Systemic Approaches to Improving Engineering Education in Australia

Professor Robin King, University of Technology, Sydney; Australian Council of Engineering Deans
Dr Prue Howard, CQ University; Australasian Association for Engineering Education (AAEE)
Associate Professor Lyn Brodie, University of Southern Queensland; AAEE
Dr Sally Male, The University of Western Australia
Dr Peter Hoffmann, Engineers Australia Accreditation Centre

Abstract

The prime responsibility of engineering education is to prepare graduates for employment in increasingly complex and diverse situations. The engineering curriculum must be continually updated with new science, materials, tools and technologies, and methods of application and practices. Engineering graduates are expected to have defined problem solving and design skills, and 'employability skills' that include communication, teamwork and project management. Fortunately, the engineering profession has largely agreed on the expected generic graduate attributes for engineers. These are exemplified in national accreditation systems, benchmarked to international agreements, such as the Washington Accord. Within these contexts, university-based engineering education is delivered by many largely independent providers, the universities and colleges. Their academic staff (faculty) mostly do not have prior formal education and training in teaching, but are accomplished researchers in engineering science.

Whilst each university has responsibility to address its curriculum independently, national accreditation and qualification frameworks suggest collaborative approaches. This paper describes how the three national Australian organisations covering the educators (the Australasian Association for Engineering Education, the faculty leaders (the Australian Council of Engineering Deans) and the accreditation agency (Engineers Australia) work together, and with the universities, to support improvements in engineering education. Areas of educational improvement described in the paper include outcome-based curriculum design, student-centred and active learning, and students' exposure to engineering practice. Accreditation also supports sound innovation in engineering education. Central to improvement are professional development activities to support engineering educators to develop their skills and knowledge in evidence-based education practice.

1. Introduction

Educators of future engineers across the world are faced with many challenges and operate within profound constraints. Challenges include formation of curricula that satisfy employers' demands for graduates to be scientifically and technologically competent and ready for engineering practice. Constraints include students' school education, university funding, educational and professional accreditation requirements, and academics' competing interests in engineering science research.

The design and implementation of effective curricula are at the heart of the education function. Yet most engineering educators in universities are not trained for this. Their engineering practice prior to becoming academics is most often, and increasingly, in engineering science research. Academics – faculty members – need support to develop best practice skills in curriculum design and implementation, on their way towards becoming effective and expert educators. Relevant support may be provided within an institution, but as we discuss here, there is also great value in having nation-wide processes for educational support.

This paper discusses a number of system-wide approaches being taken in Australia to improve the focus and quality of the engineering curriculum and engagement with industry, and support the development of strong, research-based educational skills amongst teaching academics. The activities described involve all of the 35 public universities that provide most of Australia's professional engineering degree qualifications. Three national organisations play important roles: the professional accreditation agency, Engineers Australia (EA); the Australian Council of Engineering Deans (ACED); and the national association of engineering educators, the Australasian Association for Engineering Education (AAEE). Working together over the past two decades, these organisations have contributed to significant change and innovation in engineering education and skills' development of its educators [1]. They have led and supported many projects and initiatives, some of which are summarised in this paper.

The broad characteristics and scale of the engineering education system, including the national qualification and quality frameworks, and the EA accreditation system, are described in sections 2 and 3. These frameworks all prescribe outcomes-based education. Section 4 describes the roles of AAEE and ACED for supporting skills development amongst academics responsible for design and delivery of the engineering programs, and specific projects aimed at improving the curriculum itself. Some of these projects have won support from the Australian Government's Office for Learning and Teaching (OLT).

The paper discusses three topics of current interest in Australian engineering education: the adoption of more explicitly outcomes-based, student-centred curricula; the development of ducation research capabilities amongst engineering educators; and the need to expose students to engineering practice. For each topic, the paper provides an outline of the issues of concern and the measures being taken to address them, across the national system. We also stress the need for leadership in engineering education, and observe that several universities have appointed and promoted academics with strong credentials in engineering education research to take forward their institutions' teaching and learning missions.

Improvements in Australian engineering education have been achieved by constructive combinations of institution and system-wide action. We foreshadow a future for engineering education in which the emerging challenges will be tackled in increasingly cooperative ways, with greater sharing of good practice and proven educational tools, and with correspondingly greater productivity, and responsiveness to emerging challenges.

