

Engineering Education: national programs and projects 2008-12

Introduction

The 33 Australian universities whose engineering faculties and schools make up the university engineering education system graduate more than 14,000 students each year from a wide range of coursework programs. Most of these are accredited qualifications for entry to supervised practice as professional engineers, usually a four-year Bachelor of Engineering degree. These programs have well-defined graduate outcomes to underpin their graduates' careers and further study. The wide range of programs offered aims to match the diverse spectrum of students' aspirations and prior educational experiences with the needs of employers and the engineering profession at large.

More than 2,000 academic staff design, teach and assess these and other coursework programs. Although the majority of staff do this alongside engineering science research, a small but growing proportion is pursuing research interests in engineering education practice and innovation. Australia is indeed an international leader in this area, with at least six full-professors identifying engineering education in their titles, and most universities acknowledging their academics' research in engineering education and their systematic improvements in education practice.

A further recognised strength of the national engineering education system is the strong collaboration between the three relevant organisations, the Australasian Association for Engineering Education (AaeE), Engineers Australia and the Australian Council of Engineering Deans.

Here we summarise nationally funded engineering education programs and projects that have been completed or commenced during the last five years. Most of them have been funded by the Australian Learning and Teaching Council (ALTC), its predecessor, the Carrick Institute for Learning & Teaching in Higher Education (to 2008), and its successor, the Australian Government's Office for Learning & Teaching (from 2011). The summaries have been compiled from published documents: for completed work, the executive summary of the final report; for projects in their early stages, the published project abstract; and for a small number of projects in progress, the summary has drawn on recent journal and conference publications. The Fellowships and Projects have been won competitively against discipline-independent criteria.

The engineering education community has also received national funding from other government sources, primarily to address educational aspects of skills shortages of engineers generally, and in the resources sector more specifically. Two projects in this category, plus a national review of laboratory facilities are summarised.

The programs and projects described are effectively the nationally most visible initiatives in educational improvement work that is ongoing in Australian engineering faculties and schools. Over the past seven years the projects described have gained national funding of more than \$7M, and the participating organisations have contributed a similar amount in-kind for their investigator's time and other resources.

ALTC Fellowships and Discipline Scholars

Engineering Science and Practice: Alignment and Synergies in Curriculum Innovation

ALTC Senior Fellow 2006: Prof Ian Cameron (University of Queensland)

Summary: A major and recurring theme engineering education is the lack of strong linkages between theory and practice. This fellowship explored this area, focusing on three areas:

- the fundamental importance of learning spaces and places in building graduate capabilities and their representation in a map for use in course and curriculum considerations;
- the emergence of a range of engineering themes that will continue to shape the future of engineering education; and
- the alignments and synergies that underpin the development of course and curricula in engineering.

Final report (2009): www.olt.gov.au/resource-engineering-science-practice-cameron-2009

Bridging the Gap: matching students and staff through discipline-based self-evaluation and co-creation of more appropriate pedagogies in engineering

ALTC Associate Fellow 2007: Prof Wageeh Boles (Queensland University of Technology)

Collaborating partners: Prof Roger Hadgraft (The University of Melbourne, now at RMIT University), Dr Prue Howard (CQUniversity)

Summary: A case study approach was used to explore the proposition that a mismatch between learning styles, teaching styles and institutional norms impedes student commitment to and success in learning. The study involved students and academics in three universities with different cultures that could be expected to have an impact on students' success rates and learning outcomes. Project outputs included publications on learning styles assessment, and four resource guides for academics on connecting teaching with effective learning.

Final report (2009): www.olt.gov.au/resource-matching-students-staff-self-evaluation-qut-2009

Engineering and ICT Learning and Teaching Academic Standards

ALTC Discipline Scholars 2009: Prof Ian Cameron (University of Queensland); Prof Roger Hadgraft (University of Melbourne, now RMIT University)

Summary: The outcome standards cover programs of study for a bachelor degree with a major in engineering or ICT. They were developed as part of a demonstration project funded by the Australian Government and facilitated by the Australian Learning and Teaching Council. Academic institutions and teachers, professional bodies, accreditation bodies, employers and graduates participated in the development of the statement of minimum threshold learning outcomes for the disciplines.

