Engineering Faculties

F1. All engineering faculties will establish and maintain effective industry engagement as part of faculty culture

All engineering faculties will ensure effective industry engagement in engineering degrees. Engineering faculties will establish strengths and recognise weaknesses with respect to these guidelines and plan to implement and evaluate relevant improvements.

Resources
The resources listed below are available to assist program leaders in identifying strengths and weaknesses with respect to the guidelines.

Tool for Reflecting on Effective Industry Engagement in an Engineering Program	As pdf: www.arneia.edu.au/resource/57
	Online: http://uwa.qualtrics.com/SE/?SID=SV_6L5qlmMfwOP45lp
Benchmark Responses to Tool for Reflecting on Effective Industry Engagement in an Engineering Program	www.arneia.edu.au/resource/58

F1a. All engineering faculties will establish people, processes, and resources to ensure strong relationships with industry

There will be sincere, respectful relationships between faculty members and members of organisations. An academic position and professional support staff will be allocated responsibility and resources to establish and nurture relationships with industry partners.

Engagement from within the faculty will be coordinated using a register, and will be proactively maintained. Faculty members will establish and maintain relationships with human resource managers in industry, as they can align university engagement with development and priorities in the organisation. Faculty members will also establish and maintain relationships with key individuals in each organisation, who are passionate about engaging with education. These key people will be in roles that integrate all of the organisational functions, and have established relationships and credibility across their organisations. They will be well-placed to identify others with specific expertise in the organisation and motivate them to engage with education.

A faculty member will communicate regularly with every industry contact, including invitations to events, and annual emails confirming contact details and availability for engagement in each new year. When industry members engage with engineering faculties, faculty members will thank them for their engagement and consult them about their reflections and suggestions for improvement. When a contact in an organisation moves, an engineering faculty member will identify a new partner in the organisation.

To assist with establishing initiatives, engineering faculties will consider preparing brochures for employers that combine recent examples of success, ways organisations can engage in teaching and research, and relevant university contacts. These brochures will also include examples of each type of engagement. For example, they could include expectations of vacation employment with examples of recent student experiences, and expectations of industry-based final year projects with examples (see Example 1. Faculty brochure for industry identifying potential engagement).

Resources

To assist engineering faculties in developing brochures that promote to employers the ways to engage in engineering education, two exemplars are available: the resource identified below, and Example 1. at the end of the guidelines.

ECU Engagement Handbook www.arneia.edu.au/resource/51

F1b. All engineering faculties will provide structural and developmental support for academics to engage with industry

Faculty leaders will have a clear vision for industry engagement—including expectations of and support for staff—articulated across the faculty.

Activities that contribute to exposing students to engineering practice will be recognised in recruitment, promotion, work-time allocation, resource allocation, and awards.

Engineering faculties will have processes to help academics expose students to engineering practice, which could include networks, events and resources. Such processes will provide opportunities for engineering teachers to:

- engage with industry
- access research in the field of engineering practice
- develop knowledge and skills to expose students to engineering practice.

Faculty members will have access to guidelines for the main types of industry engagement in engineering education. Examples include:

- vacation employment or internships in engineering organisations
- emulated work-integrated learning in the university
- industry-based individual or team projects
- industry-based projects within units
- units taught by engineers and with engineering practice integrated into the unit
- guest lectures
- site visits
- lunchtime panels
- mentors schemes
- industry expos.

Such guidelines will be designed to simplify the process; maximise the potential benefits for all stakeholders; and minimise risks to safety, use of resources, cost, and relationships with organisations. All processes engaging industry members will be respectful of industry members' time, use their experience, and maintain focus on benefits for students, the engineers, and the engineers' organisations.

Student clubs and societies will be supported in their engagement with industry—with guidelines, faculty resources and processes for coordination and professionalism across the faculty.

Current example of effective practice

Support for academics to engage with industry to enhance teaching

Model 1: An engineering department in Australia employed a senior engineer two days per week to teach, and identify industry applications of aspects of the curriculum. He worked with individual academics to introduce them to organisations where the theory they taught was applied, so that the academics could then use industry-based examples in their teaching.

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Model 2: Academics taught into in-house units for engineers in an industry organisation. The units were approved by the university as units in masters programs. This experience gave academics an opportunity to network with industry members, and learn about industry to inform their teaching and research.

Model 3: Academics involved in a Cooperative Research Centre (CRC) adapted industry-based problems for their teaching. These could be enhanced through photographs, video clips, objects, guests, or site visits.

F1c. All engineering faculties will engage engineers with industry experience in facilitating learning

Engineering faculties will engage industry members in facilitating students to learn, ensuring that the value of engineers' experience is respected and benefits of this optimised.

Faculty leaders will recognise the contributions of industry-based engineers who facilitate students' learning, with appropriate titles. Facilitators will be well-supported with orientation, office space, and evidence-based guidance.

Industry members will be employed in ways that optimise their experience and minimise their need to adapt. Faculty leaders will consider innovative teaching structures such as block mode, and plan for long-term employment of industry-based teachers. Industry-based learning facilitators may have roles similar to those in the workplace, as a mentor, team leader, or client.

Current examples of effective practice

Industry-based engineers engaged in facilitating learning

Model 4: In an Australian university, an organisation was paid to take responsibility for developing and teaching a unit with the involvement of several senior engineers, graduate engineers, and a human resource manager. This model is recommended because remuneration for teaching is not competitive with engineers' remuneration in industry. Under this model, the engineer, the organisation, the university, and the students benefitted. In this case the university provided tutoring and marking (see Example 2. Units developed and taught by companies).