2. Australian Engineering Education

Australia has a mature but continually developing higher education system. The principal providers are the 40 universities established by Acts of the Australia federal and state governments. Some 130 private institutions and foreign-based universities also offer higher education qualifications. All providers are subject to regulation by the federal government's Tertiary Education Quality & Standards Agency [2], with standards set by the Higher Education Standards Authority [3]. These include generic (i.e. not program specific) standards for program design, assessment and benchmarking, and staff qualifications, that must be exercised by the educational provider institution to ensure compliance of each program. For professional programs, such as engineering, the requirements of external professional accreditation agencies are expected to be met. Program awards (diplomas and degrees) must also comply with the specifications and descriptors of the ten-level Australian Qualification Framework (AQF) [4]. For each level, the expected outcomes are expressed generically in terms of *knowledge*, *skills*, and *application of knowledge and skills*. Improvements in teaching and learning practice are supported by grants and fellowships awarded by the OLT, described in more detail in section 4.

Engineering graduations at all higher education award levels (AQF 6 – 10) make up approximately 8% of all graduations, a lower proportion than most Asian countries, but similar to USA and UK. The engineering faculties and schools in 35 of the public universities graduated (in 2014) about 11,000 students per year in *formative* bachelor (honours) and master degree qualifications to commence supervised practice as professional engineers. Some universities and colleges also offer bachelors degrees in engineering technology and associate degrees. Currently there is only one private college providing an accredited professional engineering degree program in Australia.

Enrolments into universities by Australian students are essentially ‘demand-driven’ by student applications. The government subsidises the cost of each place taken by an Australian student at a fixed rate for each discipline and also sets the student fee. This fee is also paid to the university by government during the period of a student’s enrolment, but after graduation (or cessation of enrolment) the accumulated personal debt is repaid through the income tax system. International students pay fees directly to the university.

Since Australia’s demand for engineers in all engineering occupations generally exceeds supply, the universities aim to enrol as many students as meet the required entry standards. These are set by the individual universities. Most of the ‘research intensive’ universities have large engineering faculties and tend to recruit mostly from high achieving secondary school leavers. The ‘technological’ and ‘regional’ universities tend to have more varied student intakes, including more mature students and graduates from the vocational and technical education (VET) sector. Women constitute approximately 15% of the student population, although there are wide variations of this proportion between disciplines. Since 2005, at least 25% of each year’s bachelors degree graduates have been international students.

Like many industrialised nations, Australia has periodically reviewed its engineering education system and recommended changes to providers and other stakeholders. The two most recent Australian reviews, in 1995 and 2007-8 both reported the system as performing reasonably well, while identifying the relatively low demand for engineering programs by school leavers, especially women. These concerns remain current. In addition, there are documented ‘gaps’ between graduates’ capabilities and employers’ expectations, particularly in interpersonal communication and other work-place skills. Engineering education must respond to these concerns, and the emergence of new science and technologies, increasingly globalisation of engineering services and manufacturing, and intensifying concerns about pressure on the natural environment and resource sustainability.

The 1996 review [5] led to EA’s development and adoption (in 1999) of a set of graduate outcomes for accredited professional engineering programs. These were subsequently elaborated as generic sets of ‘Stage 1 Competency Standards for professional engineers, engineering technologists and engineering associates (technicians), described further in section 3. This review also led to university initiatives to promote participation of women in engineering degrees, and increased focus on student-centred and active learning.

The 2007-8 review [6] led by ACED confirmed a decade of progress. Problem-based learning had been more widely adopted, and the academic performance frameworks in most universities did include performance in teaching. Three of the review’s six recommendations focussed on improving the *authenticity* of engineering education in terms of: best practice curriculum (i.e. emphasis on student-centred, active learning, and alignment of outcomes, pedagogy, and assessment); exposure to engineering practice; and delivery by authentic educators who are knowledgeable of educational best-practice and contemporary engineering practice, as well as research in engineering science.

Such findings are substantially similar to those identified in other countries’ reviews and reports, too many to reference here. The shortcomings in traditional engineering pedagogies are well known and are reflected in negative feedback from student surveys. Many reports, such as that by Sheppard and colleagues [7], provide excellent analysis and guidance on the changes – beyond incremental improvement – needed in much of engineering education.

Australian engineering qualifications align with three occupational categories and the EA membership grades. They also align with the graduate attribute specifications for the Accords operated within the International Engineering Alliance, in which Australia is a signatory. These are summarised in Table 1, together with their alignments with the AQF.