Final report (2010): www.olt.gov.au/resource-engineering-ict-ltas-statement-altc-2010

Navigating a pathway between the academic standards and a framework for authentic, collaborative, outcomes-focused thinking in engineering education

ALTC National Teaching Fellow 2011: Prof Wageeh Boles (Queensland University of Technology)

Summary: The adoption of program learning outcomes will increasingly impact curriculum design, pedagogy and assessment and contribute to improved student learning. This fellowship is developing a transferable framework for collaborative, outcomes-focused thinking to assist academic staff to constructively engage with these imperatives. Working with five universities, an action research approach will support engineering academics to design and implement authentic assessment tasks that provide evidence of students' attainment of learning outcomes. The fellowship will also work with heads of schools to support academics' effective teaching and assessment practices.

Due for completion in 2013

Developing learning and professional judgement in large classes through collaborative self and peer assessment

ALTC Teaching Fellow 2010: Dr Keith Willey (University of Technology Sydney)

Summary: This fellowship focuses on assisting academics to adopt, design, and implement collaborative learning-oriented assessments incorporating innovative self- and peer-assessment. Emphasis is placed on using the tool SPARK^{PLUS} that facilitates self- and peer-assessment of an individual's contribution to a team project, or individual work, and enables students to benchmark their judgement against that of peers and academics. SPARK^{PLUS} also supports effective assessment in large classes and assists in the moderation of academic standards.

Due for completion in 2013

Discipline-based projects and programs

Addressing the supply and quality of engineering graduates for the new century

Project manager /lead author: Prof Robin King (Australian Council of Engineering Deans)

Partners: all ACED member universities, Engineers Australia, AaeE and ATSE

Summary: This consultative review focussed on formative professional engineering degree programs since the previous national review, *Changing the Culture* published in 1996. The report included aggregated data on student enrolments, graduations, and staffing, and examples of good educational practice. The six broad recommendations emphasised authenticity with respect to both engineering and education practice, proposing actions on improving: the public perception of engineering; definitions of engineering occupations and graduate qualifications; best-practice engineering education; resources for engineering education; engaging with industry; and addressing shortages of engineers. These recommendations were adopted formally in 2008 by the ACED membership as a framework for action.

Final report (2008): www.olt.gov.au/system/files/resources/Grants_DBIprojec_engineeringquality_project%20report_25march08.pdf

ALTC Discipline Support Strategy for Engineering and ICT (2009-11)

OLT Education Support Network in Engineering and ICT (2011-13)

Network leaders: Prof Robin King (Australian Council of Engineering Deans)
Dr Tony Koppi (Australian Council of Deans of ICT).

The discipline support strategy followed the completion of the discipline scoping study in engineering reported above, and a separate one for information and communication technologies. The strategy and subsequent network have supported development and dissemination of best practice education in Engineering and ICT in four areas:

- workshops on pedagogy and curriculum development in engineering and ICT, for engineering and ICT academics, each tailored to individual universities' needs. Since 2009, more than 12 workshops have been run with xx participants;
- annual meetings of Education Leaders in Engineering and ICT. From 2009, for Engineering, this has been convened as a meeting of Associate Deans (Teaching & Learning) and others, as a satellite event of the annual AaeE Conference. This has provided opportunities for project dissemination and for raising issues of concern and collaborative action;
- workshops and events on specific topics to disseminate good practice, and to address future educational issues. Several of these have been in collaboration with other groups; *and*
- development of a website of resources and links to best practice in engineering and ICT education. The site, www.arneia.edu.au, was launched in April 2012, and contains links to all the projects included in this bulletin.