Model 5: In an Australian university, an engineer based in a consulting firm developed and taught a unit and the university paid his employer. This model is similar to Model 4 above, except that the individual engineer built the relationship with the university, and gained approval and support from the employer. Longevity of the model would be improved if the industry organisation committed to maintaining the responsibility for the unit, in the case of the individual engineer becoming unavailable.

Model 6: In many Australian universities, senior engineers give one or two guest lectures a semester. In one Australian university, a head of school in a single engineering discipline implemented a policy in which every unit had a prize sponsored by industry, and the sponsoring organisation provided a relevant guest lecture every semester the unit was taught. It is important that the quality of guest lectures is monitored in this context.

Model 7: In at least two Australian universities, semi-retired and retired engineers with industry-based careers were employed on contracts to teach at a level recognising their industry experience, although not competitive with industry (see Example 2. Units developed and taught by companies).

Model 8: In an Australian university, an engineer took time off from his job to teach into a unit with prepared lesson plans and assessments. This is preferred to Models 4 and 5 above only if the engineer is self-employed, and the engineer should be paid at a level that recognises the engineer's industry experience, although the rate will not be competitive with industry rates.

Model 9: A US college recently advertised a one-year contract for an Endowed Visiting Professorship in Science and Technology ("Endowed Visiting Professorship in Science and Technology", 2013). The expert from industry will teach and 'interact with and mentor students who are interested in careers in computer science. In particular, the appointee is expected to create connections with technology companies'.

F1d. Industry consultation will be structured and transparent

Industry advisory boards will have publicly available membership and terms of reference, including the purpose of the board, responsibilities of the chair and members, periods of membership, and diversity among members. Industry consultation will focus on significant issues. In addition to engineering faculty

industry advisory boards that discuss current issues, faculties will host forums to engage industry in longer term planning.

F2. All engineering programs will use industry-based assignments

Academics will use industry-based examples and assignments *extensively* to provide context and give students interactive experience of socio-technical engineering practice using engineering tools.

In some cases, one industry-based project will be used in multiple units so that the students understand it well and experience different aspects. For example, students might call for tenders and select a team in one unit, and work on project management with the 'winning' tender in another unit.

Current examples of effective practice

Industry-based assignments

Model 10: A mock project was developed and taught within a unit by experienced engineers as unit coordinators (see Example 3. Mock project developed and taught by experienced engineers as unit coordinators).

Model 11: A design project with industry as a client was developed and taught within a unit by an academic with industry experience as unit coordinator. A senior engineer gave one or two guest lectures a semester (see Example 4. Design project with industry as client).

Model 12: A project using data and presentations from a completed industry project was used in a unit. The project was developed and taught by an academic with industry experience.

F3. All student engineers will have substantial opportunities to work and learn in industry

Engineering faculties will ensure that *all* student engineers have access to substantial opportunities to work and learn in industry, whether through vacation employment, stand-alone internships, or internships as part of a 'Co-op program' or diploma of professional practice (as identified in the examples below).

Workplace learning will be resourced, developed and managed with at least as much care as a unit. University staff members led by an academic or engineer should be given responsibility to optimise the availability and quality of opportunities for students. Students will be encouraged to seek student employment in diverse organisations.

Flexible guidelines clarifying responsibilities and processes for internships and/or vacation employment must be given to students, staff, and industry members. As recommended in engineering program accreditation guidelines, students will be supported in reflective practice using an e-portfolio or similar. Ideally, students will have a mentor from the university who might visit the workplace and can be contacted by students during employment.

Engineering faculties will assess workplace learning as a component of the award. As recommended in engineering program accreditation guidelines, students will be supported in reflective practice, helping them to 'capture their tacit knowledge' (Raelin, 2007, p. 507). Students can reflect individually, and with peers, an academic, and a workplace mentor, using an e-portfolio or similar. Any interactive group activities such as web discussions and workshops will be facilitated. Details about what, how, how much, and why students have learnt should be collected. This could include improvements the student made to engineering practice, a project or an organisation during their workplace experience (Raelin, 2007).

Engineering faculties will provide students with access to a standardised, convenient resource for reflecting on and recording their development throughout their programs against the Stage 1 competency standards. A potential benefit to students of e-portfolios could be in applying for jobs. However, employers will find e-portfolio extracts useful in the selection process only if they are standardised in the competencies against which students map their development. Engineering faculty leaders should collaborate with Engineers Australia to establish this (see Recommendation B3. below).

To help students understand how to make the most of the workplace experience and as part of students' reflections on their learning, students who have not yet undertaken workplace learning should engage with returned interns or vacation students. This will be facilitated by an academic or engineer with awareness of engineering practice.

Although an internship or student employment is optimal, students should have a back-up alternative in case no such experience is found. A common alternative to employment is an industry-based project. A second alternative for students can be a collection of experiences exposing the student to practice. The structure for this alternative should be designed to guide the student in making opportunities to gain many of the benefits otherwise offered by an internship or employment. For example, the student might be guided in attending events at Engineers Australia, interviewing engineers in their workplaces, visiting engineering sites, and maintaining a portfolio recording reflections and development during these experiences. This alternative to an internship or vacation employment should be used only as a last resort.

Resources
The resources listed below are exemplars provided to assist engineering educators to develop schemes for their students to work and learn in industry.