Table 1 Formative engineering qualifications provided by Australian universities, showing correspondence with the AQF and the international accords.

EA grade	qualification	AQF level	post-school award duration	international accord
Engineering Associate (senior technician)	Associate Degree or Advanced Diploma	6	2 years	Dublin
Engineering Technologist	Bachelors Degree	7	3 years	Sydney
Professional Engineer	Bachelor Honours Degree or Masters Degree	8 9	4 years 5 years	Washington

Universities are increasingly offering masters degrees as formative professional engineering qualifications. There are a range of program patterns. A two-cycle approach has been adopted at The University of Western Australia and The University of Melbourne for all professional degrees; students entering these universities have only a small range of choice of 3-year bachelor degrees, before progressing to 2-year masters programs. Those aiming to become professional engineers would take the engineering strand in their bachelor degree. Some universities offer integrated masters programs that extend their bachelor programs. Others have devised ‘stand-alone’ 2-year masters to enable graduates of a cognate science, or international engineering students, to gain an Australian professional engineering qualification. EA has extended its accreditation system to cover these masters degrees, and requires providers to demonstrate that the whole program (including the prior bachelor degree or other entry pathway) fully delivers the Stage 1 Competencies.

In summary, the providers in the Australian university engineering education system are responsive to student demand and the changing needs of employers and the profession. National qualification standards and accreditation provide frameworks rather than strong constraints on education program innovation and change. Periodic reviews identify directions for change and improvement but major (transformational) changes are generally difficult to implement rapidly within the missions, mindsets and constraints of most Australian universities.

3. Program Accreditation by Engineers Australia

As noted earlier, program accreditation by EA plays a very central role in the Australian engineering education system, including in universities’ quality assurance processes. EA is a membership-based body, independent of government. EA provides program accreditation services as a membership service and public good. The Accreditation Board is a standing committee of the EA Council, and exercises responsibility for all aspects of the accreditation process and its standards development. The Board covers accreditation of programs the three occupational categories in which EA has members, referred to in Table 1. Accreditation is managed by the EA Accreditation Centre.

All universities seek EA accreditation for their professional engineering programs. There is less than full take-up of accreditation for engineering technologist programs because this occupation is less well defined in Australian industry, and many graduates from these programs progress to professional engineering degrees, with credit for their previous studies in engineering technology. Program accreditations of engineering associate qualifications are growing, as more universities are providing associate degrees. The universities contribute to the costs of accreditation through annual subscription; colleges with small numbers of programs contribute on a per-accreditation fee basis.

The prime purpose of accreditation is to assure employers (and the public) that the graduates of accredited engineering programs have the knowledge, skills and personal attributes to commence practice in their occupation. The EA accreditation criteria and processes cover the university/faculty environment, the academic program, and the supporting quality systems. The overall assessment is a holistic one around the question: "*For the next five years, will the program produce graduates that meet threshold levels of attainment?*" Accreditation panels must therefore make judgments about future performance, and expect to see evidence of the capacity for improvement in curriculum and its delivery and assessment.

Table 2 Engineers Australia Stage 1 Competency Standard for the Professional Engineer

Unit of Competency	Elements of Competency (Professional Engineer)
Knowledge and Skill Base	1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline. 1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline. 1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline. 1.4 Discernment of knowledge development and research directions within the engineering discipline. 1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline. 1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline.
Engineering Application Ability	2.1 Application of established engineering methods to complex engineering problem solving. 2.2 Fluent application of engineering techniques, tools and resources. 2.3 Application of systematic engineering synthesis and design processes. 2.4 Application of systematic approaches to the conduct and management of engineering projects.
Professional and Personal Attributes	3.1 Ethical conduct and professional accountability 3.2 Effective oral and written communication in professional and lay domains. 3.3 Creative, innovative and pro-active demeanour. 3.4 Professional use and management of information. 3.5 Orderly management of self and professional conduct. 3.6 Effective team membership and team leadership.