Completed ALTC/OLT projects

Remotely accessible laboratories – enhancing learning outcomes

Project leader: Prof David Lowe (University of Technology, Sydney, now University of Sydney)

Partner institution: Curtin University of Technology

Summary: The technologies and potential benefits of remote laboratories for increasing student flexibility and improved learning outcomes have been established, but have not been consistently achieved. This project investigated student reactions and educational outcomes from using remote laboratories, including evaluation of cross-institutional access by a diverse base of students. The two key issues considered in detail included students' acceptance of the reality of the laboratory experience, and how professional reality is reflected in the laboratory design.

Final report (2008):

www.olt.gov.au/system/files/resources/grants_project_report_engineering_uts_oct08.pdf

Teaching and Assessing Meta-attributes in Engineering: identifying, developing and disseminating good practice

Project Leader: Dr Anna Carew (University of Wollongong)

Partner Institutions: University of Melbourne, University of Sydney, University of Queensland, University of Tasmania, Engineers Australia

Summary: Engineering faculties experience substantial pressure from industry, the professional body and their institutions to contextualise and embed graduate attributes in undergraduate degree programs. Through literature search and consultations, this project identified the core problems of implementation of graduate attributes. The team produced and disseminated two heuristic guides to assist educators in both curriculum design and the assessment of graduate attributes.

Final report (2009):

www.olt.gov.au/system/files/resources/CG623_UoW_Carew_Final%20Report_new.pdf

Development, deployment and educational assessment of advanced immersive learning environments for process engineering

Project Leader: Prof Ian Cameron (University of Queensland)

Partner Institutions: Curtin Uni. of Technology, Uni. of Melbourne, Monash Uni., Uni. of Sydney

Summary: This project has developed two prototype immersive virtual reality systems in process engineering, and has broken new ground in engaging instructors, students, industrial operators and trainers with a range of process engineering concepts and practices. Using high fidelity digital imaging, full 3D walk-through learning environments have been created for two industrial petro-chemical processing plants. Users are virtually present in these environments that are rich in process engineering information, allowing them to discover, analyse, and understand underlying principles of process engineering designs.

Final report (2009): www.olt.gov.au/resource-development-deployment-educational-uq-2009

Creating a student-centred online learning environment for report writing in the sciences and engineering

Project report authors: Ms Helen Drury, Dr Janet Jones (University of Sydney)

Partner Institution: University of New South Wales

Summary: An online learning environment, the WRiSE site, was developed, implemented and disseminated to assist science and engineering students to improve their writing. For each of seven disciplines in science and two in engineering, the project delivered comprehensive support both for report writing and for understanding content in the discipline. The materials include example reports and exercises into which students and lecturers can interact with audio commentary and text. Evaluation demonstrated that students improved their understanding, confidence and performance in their report writing.

Final report (2009): [www.olt.gov.au/system/files/resources/CG6-](http://www.olt.gov.au/system/files/resources/CG6-30_Sydney_McGee_Final%20Report_Sept09.pdf)

[30_Sydney_McGee_Final%20Report_Sept09.pdf](http://www.usyd.edu.au/learningcentre/wrise/) and www.usyd.edu.au/learningcentre/wrise/

Developing and disseminating team skills capacities using interactive online tools for team formation

Project Leaders: Assoc Prof Lydia Kavanagh, David Neil (University of Queensland)

Partner Institutions: RMIT University, University of Melbourne, University of Western Australia, University of Southern Queensland, University of Technology, Sydney

Summary: This project developed earlier work on the PETS (Proactively Ensuring Team Success) process that takes a multifaceted approach to creating effective, productive and happy student teams and minimising team dysfunction and poor project outcomes. Three resources that encapsulate the PETS process were produced: a printed/online manual, an interactive and customisable website (*Working in Teams*), and an online peer-evaluation tool (*WebPAf*). These include interactive teamwork exercises, downloadable models and examples of team structures, and video and audio packages to complement text and images.