AMC Employer Handbook	www.arneia.edu.au/resource/49
QUT Work Integrated Learning Unit	www.arneia.edu.au/resource/48
QUT Work Integrated Learning Unit background	www.arneia.edu.au/exemplar/23
RMIT Student Engineering Experience Guidebook	www.arneia.edu.au/resource/60
Swinburne IBL Responsibilities	www.arneia.edu.au/resource/50
UTS Engineering Practice Program Student Guide	www.arneia.edu.au/resource/53

Current examples of practice

Students working and learning in industry

Model 13: Among Australian engineering faculties, the most common model for student engineers to learn while working in industry was 12 weeks of vacation employment. It was usual for this to be required, but not contribute to program credit points. The required was usually graded only as 'satisfied' or not, based on the student's report and the industry supervisor's report. Universities stipulated the nature of work that was acceptable. Students found their own employment, universities offered support and many employers visited campus. This model could be enhanced as recommended above.

Model 14: At least one research-intensive university and at least three other Australian universities offered students internships of 3 to 12 months for program credit (see Example 5. Internship program in a research-intensive Australian university). Internships were well-structured with negotiated agreements between universities and employers. These would be enhanced by increasing the numbers of students participating.

One Australian university offering internships had 200 students (30–40% of the cohort) on internships in Europe in automotive, aerospace, and manufacturing engineering. After third year, students spent 6 to 12 months on internships, contributing to one semester of program credit points. This university reported that students could also do local internships, but due to the local culture these were harder to find. Students who did not take an internship were required to complete 12 weeks of vacation employment. This program would be enhanced by increasing student participation.

Another Australian university offering internships had 250 students (approximately 45% of the cohort) on internships—mainly in Australia, including a majority in manufacturing and some employed by councils, a casino, and several biomedical companies. After first semester of third year, students spent 6 to 12 months on internships contributing to units (see Example 5. Internship program in a research-intensive Australian university). This program would also be enhanced by increasing student participation.

Model 15: In four identified Australian universities, student engineers completed two internships. Programs such as this are sometimes called 'Co-op programs' and can lead to a combined degree in engineering and engineering practice. These programs took longer than four years. The internships were structured, with units preparing students and helping them reflect on their internships (see Example 6. Internship program in an Australian university of technology). This model addresses the F3. recommendation.

F4. High percentages of students will have opportunities to undertake industry-based final year (capstone) projects

Industry-based final year projects, addressing real research or design problems faced by industry, will be undertaken by many students. Each student will have an academic and an industry-based supervisor. There

will be communication between all three parties (the student and both supervisors) and an agreement regarding responsibilities, confidentiality, intellectual property, and liability. Final year project coordinators will ensure that students and supervisors are aware of the need for an agreement, and supervisors should ensure an agreement is in place.

If possible, matching of students and projects will occur well in advance of the students undertaking the projects. This allows time for organisations to offer opportunities for students to visit sites or meet people whose problems the projects will address.

As for internships and vacation employment, engineering faculties will have clearly-defined structures for industry-based projects. Academic supervisors of industry projects must scope problems proposed by industry members, to a suitable size and level. Supervisors will also ensure that assessment criteria are well-defined.

It is important that students are actively encouraged to explore aspects of a project that are related to engineering practice, as well as those involving engineering science. An example is how cost analyses relate to whether an engineering design can add value for an organisation. Academics who grade industry-based projects will be familiar with the nature of engineering practice and will be skilled in assessing the quantity and quality of industry-based project work.

It is sometimes suggested that consulting firms have difficulty offering these projects because they operate on clients' schedules. However, this can be overcome by involving consultants and their clients in projects (see Model 16 below).

Current examples of effective practice

Industry-based assignment with consultants and consultants' clients

Model 16: Thirty-two second-year students of technology management at the Amsterdam School of Technology worked on 10-week individual projects (Oosterloo, 2005). Each had a university supervisor, a consulting supervisor, and a client supervisor. The client's role was similar to a client's usual role with respect to a consulting firm. It was critical that the academic did not allow the student to scope a project that was too large in an attempt to meet the client's enthusiasm. These projects provided an opportunity for students to develop professional skills for following internships. The model is transferable, although it involved second-year students. This model included all students.

Model 17: At most Australian universities, academics propose final year projects and students approach academics to work on their projects. Some of these projects are linked to industry-based research undertaken by academics.

Model 18: In a research-intensive Australian university, students were encouraged to negotiate final year projects with their vacation employers. The students also had to secure a suitable academic supervisor. This university stipulated that the student should not be paid. This model relies on students' skills at initiating discussions with industry supervisors.

Model 19: Co-operative Education for Enterprise Development (CEED) projects were run at two research-intensive Australian universities (see www.corptech.com.au and www.ceed.uwa.edu.au).

The CEED director negotiated with the industry organisation to provide an industry-based final year project. There was a standard agreement between all three parties: industry, university, and student. In contrast with the above model, the organisation paid the student and the university and the CEED director approached the employer regarding negotiating a final year project. This model is more inclusive than many others.

Resources

To assist engineering educators in developing the structures for engineering design projects the resource identified below is available.

Curtin University Design Project   www.arneia.edu.au/resource/52

F5. Emulated work-integrated learning will be developed as an example of effective industry engagement

Emulated work-integrated learning opportunities are recommended as a low-risk way to give students practical experiences in environments that simulate features of engineering workplaces. This does not replace workplace experience.

Current examples of effective practice

Emulated work-integrated learning

Model 20: Two virtual processing plants were developed in a collaboration between chemical engineering departments in five Australian universities, BP and Coogee Energy (Cameron et al., 2009). Students could 'walk' through virtual three-dimensional environments representing the two plants. Embedded in the environments were process diagrams, unit processes, unit operations, and system dynamics. Students could learn about the sense of being at the plant, process operations, system dynamics, and risk management. The environments were used by students from first year to the final year of their programs.