Expected graduate attainment is expressed as a set of sixteen 'elements of competency' in the Stage 1 Competency Standards [8]. These were last revised in a consultative process with industry and educators over 2009-10 with minor updates in 2013. They take into account the graduate attribute exemplars of the Washington, Sydney and Dublin Accords [9]. The professional engineer set is provided as Table 2. For educators, the elements of the Standards are learning outcomes. For employers, they express expectations of graduates' capabilities. The Standards also include a number of action-oriented indicators of attainment. These are intended primarily to assist curriculum designers to devise ways to deliver each element in terms of learning outcomes, and assist accrediting panels. Table 3 shows the indicators for complex problem solving for professional engineers.

After the adoption of these Standards in 2011, the EA Accreditation Centre, together with ACED and AAEE representatives, provided workshops to assist engineering program leaders to more deeply understand the intention and operation of the outcomes-based accreditation process. Work on mapping between intended program outcomes, curriculum unit outcomes, and assessment is addressed further in section 5.

Table 3 Indicators of Attainment for Element 2.1

2.1 Application of established engineering methods to *complex* engineering problem solving
a. Identifies, discerns and characterises salient issues, determines and analyses causes and effects, justifies and applies appropriate simplifying assumptions, predicts performance and behaviour, synthesises solution strategies and develops substantiated conclusions.
b. Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic.
c. Competently addresses engineering problems involving uncertainty, ambiguity, imprecise information and wide-ranging and sometimes conflicting technical and non-technical factors.
d. Partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combining to form a whole, with the integrity and performance of the overall system as the paramount consideration.
e. Conceptualises alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.
f. Applies relevant standards and codes of practice underpinning the engineering discipline and nominated specialisations.
g. Identifies, quantifies, mitigates and manages technical, health, environmental and safety risks associated with engineering application in the designated engineering discipline.
h. Interprets and applies legislative and statutory requirements applicable to the field of practice.
i. Investigates complex problems using research-based knowledge and research methods.

EA Accreditation reports drive innovation and improvement. Explicit recommendations are made to providers. Some may require immediate action and report, with the accreditation status conditional on the action. Recommendations on improvement are less critical, but will need to be addressed before the next scheduled accreditation review, or as otherwise specified. The acceptance, performance and revision of the EA accreditation process has led to many engineering academics looking to future updates of the accreditation outcomes and process requirements to drive change, including in such areas as sustainability and work integrated learning.

4. Engineering Education Communities: AAEE and ACED and the OLT

This national accreditation system provides an important outcomes-based framework, but does not of itself deliver actual improvements in engineering education in the engineering faculties and schools. This requires engagement by academics responsible for leadership, design and delivery of the engineering programs. Such engagement has been nurtured and supported nationally, by two communities: the Australasian Association for Engineering Education (AAEE) for the engineering educators; and the Australian Council of Engineering Deans (ACED). These bodies work closely and systematically with Engineers Australia, to stimulate and support initiatives to improve engineering education.

AAEE [10] has provided a forum for Australian and New Zealand engineering educators since 1989 through its annual conference, journal and workshops. AAEE is a technical society of Engineers Australia, and is supported financially by the 35 university engineering schools, via ACED. A member of the ACED Executive is a member of the AAEE Executive Committee. At any one time AAEE has more than 250 active members, from the 2,000 teaching academics in Australian engineering schools.

In 2011, AAEE ran its first winter school for engineering education researchers, and jointly led the curriculum mapping workshops with Engineers Australia during 2011-12, with funding from ACED. As a result of their innovative and research-based work in engineering education, many members of AAEE are active in international engineering education groups, including the annual Research in Engineering Education Symposium (REES) and the CDIO movement. AAEE is a member of the International Federation of Engineering Education Societies (IFEES), and the Association for Engineering Education in Southeast Asia, East Asia and the Pacific (AEESEAP). AAEE also has a formal collaboration with the American Society for Engineering Education (ASEE), the European Society for Engineering Education (SEFI) and the Journal of Engineering Education (JEE). As a result of the activity and outreach of AAEE members, Australia and New Zealand have built strong international reputations for quality and innovation in engineering education.

Since the mid-1990s, ACED [11] has provided a forum for the leaders of the university engineering schools to provide leadership on national matters concerning engineering education and research and accreditation. The Council formulates unified responses to government consultations and policy papers, and shares other matters of concern. Representatives of the EA Accreditation Board and Centre and the president of AAEE are observers at the ACED Council meetings. The Council is funded by a small subscription from each university, and maintains a part-time Executive Officer, often a retired Dean. A former president of ACED is the current chair of the Global Engineering Deans Council [12].