Final report (2011): www.olt.gov.au/system/files/resources/CG7_531_Kavanagh_Report_2011.pdf and <http://ceit.uq.edu.au/content/pets>

Double degrees: research pathways, enabling cross-disciplinarity and enhancing international competitiveness

Project Leader: Dr Bruce Moulton, University of Technology, Sydney

Partners Institutions: Curtin University of Technology, Queensland University of Technology, RMIT University, University of South Australia

Summary: The project addressed concerns about double /combined /dual degrees, where one of the degrees is a Bachelor of Engineering. The project examined the integration of teaching and research across the discipline interfaces; support for dual degree staff and students, and ways to improve research pathways for students to move from undergraduate dual degrees to postgraduate research. The project confirmed concerns about reducing mathematics and deleting of sub-majors in dual degrees, and their limiting aspects for critical thinking and for research pathways.

Final report (2011): www.olt.gov.au/resources?text=double+degrees

Curriculum specification and support systems for engineering education that address revised qualification standards

Project Authors: Dr Elizabeth Godfrey and Prof Robin King (ACED)

Partners: University of Technology, Sydney, CQUniversity, Engineers Australia, University of Melbourne, University of Queensland, University of South Australia

Summary: The four themes addressed recommendations of the 2007-8 review. Cohort studies of student attrition revealed impacts of admission and study pathways, and underpinned recommendations on retention strategies. Units on pedagogy and curriculum design were developed to assist novice and experienced engineering educators develop their teaching skills. Engineers Australia's Stage 1 Competency Standards for future accreditation of formative qualifications were revised in a consultative process. Recommendations on increasing non-school leaver pathways into engineering degrees, and increasing participation in engineering by women and indigenous people, were developed from analysis of practice.

Final report (2011): www.olt.gov.au/resources?text=godfrey+king+curriculum provides access to the report and other materials

Design based curriculum reform within engineering education

Project Authors: Assoc Prof Carl Reidsema (University of New South Wales, now University of Queensland), Rosalie Goldsmith (UNSW, now University of Western Sydney)

Partner Institutions: Queensland University of Technology, University of Melbourne, University of Queensland, University of Sydney

Summary: This project aimed to inform future curriculum change necessary to meet student, academic and employer needs and bridge the disjunction between theory taught at university and engineering practice. The extent to which the current curriculum as practised in the participating universities aligns to a design-centric syllabus such as CDIO was investigated through curriculum analysis, surveys and interviews with staff and students. The critical barriers to change arise from the prevailing epistemological beliefs and pedagogical practices of engineering academics. Three main recommendations for action emerged: advocacy; professionalisation of teaching and learning; and engagement with industry.

Final report (2012): www.olt.gov.au/system/files/resources/PP8_919_Reidsema_Report_2012.pdf

A pro-active approach to addressing student learning diversity in Engineering Mechanics and the subsequent project

Project Leader: Prof Timothy McCarthy (University of Wollongong)

Partner Institutions: Aust. Maritime College, University of Tasmania, Uni. of Technology, Sydney

Summary: This project set out to explore the reasons for high failure rates in first year engineering mechanics courses, and to propose an approach to improving learning outcomes. Student and staff perspectives on the main reasons for failure were inconsistent. Areas for improvement included: tutor preparation and responsiveness; fostering greater awareness amongst staff of the diversity of possible challenges faced by students, and understanding their own perceptions of the 'easiness' of particular topics. An online directory to the existing online learning resources was designed to help students, with positive early findings on its use.

Final report (2011): www.olt.gov.au/system/files/resources/CG8-695_UoW_McCarthy_Final%20Report%202011_0.pdf and <http://learnmechanics.org/>

The engineering design journey: needs, concept and reality

Project Leader: Prof David Shallcross (University of Melbourne)

Partner Institutions: Charles Darwin University, Coogee Energy P/L, Curtin University, University of Queensland, University of Sydney

Summary: Although design is a core theme of any engineering curriculum it is most often taught through unrelated and unintegrated open-ended problems that limit students' appreciation of how design decisions are made and how the engineering disciplines combine to deliver project outcomes. Students today rarely visit construction sites or follow a major engineering project from conception to completion. This project delivered interactive, immersive, virtual reality learning environments for two major engineering projects compiled from high resolution images taken during their construction, supplemented with over 2,100 descriptions. The environments allow students to follow (under their control and at their own pace) the construction through from the initial phase to final operation.