Model 21: A miniature plant simulating parts of the Bayer process was built at Murdoch University with support from industry (Hopkinson, 2010). The plant included safety infrastructure such as showers, safety clothes, and safety routines. It was used by students to learn about process control in a simulated industrial environment. Students selected control loops and applied various control algorithms, parameters, and operating points to control pumps and valves.

Model 22: Three universities collaborated with what was initially 25 industry organisations, to establish the 'Learning Factory', which provided hands-on experience for students in an electronics manufacturing facility on campus (Lamancusa, Zayas, Soyster, Morell, & Jorgensen, 2008). Students worked in the factory and then took internships in industry. Their analytical and theoretical learning had an industrial context and they also learnt about aspects of manufacturing engineering, such as

quality, delivery, and productivity.

Similarly, one Australian university has an advanced manufacturing facility, in which students work on project-based learning and final year projects supervised by engineers from industry.

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Model 23: An Australian university provided an off-campus experience through the university's resources. All third-year students went on educational trips on the university's research and teaching vessel. The experience was more industrial than the campus, because students had to relate to the professional crew on the vessel.

For further details contact David Harte, Australian Maritime College, University of Tasmania, dharte@amc.edu.au

Model 24: Eight hundred students in various years and disciplines within built environment programs—including structural engineering—at Amsterdam University of Technology, worked on eight design assignments in 80 teams during one week. They camped in empty floors of an office building in a city which was the subject of the design projects. On Monday, city leaders and planners met the students to clarify the project. There were 16 relevant guest lectures (two per project) on Tuesday. The students undertook the design on Tuesday, Wednesday and Thursday. Friday included judging and networking with local industry organisations which also provided internships for students.

Model 25: In 2011, the engineering industry liaison manager at an Australian university took engineering and other students to Cambodia to work on 20 humanitarian projects. It was fully funded by grants and industry and some of the projects were ongoing.

For further details contact Gail Jackman, University of South Australia, Gail.Jackman@unisa.edu.au

F6. Students will be encouraged to take responsibility for seeking opportunities to learn about engineering practice

The benefits of exposure to engineering practice will be promoted to students and they will be encouraged to take responsibility for learning about engineering practice from the beginning of their degrees (if not earlier). Students will take responsibility for their learning and development, including gaining opportunities to learn about engineering practice. Students' reflections should focus on the Stage 1 competencies and the importance and meaning of these should be well understood by students.

F7. Engineering faculties will support and recognise industry engagement undertaken by student groups

Engineering faculties will support and guide student societies and student groups working towards competitions, and integrate these activities into the curriculum. Many students currently gain exposure to practice and opportunities to develop competencies through these activities, which provide a platform for helping students realise the importance of industry exposure and being proactive about gaining this from early in the degree. Opportunities taken by students to engage with industry could be considered in their e-portfolios and count towards their exposure to practice, especially when they have been unable to secure engineering student employment. Engineering faculties can support student societies in their industry engagement by providing administrative and other support, such as transport for site visits, promotion of events through faculty newsletters, space for posters, and inexpensive venues and storage space.

Recommendations for Industry

I1. Organisations should provide regular and structured student engineer employment

Engineering employers are encouraged to consider employing vacation students or student interns wherever possible.

Being proactive about managing vacation student recruitment will save time for the organisation and students. Every year, many engineering students seek summer vacation employment. Organisations should plan for this by liaising with engineering managers early in the year to identify opportunities for the next year. Organisations should advertise whether vacation employment will be available, the disciplines and locations in which it will be available, and application processes and deadlines. These can be promoted through Engineers Australia, university careers centres, and the organisation's website.

Employers should read the guidelines for vacation employment or internships of the universities from which they hire students. If possible, employers should encourage their student employees to invite their academic mentors, or other representatives from the university to visit the workplace.

It is critical that at least one engineer has official responsibility to mentor the student, ensure that the student is given support when needed, and ensure the student has responsibilities. It is important that the student interacts with engineers in the workplace, preferably a diverse group of junior and senior engineers.

Resources

To assist employers in developing support for students in the workplace, the exemplar identified below was kindly shared by an engineering employer.

Vacation Student Buddy Training Presentation   www.arneia.edu.au/resource/54

A senior manager should ensure that the people working with the student are aware of the concept of employing student engineers, the motivation for the organisation employing the student, and their responsibilities to help the student learn. Policies should be in place to ensure that the student is given meaningful tasks and all practical opportunities available. For example, where possible the student should be invited to accompany engineers on any site visits and appropriate events. Networking with other students can provide valuable opportunities for reflection as the students compare their experiences.

Employers can simplify and improve the supervision of students by preparing a booklet that provides information and questions for the student. The booklet is completed by the student during downtime. The booklet should include: orientation detail; information the student should discover about the organisation, its structure, what it provides, and how it makes a profit; and entries to be completed by the student to encourage reflection on the student's development. Responses can additionally help managers in the organisation to reflect on the organisation's practices and culture.

Employers can simplify and improve supervision of students by employing students every year. Students can continue roles that other students undertook in previous years and students returning for a second period of employment can help students employed for the first time.

Each student's welfare must be supported and pay should be appropriate to the employer and the project. Students must have occupational health and safety coverage, and a non-discriminatory environment.

I2. Engineering employers should provide support for their engineers to engage with engineering education

Employers of engineers should encourage and support their staff members to engage with universities and assist with exposing student engineers to engineering practice. Many of the possible roles that engineers can take to help students learn involve the engineer acting in an emulated engineering team role. For example, graduates can be student mentors. Project engineers might suggest industry-based projects and act as clients. Senior engineers might give guest lectures or serve on industry advisory boards. Other possible formats for engagement are industry weeks on campus, short-term student engagements with industry, and site visits.