The Council annually funds small and pilot projects amongst its member universities, particularly to promote dissemination and sharing of expertise, and to support the early development of projects that have the potential to win more substantial external funding. The Council itself has managed several major national projects funded by the OLT, and other government agencies. It is worth reporting that until the mid 2000's Australia's university-based educators had no regular national funding source for education projects. Prior to that date individual universities allocated some funds to their own educational improvements. The creation of the national agency for supporting teaching and learning in universities, now the OLT, made a profound change to the status of university education practice and supporting research and innovation.

For engineering, since 2007, educators from most of the universities have won competitively more than 30 OLT grants and fellowships in areas such as problem-based learning, design-based curriculum thinking, virtual environments, student peer assessment, communication skills, remote laboratories, capstone project assessment, shared resources for teaching engineering mechanics, and threshold concept learning. A characteristic requirement of most OLT grants and fellowships is that is that they include collaborative partnerships universities and have strong dissemination strategies. Without question, these grants have improved the quality of engineering education as designed and delivered by the project leaders, and raised the educational aspirations across the systems as a whole.

5. Outcomes-based and student-centred curriculum design

As described earlier, Australian engineering degrees are accredited to an outcomes-based generic framework of sixteen elements of competency. Each program must be designed to deliver a balanced set of those competencies, *in its particular branch of engineering*. This requires program designers to have a 'big-picture' perspective of what the program aims to achieve for its graduates and their prospective employers. They also need to have clear understanding of the prior knowledge and capabilities of students commencing the program. These may be quite diverse across a large student cohort.

Individual university educators, in contrast, are usually assigned to deliver pre-designed curriculum subject units that are typically one-eighth of a full-time student's academic year. To be successful for the students, each unit should be designed with full knowledge of how each unit fits into the whole program design, and in a form that is not dependent on one specific teacher. (This point may be at odds with university cultures in which the academic has very strong control over what and how he/she teaches.)

A key to good curriculum design is therefore detailed mapping of how each unit contributes to the development of the overall program learning outcomes. From such a description, unit learning outcomes can be considered and refined through collaborative curriculum design. Once outcomes are specified, it should be relatively easy to develop content and assessment. Such thinking, including progressive revision and documentation, should be natural for engineers, as it mirrors the engineering design process [13]. In educational design, the importance of 'constructive alignment' of outcomes, content and pedagogy, and assessment has been well established by Biggs and Tang [14]. The outcome of the program and unit design is a set of documents, for approval by the relevant academic authority, prior to implementation in classrooms, laboratories, studios and workplaces.

Within Australia, several good program and course mapping tools have been developed to assist both curriculum design and compliance with EA accreditation for mapping against the Stage 1 Competencies. National workshops have been run by several of this paper's authors on behalf of AAEE, EA and ACED to assist staff of engineering schools to efficiently develop the required accreditation documentation, whilst also meeting specific documentation requirements of their own institutions.

Students experience the delivered curriculum, not the quality of the design documentation. All of educational psychology points to the benefits of active learning over passive forms. Engineering programs have, in most countries, maintained and increased the proportion of class time that students spend in active learning, despite resource constraints and increasing enrolments. Problem- and project-based learning [15] have been adopted in all Australian engineering faculties to some extent, and as a whole curriculum framework in some. The individual capstone project is a rewarding activity for most students. Recent OLT sponsored research has delivered guidelines to assist academics in improving the value of capstone projects as a learning opportunity for students [16]. The quantity and quality of group project work in engineering throughout the curriculum has increased, as academics have gained deeper understanding of this methodology and its assessment. The flipped classroom concept is being increasingly adopted to focus students' attention on active learning. Given the almost free availability of content via the Internet, academics' attention should increasingly be on understanding their students' learning difficulties, and developing strategies to overcome them. The task of assisting engineering academics collectively to become more confident in student-centred learning is the topic of the next section.

6. Supporting Engineering Educators: the role of AAEE

From a national perspective, engineering educators are supported by The Australasian Association for Engineering Education (AAEE), which is a technical society of Engineers Australia. It is a professional association of academics, support staff, postgraduate students, librarians, professional engineers, and employers who all have vested interests in fostering excellence and innovation in engineering education. The general mission of AAEE is to improve the quality, relevance and performance of engineering education in Australasia. Among its objectives the Association aims to:

- Promote the development and use of new teaching techniques and tools and promote measurement of teaching effectiveness.
- Provide assistance to the engineering educators, especially to the new members of the teaching staff.
- Promote the professional development of engineering educators.