Final report (2011): www.chemeng.unimelb.edu.au/research/eng-vr/ and www.olt.gov.au/system/files/resources/CG9_1006_Shallcross_Report_2011.pdf

Enriching student learning experience through international collaboration in remote laboratories

Project Leader: Prof Andrew Nafalski (University of South Australia)

Partner Institutions: Blekinge Institute of Technology (Sweden), University of Porto (Portugal), University of Technology Sydney

Summary: Graduates will increasingly need skills in online collaboration and communication in international settings. In this project, online collaborative laboratory sessions between Australian students and students from Singapore and Sweden were recorded and analysed. While the students were very enthusiastic about participating, they lack confidence and skills, and understanding of the meaning of being interculturally capable in the context of professional work. This project developed a framework for international online collaboration skills and intercultural capability, and materials for engineering students to use in online collaboration with students from other countries and cultures.

Final report (2011): resource.unisa.edu.au/course/view.php?id=1411 and www.olt.gov.au/system/files/resources/CG8_697_Nafalski_Report_2011.pdf

Gender inclusive curriculum in engineering and construction management

Project Leader: Prof Julie Mills (University of South Australia)

Partner Institutions: Uni. of Melbourne, Uni. of Newcastle, Uni. of Technology Sydney

Summary: This project aims to bring about sustainable change in the teaching and learning of Engineering and Construction Management (EC & M) that will encourage the enrolment of a larger number of women, better accommodate the increasingly diverse student body and improve the retention and success of all students. Benchmarking between the partners demonstrated that E&CM students and faculty exhibited similar understandings and misunderstandings about both the inclusivity of their teaching and learning and the rationale for adopting a more inclusive approach. Outcomes included a monograph and guidelines for the design of inclusive engineering education programs. The latter provide practical teaching strategies and advice on benchmarking the current position of an engineering program and faculty with regard to its gender inclusivity.

Final report and guidelines (2012): www.olt.gov.au/resources?text=mills+gender+inclusive+

Engineering thresholds: an approach to curriculum renewal

Project Leader: Prof Caroline Baillie (University of Western Australia)

Summary: Many disciplines have been found to contain central concepts that are ‘troublesome’ and yet potentially transformative for students. Threshold concept theory forms a basis for the study of the learning of such concepts which can, in turn, lead to improved pedagogy and curriculum design. As part of the development of an entirely new engineering program, educators at UWA have used the threshold concept framework to develop the engineering foundation curriculum, integrated across all engineering disciplines. ‘Knowledge creation’ workshops in three capital cities identified threshold concepts, and findings were disseminated and discussed at workshops in three other cities. Project outcomes include a three-multidimensional inventory of threshold concepts, with suggestions on how students may be helped to overcome the thresholds, and a guide for academics seeking to identify threshold concepts and using them to inform curriculum development at program and unit levels.

Final report, inventory and guidelines: www.ecm.uwa.edu.au/engineeringthresholds

Projects - near completion

DYD: Defining Your Discipline to facilitate curriculum renewal in undergraduate programs

Project Leader: Prof David Dowling (University of Southern Queensland)

Partner Institutions: University of Melbourne, University of Tasmania

Summary: This project has developed an efficient, effective and inclusive consultation process, the DYD process, which may be used by discipline stakeholders to define practitioner-authenticated graduate outcomes for their discipline. The process was trialled with Engineers Australia's Environmental College and produced an outcome that, in effect, provides insight into how the generic Stage 1 Competency may be assessed for the environmental engineering discipline. The graduate requirements may be visualised as a 'Capability Cube' with technical, process and generic capabilities on the three axes, and a identified a set of seven 'contexts' in which environmental engineers work. Learning activities may thus be located within the cube to assist curriculum design. The process is commended for national use in other engineering disciplines.