Human resource managers should give structure to engineers' engagement with engineering education by designing alignment with organisation needs. Additionally, they should structure provisions for engineers to allocate time to engaging with universities, and support organisational commitment to continued engagement.

Appendix B. lists ways that industry members can engage in engineering education degree programs.

Current example of effective practice

Unit developed and taught by an engineering organisation with a university coordinator

A design project unit described earlier in **Model 4** was run by an engineering organisation. A human resource manager met weekly with the graduate and senior engineers to help design the engagement, help the graduates engage in reflective practice, and align the experience with professional development in the organisation (further details can be found in Example 2. Units developed and taught by companies).

I3. Engineering employers should provide support for academics to experience industry

Engineering employers should provide opportunities for academics to become aware of their industries. Possibilities to consider are inviting academics to visit sites, network with engineers in an organisation, or providing support to develop teaching materials such as assignment problems, projects, and demonstrations.

Recommendations for Professional and Industry Bodies, and Governments

B1. Industry bodies, universities, student societies, and the Australasian Association for Engineering Education, should consider establishing a resource centre to support industry engagement with universities

Industry bodies and universities should consider collaborating to establish a national resource centre for industry engagement in engineering education, to assist students, universities and industry to identify opportunities and establish relationships.

The resource centre could provide something akin to a 'dating' service, which matches employers and students. It could encompass vacation employment, internships, and final year projects. A mechanism so that students can trust the listings as authentic would be necessary. The resource centre staff, possibly using online processes, would collect, publish, and maintain lists of available types of engagement and contact details for universities and engineering employers, and organise regional events to facilitate collaboration. Engineering faculty members, university careers centres, and university development offices should work together such that suitable contacts are clear to engineering employers.

A bank of case studies and exemplars that could be shared between universities, employers and students should be developed. For employers, exemplars would include models of vacation employment programs from organisations of different size and type. For universities, exemplars would include examples of guidelines for internship programs, vacation employment, mentoring programs, site visits, industry-based projects, and engaging student societies. For students, case studies would include examples of how students found vacation employment or internships.

The resource centre staff could also support employers, students, and universities during and following a student's period of employment, by providing opportunities for students and supervisors to reflect at workshops, and using the e-portfolios discussed below. This could be especially helpful for students and supervisors in small organisations.

The centre should support stakeholders in developing networks of people interested in enhancing industry engagement in engineering degrees. Events to establish the networks and online communication tools could be provided to support the networks.

The centre could maintain a record of available teaching resources such as: pumps; photographs of sites, failed parts, or safety hazards; and examples of specifications and tender documents, which could be shared between universities. These would be provided by industry and stored in universities, with a record of their location, availability, and an industry contact name for further details, maintained as part of the resource centre.

Current example of effective practice

Resource centres to support industry engagement with universities

Model 26: Engineers Australia divisions publish books for students listing details about vacation and graduate employers (Engineers Australia WA Division, 2012). A similar resource for engineering faculties and employers focusing on possible industry engagement with engineering faculties should be considered.

Similarly, the Medical Technology Association of Australia established a directory of workplace learning opportunities in the medical technology industry (Shipman & Trimmer, 2008).

Model 27: Engineers Australia divisions hold annual vacation and graduate engineering employment expos. An adaptation for universities and employers should be considered.

B2. Government, professional bodies, and engineering faculties should consider establishing a joint internship scheme

Work-integrated learning has been endorsed by a 'Work Integrated Learning Statement of Intent' between Universities Australia and business groups released on 26 February 2014 www.universitiesaustralia.edu.au/news/media-releases#.UzPY1k2KAiQ

A national engineering internship scheme should be considered by industry bodies, engineering faculties, and the Australian Government. Employers would be able to offer internships in Australia if threshold standards were met. Students would be able to apply for internships with registered universities, with the assurance that university requirements will be met. The employer, university, and the student would sign a standard agreement, with variations negotiated between parties if necessary.

Proposed model

National internship scheme

Model 28: Universities Australia proposed a National Internship Scheme (Universities Australia, 2008), under which it was proposed that the Australian Government should contract out management of the scheme and provide tax incentives to support employers in paying interns.

Model 29: Kelly and Dansie (2012) considered the proposal of a national internship in engineering, reporting a comment that agreed standards would be more appropriate, because diversity between approaches is valuable.

B3. Engineers Australia should consider developing an e-portfolio resource for student engineers

Engineers Australia in consultation with engineering faculties should consider adaptation of Engineers Australia's e-chartered system www.engineersaustralia.org.au/echartered-portal for student engineers (see Recommendation F3.). An e-portfolio for student engineers would be specifically tailored to Stage 1 or Stage 2 competencies and follow the e-chartered structure so that student engineers could conveniently progress to this as they developed further competencies after graduation.

> *Current examples of effective practice*
>
> *Resource to support interns in reflecting on development towards competency standards*
>
> At least two universities aligned student internship report sections with reflection towards development of the Stage 2 competencies standards. Several used the Stage 1 competencies. At least one Australian university allowed students to use an e-portfolio as evidence for claims of progress towards Stage 1 competencies.

B4. Industry bodies should foster a culture of industry engagement with education

Engineers Australia should encourage engineers to take the opportunity to support the development of other engineers and students as part of developing and maintaining their competency for chartered status. One of the indicators of attainment under the element of competence 'performance' is 'collaborate within and outside educational institutions to enhance the quality and value of engineering education to students' (Engineers Australia, 2012, p. 7). This should be promoted as part of professional development program relationships with employers.

Industry bodies could recognise industry–university engagement with awards.