To this end AAEE provides continuing professional development (CPD) for engineering educators. The major avenue for CPD is the annual conference. This conference typically attracts 250 – 300 delegates, with usually over 100 peer reviewed papers presented. An aspect of the conference that is always popular are the workshops delivered within the conference. These workshops are of 1.5 – 3 hours duration, and introduce new resources or delivery methods, or activities that impact academics, such as changes to accreditation processes. The delegates have the opportunity to discuss what approaches other universities are adopting, and keep abreast of changes.

The Australasian Journal of Engineering Education, published online, publishes peer reviewed research papers in engineering education. Academics can read about the issues and approaches that are being investigated in a scholarly manner.

A number of universities are supporting Engineering Education Research groups. These important groups are populated by academics who have chosen education within their discipline as a research area. A 2011 paper [17] considered three such groups in Australia in an attempt to identify the essential elements of these groups for supporting academics. This paper recognised the transdisciplinary nature of engineers conducting education research. These research groups provide an important home for these academics with a different identity to traditional engineering researchers.

A flow on from these groups has been the development of a biannual Winter School which offers an intensive week of workshops and seminars designed specifically for engineering education researchers and PhD students. Whilst direct support for 'education research' in engineering schools and faculties is not always strongly supported as it is seen as detracting efforts from 'technical research', efforts to support grass roots teaching improvements are encouraged and supported.

There is a close collaboration between AAEE and EA to develop and deliver targeted workshops for engineering educators. For example, two authors of this paper have designed and delivered workshops and associated tutor training, accreditation preparation, flipped classrooms, and assessment strategies that have been well received by both management and attendees.

7. Improving Students' Exposure to Engineering Practice: work integrated learning

Australian engineering degrees have traditionally included requirements for industry exposure, to round out and contextualise students' engineering science and application knowledge, and provide experience relevant to their future practice as graduate employees.

‘Exposure to practice’ is a requirement of program accreditation. During a period of particularly strong engineering employment, national peak employer bodies expressed concerns about graduates’ readiness for practice, and that the teaching of engineering science (by traditional methods) may be contributing to excessive student attrition. As a result, the Australian government’s Department of Industry provided significant funding to ACED during 2011-13 to examine and make recommendations on these matters. The working hypothesis for the project was that student retention and graduation rates, and graduates’ employability could be increased by stronger industry engagement for all students, particularly in the early years of engineering degree programs.

The project, led by two of the authors, involved a representative set of 12 of the 35 Australian universities that provide engineering degrees, and was supported by Engineers Australia, several industry peak bodies, and many engineering employers. Two approaches were taken.

In the first, a research-based model for improved industry engagement in engineering degrees, was developed and refined in extensive sector-wide consultation processes. This led to the formulation of model principles for an industry engaged curriculum, that point to radical transformations of thinking about the curriculum, students and academics. Best-practice guidelines and recommendations are proposed for action by academic providers, industry and employers, and sector wide stakeholders, including government [18]. The guidelines are complemented with a suite of resources, including a reflection tool [19] for universities to self assess their programs against the model, and exemplars of current good practice. The participating universities all demonstrated or planned practice improvements in their industry engagement methodologies.

In the second approach, seven universities developed, implemented, and evaluated ‘industry-inspired’ content, mostly for large enrolment subject units in core curriculum areas of engineering science and practice. This content involved about 30 engineering employers, and the revised curriculum was taken by about 1,000 students. Evaluations of these projects indicated positive impacts on learning. Project materials have been packaged for other engineering educators to use.

ACED is currently disseminating the outcomes of these projects to all universities, and is planning further work to support continuing improvements in the quality of student work placements, and other areas. The findings and directions of the project are also contributing to the implementation of a national strategy [20] on workplace integrated learning (WIL) in higher education, in all university disciplines. In this regard, engineering has a considerable advantage of experience, compared with other areas of STEM education.

8. Conclusions: the way ahead

Engineering education will continue to face many challenges in its service to students and the profession. Traditional classroom-based techniques are rightly under question and change, as ‘digital learning’ grows in scope. The national organisations and the supporting systems described in this paper will continue to innovate and evolve to ensure that Australian engineering education meets these challenges, and contributes to global engineering education, accreditation and advancement of the profession.

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