Recent publication: 'What should we teach?' SEFI 2012 Conference, Thessaloniki. See <http://www.sefi.be/conference-2012/Papers/Papers/015.pdf>

An adaptive e-learning community of practice for mechanics courses in engineering

Project Leader: Assoc Prof Dr Gangadhara Prusty (University of New South Wales)

Partner Institutions: University of Tasmania, University of Technology Sydney, Uni. of Wollongong

Summary: This project explored the use of online e-learning adaptive tutorials to develop a community of practice for academics teaching mechanics in engineering amongst Australian universities. The research drew upon data from academics and students at six partner universities and has delivered a set of adaptive tutorials covering core threshold concepts. These have been incorporated into the partners' courses. The project recommends actions to: retain the focus on developing students' understanding of threshold concepts; create further adaptive tutorials for engineering mechanics; use the results of this study when planning strategies for implementing adaptive tutorials; continue to promote the community of practice; incorporate other e-learning resources for mechanics in engineering and create and implement adaptive tutorial technology for other engineering courses and disciplines.

The final report will be published in 2013. See <http://adaptive-mechanics.eng.unsw.edu.au/>

Exploring intercultural competency in engineering

Project Leader: Thomas Goldfinch (University of Wollongong)

Partner Institutions: Queensland Uni. of Technology, Uni. of Tasmania, Uni. of Technology, Sydney

Summary: The project explored the issues and opportunities surrounding students' intercultural competence in engineering education. Their current levels of competence, judged from assessable work, group observations, and surveys, suggest that improvements are needed. The project team has developed an eBook, *Engineering Across Cultures* covering the key principles. This will support educators to utilise the learning modules also developed by the project. These modules combine student guides, tutor instructions and supporting materials, and cover many aspects of culture that affect engineering practice. The project team also makes five recommendations to ensure the ongoing improvement of engineering education in the area of intercultural competence.

The final report will be published in 2013

Engineering education for social and environmental justice

Project Leader: Prof Caroline Baillie (University of Western Australia)

Partner Institutions: Engineers without Borders (Australia), Murdoch University, Rensselaer Polytechnic Institute (US), University of Sydney

Summary: The project used an interdisciplinary approach to create innovative curriculum changes within engineering education with the aim of generating critical understanding and self-reflexivity about the purpose and impact of engineering practice. The interdisciplinary team, comprising members from engineering, anthropology, history, philosophy, Asian studies and education, collaborated to isolate key transformatory concepts which would enable engineers and others to see engineering as an agent of change and justice for the most socially oppressed and marginalized amongst us. The knowledge mapping process led to material that was included within the engineering curricula of the Australian partner universities. Pedagogical developments were adopted in these and other units across Australia and internationally. Student learning in these units was explored using threshold concept theory and phenomenographic approaches to discover whether the new curricula and pedagogies assisted students to see engineering practice through a lens of social justice.

Recent publications: The International Journal of Engineering, Social Justice and Peace contains three papers from the project: see <http://library.queensu.ca/ojs/index.php/IJESJP/issue/view/381>

Projects in progress

Get set for success: using online self-assessments to motivate first year engineering students to engage in and manage their learning

Project Leader: Assoc Prof Lorelle Burton (University of Southern Queensland)

Partner Institutions: University of Newcastle, University of Queensland, University of New England, University of Technology, Sydney

Summary: This project has the potential to alleviate the current engineering skills shortages in Australia. It aims to improve the retention and progression of engineering students by identifying key factors that impact on successful transition past the first year hurdle. To this end, the team has developed and applied a series of self assessment tests to identify incoming first-year students' attitudinal, motivational and cognitive strengths. Students receive immediate individual feedback from the Phase 1 cognitive tests, to help them focus their study efforts. Phase 2 tests have been designed to help students better understand the skills and knowledge required in engineering. Initial findings from Phase 1 tests show mathematical skills differ most between students in different program types and study modes. The project aims to develop an online career assessment tool, EngCAT enabling prospective students to self-assess their readiness to study engineering and make an informed career choice.