Industry bodies should hold some technical events on university campuses, so that they are convenient for students and academics.

B5. Government should consider incentives for employers to support engineering education

The Australian Government should consider incentives for employer organisations to engage with engineering education. Three possibilities are identified below:

- The Australian Government could expand the National Workforce Development Fund from supporting employees training in Vocational Education and Training (VET) courses, to support employers in employing tertiary students undertaking workplace learning for Commonwealth-supported programs.

- The Australian Government could classify employing a Commonwealth-supported tertiary student for workplace learning of 12 weeks to 6 months as 'providing a scholarship', for payroll taxation purposes.

- Australian, state, and territory government contracts could be required to build-in education of undergraduate students. The 'Priority Start – Building' policy in Western Australia, under which tenderers for large government contracts must commit to assisting with training of apprentices, is an example that could be adapted for tertiary students undertaking workplace learning under a Commonwealth-supported scheme.

   The Policy applies to all Western Australian State Government building and construction projects including civil and engineering projects with a labour component in excess of $300 000. All Western Australian State Government Agencies and all contractors tendering for projects must comply with the policy in all of their operations. This means that contractors are expected to comply with Priority Start – Building in their private contracts… Successful tenders are required to meet a pre-determined training requirement by providing training opportunities for a target number of apprentices to be engaged for the full duration of the contract. This target is linked to the labour component of the contract… and will be identified by the Works Agency for inclusion in the initial tender documentation.(Government of Western Australia Department of Training and Workforce Development, 2010, pp. 3-7)

B6. The engineering program accreditation board should review the accreditation guidelines with respect to exposure to engineering practice

The engineering program guidelines are consistent with these guidelines. However, they should be reviewed to investigate the possibility of more strongly encouraging increased industry engagement.

Identified Examples of Effective Practice

1. Faculty brochure for industry identifying potential engagement

Refer to the following link for an online example:
http://issuu.com/uqeaitfaculty/docs/engage-with-us-2012

Features addressing the recommendations
The staff member who developed the brochure was appointed with responsibility to enhance industry relationships.

For further details contact Jonathan Cosgrove, Director, Faculty Advancement, Office of the Executive Dean, Faculty of Engineering, Architecture and IT, The University of Queensland, j.cosgrove@uq.edu.au

2. Units developed and taught by companies

a) At several universities in Australia, engineering organisations take responsibility to develop and teach entire units, with an academic as unit coordinator. The recommended model is for the university to pay the engineer's employer. The university sometimes provides some of the marking.

b) At one university, a government utility taught a unit in alternate years to make it more feasible for the senior engineers to participate. In the other years, the same unit was taught jointly by three

consulting companies.

Engineering graduates in the organisation were mentors for students and senior engineers gave lectures. A human resource manager supported the process and reflective practice among the graduates, in order to help the graduates develop from the experience. The teaching was well-aligned with the organisation's strategic emphasis on development of people.

c) In two identified cases, organisations taught a unit each, for no financial reimbursement. In each of these, the university had an alumnus championing the relationship, and the organisation employed graduates of the university every year. The organisations benefitted from the opportunity to influence the capabilities of graduates they might employ.

Critical features of the context
A strong relationship between the university and the organisation was critical. Participants in this study frequently noted university alumni within organisations as influential.

Features addressing the recommendations
Students participated in socio-technical activities using engineering tools. Students were exposed to many engineers, assisting identity development. All students participated.

For further details on Example 2b above, contact:
Melissa Phillips, Main Roads Western Australia, melissa.phillips@mainroads.wa.gov.au
James Doherty, The University of Western Australia, James.Doherty@uwa.edu.au

3. Mock project developed and taught by experienced engineers as unit coordinators

Two experienced engineers employed as teaching staff in an Australian university gave units in which students worked individually and in teams on a mock project. The units were developed, taught, and coordinated by the experienced engineers.

The engineers prepared a call for tenders including drawings, contour maps for the site, requirements, and specifications. The students completed quantity take-offs and—as a team—bid for the job. As individuals they completed program schedules using scheduling software. Halfway through the job, the students were told about events that had happened and they prepared a cost control report for the project manager, including recommendations for how to realign the schedule to meet the deadline.

One team member presented the report and the whole team answered questions that a project manager would ask. Students gave and received feedback on how they answered the questions. For example barricading, dishonesty, dodging questions, or avoiding the hard truth were identified as losing trust. Transparency was identified as essential from a project control point of view.

Critical features of the context
The engineers had vast industry experience. They valued strong support from the dean, and felt able to approach him for required resources. Teaching orientation was important. Support from an engineering education researcher helped the engineers to improve assessments to motivate learning and team work. It was critical that the teachers had office space where they could do marking and where students could meet them to ask questions.

Features addressing the recommendations
The students participated in socio-technical activities using engineering tools. They were supported in reflective practice. All students participated.

For further details contact
Nolan Bear, Swinburne University of Technology, nbear@swin.edu.au
Laurence Pole, Swinburne University of Technology, lpole@swin.edu.au

4. Design project with industry as client

An academic in an Australian university described a design project unit in which an organisation took the role of client and the class project focused on a real project that had not yet started construction, but was about to start. This was selected so that data were available but the students were not heavily influenced by a completed design. The students completed a budget, a tender, and a feasibility study. The client presented results of community consultation and other data. External presenters spoke about relevant aspects of the project, such as safety and environmental issues. A maximum of about 35 students per project was optimal.

Students organised themselves as a company. They elected positions such as project manager, deputy project manager, quality managers, and team leaders. There were three stages to the project and different students were elected into the leadership roles for each stage. Students nominated representatives to meet with the client and they kept the client informed of progress as appropriate. This included five or six student meetings with the client during semester. Students reported against the budget and deadlines. All students presented to the client and the client gave them feedback.

Critical features of the context
The current and previous unit coordinators had extensive industry experience.

Features addressing the recommendations
Students participated in socio-technical activities using engineering tools, with opportunities to build identities, build capabilities, and receive feedback from the client. All students participated.

For further details contact Julie Mills, University of South Australia, Julie.Mills@unisa.edu.au

5. Internship program in a research-intensive Australian university

At a research-intensive Australian university, students could spend up to six months on internship with credit towards their engineering degrees. Students undertook the internship in second semester of third year or first semester of fourth year. The internship did not necessarily add to the duration of a student's engineering program.

The university approved each employer's proposed project, having guided the employer in the nature of suitable projects. Systems for recruiting interns varied across employers. Some employers recruited through the engineering faculty, leaving the faculty to select the students. Some interviewed after the faculty short-listed. Other employers undertook the whole recruitment process themselves.

A chartered engineer was employed to mentor students while they were on internship and guide them in completing their reports. Students could contact the mentor by email, telephone, or internet as required. The mentor sometimes visited the students and employers during the internships. The report was aligned with Stage 2 competencies as required by engineers for chartered status in Australia.

Some organisations involved in the internship program also then engaged with the engineering faculty in other ways. For example, one company provided a field trip for students.

Critical features of the context
The academic leading the internship program had a transformative internship experience as a student and hence was passionate about the value of internships. In this research-intensive university, the internship was an alternative to elective units in the program. This was strategic for its approval, because it did not displace other engineering units.

Features addressing the recommendations
Students participated in engineering environments with opportunities to build identities and capabilities. The mentor support for writing reports encouraged students to reflect on their development and learning related to engineering practice.

For further details contact Paul Compston, Australian National University,
paul.compston@anu.edu.au

6. Internship program in an Australian university of technology

At an Australian university of technology, students spent 6 to 12 months on internship as part of their engineering degrees. Students undertook the internships in second semester of third year or first semester of fourth year. The internship did not necessarily add to the duration of a student's engineering program.

The university had relationships with approximately 300 employers, although not all offered internships every semester. Approximately 250 students at a time were on internships. This included approximately 45% of each cohort. Placements were mainly in Australia, including a majority in manufacturing, and a casino, councils, and several biomedical companies.

To gain an internship coordinated by the university, students required an average grade of 'credit'. However, students below this grade could secure their own internships. The internship program was managed by a university staff member with human resource and marketing skills. Students applied through the internship scheme online and were then interviewed by the employers, on campus or at the employers' offices. The internship manager helped students prepare resumes and develop interview skills.

Discipline leaders assigned academic supervisors to each student and that supervisor was then responsible for the student while on internship. The academic supervisor visited the student and on-site supervisor during the internship. Student reports were assessed as satisfactory or not by the academic and the industry supervisors. The internship program manager also visited sites where possible, to maintain relationships.

At this university, students who did not complete an internship were required to enrol in a unit which could be completed through 12 weeks of professional experience in engineering. This could include any one of many types of interaction with industry. Examples are classes given by guest lecturers with industry experience, completing an industry-based project, individual or group site visits, and interviewing professional engineers.

Critical features of the context
The internship program had been operating university-wide for 50 years and therefore it was well-known in industry. Even in this circumstance, the student demand increased every year and finding enough employers was a challenge.

Features addressing the recommendations
Students participated in engineering environments with opportunities to build identities and capabilities. The supervisors and report writing supported reflective practice.

7. Combined degree in engineering and diploma of engineering practice at an Australian university of technology

In an Australian university of technology, domestic student engineers who were not enrolled in combined degrees with other faculties, completed combined degrees in engineering and engineering practice (BE, Dip Eng Prac), including two internships of at least 22 weeks each. They were required to take the first internship, the junior internship, after three or four semesters. The senior internship had to be completed before the student started his or her final year project. Therefore, students studied theory for two years, experienced practice for six months, theory for 18 months further, practice again, and then theory and application leading to graduation. Every year 600 to 700 students undertook a junior or senior internship.

All internship projects were approved by the university. The junior internship could involve work that might not normally be undertaken by engineers, but was based in an engineering environment and was a valuable learning experience. The second internship was required to be similar to the work of a graduate engineer.

Before their internships commenced, each internship student completed a preview unit, and afterwards a review unit. The first preview unit was taught by practice-oriented academics and engineering practitioners, and encompassed personal and professional development and the nature of engineering practice.

In the review units, students were asked to reflect on their development towards the Stage 1 competencies stipulated by Engineers Australia. For example, students were required to write significant internship episode reports about their exposure to ethical practice and its implications, and their contributions to it. For example, they were required to write about sustainability and their understanding of it, as well as sustainability practice within the engineering organisation that employed them, their contributions to it, and their influences on it. Similarly, they wrote about team leading, team working, and communication. Students were required to provide evidence for their claims in the form of a log book or an e-portfolio. The reports were 30 to 50 pages and worth 50% of the review unit mark. The other 50% was based on students' participation in peer assessment settings.

Students peer-reviewed others' reports and advised whether the students should submit their reports, or revise the report and accept the penalty for submitting one week later. Many students improved their report so significantly based on feedback that revision was the better option. Review students gave presentations, which were attended by all preview and review students. All students participated in the three to four hours of presentations. Students received grades for their questions.

Many internships grew into final year projects and graduate employment.

Critical features of the context
Key university staff involved in tutoring the preview and review units had substantial industry experience. The tutors were all committed to the program. No tutor was a postgraduate or undergraduate student. Staff with industry experience had been recruited before a research track record became an imperative to joining academia. A program structure involving multiple periods of internship had been well established at this university and well-known among employers since 1965.

Features addressing the recommendations
Students participated in engineering environments with opportunities to build identities and capabilities. The involvement of preview students in review students' presentations supported identity development. The review units supported reflective practice. The peer review opportunities and hearing many student presentations, supported reflective practice and identity development. All students within the program participated.

For further details contact Rob Jarman, University of Technology Sydney, Rob.Jarman@uts.edu.au

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Appendix A. Project Resource Kit

Project Resources

Best Practice Guidelines for Effective Industry Engagement in Australian Engineering Degrees   http://arneia.edu.au/resource/59

Summary of Best Practice Guidelines for Engineering Faculties on Effective Industry Engagement in Australian Engineering Degrees   www.arneia.edu.au/resource/56

Tool for Reflecting on Effective Industry Engagement in an Engineering Program

As pdf:
www.arneia.edu.au/resource/57

Online:
http://uwa.qualtrics.com/SE/?SID=SV_6L5qlmMfwOP45Ip

Benchmark Responses to Tool for Reflecting on Effective Industry Engagement in an Engineering Program   www.arneia.edu.au/resource/58

Employer Exemplars

Student Engineering Induction Guide   www.arneia.edu.au/resource/55

Vacation Student Buddy Training Presentation   www.arneia.edu.au/resource/54

University Exemplars

AMC Employer Handbook   www.arneia.edu.au/resource/49

Curtin University Design Project   www.arneia.edu.au/resource/52

ECU Engagement Handbook   www.arneia.edu.au/resource/51

QUT Work Integrated Learning Unit   www.arneia.edu.au/resource/48

QUT Work Integrated Learning Unit background   www.arneia.edu.au/exemplar/23

RMIT Student Engineering Experience Guidebook   www.arneia.edu.au/resource/60

Swinburne IBL Responsibilities   www.arneia.edu.au/resource/50

UTS Engineering Practice Program Student Guide   www.arneia.edu.au/resource/53

UWA Career Mentor Link Guide   www.arneia.edu.au/resource/44

Appendix B. Ways that Industry Members can Engage with Engineering Education Degree Programs

Engineers Australia (Bradley, 2008, p. 18) stipulates that accredited engineering programs must expose students to engineering practice.

> *Professional engineering practice exposure must include some of the following:*
> *use of staff with industry experience,*
> *practical experience in an engineering environment outside the teaching establishment,*
> *mandatory exposure to lectures on professional ethics and conduct,*
> *use of guest presenters,*
> *industry visits and inspections,*
> *an industry based final year project,*
> *industry research for feasibility studies,*
> *study of industry policies, processes, practices and benchmarks,*
> *interviewing engineering professionals,*
> *industry based investigatory assignments,*
> *direct industry input of data and advice to problem solving, projects and evaluation tasks,*
> *electronic links with practising professionals, and*
> *case studies…*
>
> *…The requirement for accreditation is that programs incorporate a mix of the above elements, and others – perhaps offering a variety of opportunities to different students – to a total that can reasonably be seen as equivalent to at least 12 weeks of full time exposure to professional practice in terms of the learning outcomes provided. In the same way as for other modes of learning, submitted documentation must explain how the various dimensions of professional practice exposure contribute to the overall educational design. Where practice exposure is incorporated within the four-year equivalent curriculum, it must embody assessable requirements comparable with other curriculum elements that attract similar credit. Where it consists of work experience in industry, not otherwise formally assessed, it should be counted in addition to the four year academic requirement.*

Industry members can assist engineering faculties in providing the above opportunities to students. For example, in this project engineers worked with engineering academics to develop industry-based projects. The involvement varied and included any of the following:

- showing an academic around a site and providing data for student projects
- hosting a site visit for students
- giving a guest lecture
- providing potential cases and important skill-development for development of a case study
- attending classes to contribute to interactive lessons
- providing feedback on students' reports and presentations
- being interviewed by students.

Engineers might also provide samples or photos of (perhaps failed) equipment for students to see and touch, provide photos of sites and engineering offices, provide short videos for students to watch. In Example 4. above, engineers acted as the clients for engineering students.

The above list includes staff members with industry experience, and guest lectures. As described under Recommendation F1c. above, there are many models under which faculties can engage engineers in teaching. These include various ways to help guide learning, and various payment and employment models. Many engineering classes are now interactive. Engineers who can facilitate interactive classes, move around a class providing support to student groups, or demonstrate in laboratories can be valuable. There are now also many virtual media through which engineers can contribute to students' learning remotely and asynchronously.

Engineers can serve on the advisory board of a faculty or department. These positions are by invitation, but it is possible to express interest in being invited. Serving on such a board is an opportunity to inform program development.

As per Recommendation I3., engineers can host academics in an engineering workplace or on a site visit to expose the academics to engineering practice so that they can then include real applications of concepts in their teaching, and portray a realistic understanding of engineering practice to students.

Many of the industry-based participants in the project advised that they were involved with no universities or perhaps one university, only because universities had not approached them. There is no need to wait to be contacted. All universities provide contact details for their staff members on their websites.

Acknowledgements

The Australian Council of Engineering Deans is an incorporated association of the 36 leaders of the Australian universities and associated colleges that provide engineering education and research. ACED promotes and advances engineering education, research and scholarship on behalf of the Australian higher education system by undertaking and supporting projects in collaboration with its members and other organisations. ACED works closely with the national professional body, Engineers Australia, and with the Australasian Association for Engineering Education.

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