Recent publication: *'Examining First Year Students' Preparedness for Studying Engineering'*, AAEE 2012 <http://www.aaee.com.au/conferences/2012/documents/abstracts/aaee2012-submission-157.pdf>

Curriculum renewal in engineering through theory driven evaluation

Project Leader: Professor Caroline Crosthwaite (University of Queensland)

Partner Institutions: Canterbury University (NZ), Central Queensland University, Charles Darwin University, Curtin University, Deakin University, Queensland University of Technology, RMIT University, Australian National University, University of Melbourne, University of Western Australia, University of South Australia, University of Southern Queensland

Summary: This project is applying the program logic evaluation model to a recent innovation which has been implemented in most of the universities in Australasia, the Engineers Without Borders (EWB) Challenge for first year engineering students. The project partners have implemented this innovation differently and a comparison affords the opportunity to assemble data to provide evidence of which approaches work for which students in which learning environments. Data analysis has used a Realist approach to elucidate how observed outcomes relate to Context and Mechanisms (learning processes). The initial analysis has revealed both intended and unintended consequences of the implementations, and can thus inform processes of rigorous curriculum design to deliver required learning outcomes.

Recent publication: 'Making principled decisions about curriculum development: outcomes of a Realist evaluation across 13 universities'. <http://www.sefi.be/conference-2012/Papers/Papers/061.pdf>

An online writing centre for undergraduate engineering students: a one stop shop

Project Leader: Ms Helen Drury (University of Sydney)

Partner Institutions: University of New South Wales

Abstract: This project addresses ongoing concerns about the discrepancy between engineering students' communication skills and those identified as necessary by government, employers and professional bodies. Many engineering students find writing difficult and consider it a low priority. This attitude is often reinforced within curricula where many lecturers find teaching writing challenging, especially when faced with a diverse student cohort. The on-line writing centre (*iWrite*) aims to make explicit to students their learning outcomes in writing through interactive resources targeting the writing products (the assessment tasks and genres) of the four undergraduate years in engineering. After trial at the participating universities, *iWrite* will be publically available from 2013.

Recent publication: <http://sydney.edu.au/engineering/latte/docs/12-CDIO-MortDruryCalvo.pdf>

Enhancing remote laboratory learning outcomes through lesson plan integration within an LMS framework

Project Leader Professor David Lowe (University of Technology, Sydney)

Partner Institutions: Curtin University

Abstract: Remote laboratories have emerged as valuable educational resources, providing positive educational outcomes. A national laboratory sharing initiative has been established, that although successful, has been limited by a lack of a mechanism for systematically guiding students through laboratory lesson plans that aim to structure their learning. This project will extend preliminary international work on e-learning support by creating lesson templates that capture best practice in laboratory-based learning, and then provide for automated linkages between stages of the lesson plan and the physical laboratory session. The result will be a learning tool that supports structured guidance for students in undertaking remote laboratory experiments.

Funded from 2011

Developing engaging, effective and enlightening practical experiments in geotechnical engineering

Project Leader Associate Professor Mark Jaksa (University of Adelaide)

Partner Institutions Curtin University, Monash University, University of Melbourne, University of Sydney

Abstract: Although the study of soils is fundamental to a civil engineer's education, students, almost universally, find laboratory classes on measuring soil behaviour uninspiring and they often disengage from the unique learning experience that the laboratory provides. This project will develop a new framework for geotechnical lab classes which will use online tools to give students a more engaging and deeper learning experience. The sequence of pre-lab online module; streamlined, more focussed lab component; and post-lab online module will introduce, teach and reinforce learning from the laboratory. The online modules will be media-rich, with computer-assisted learning objects to enhance engagement and learning outcomes.

Funded from 2011

Renewing the sustainable energy curriculum in the 21st century: providing internationally relevant skills for a carbon constrained economy

Project Leader: Associate Professor Chris Lund (Murdoch University)

Partner Institutions: Queensland University of Technology, Australian National University, University of New South Wales, University of South Australia

Abstract: This project will develop sustainable energy curriculum frameworks to meet the needs of Australian and international student graduates and employers, both now and into the near future. The frameworks developed will be based on existing literature and reports related to skills and knowledge required, surveys of graduates, employers and employer representative bodies as well as best practice in other international institutions. The curriculum frameworks will enable the assessment of existing curricula, course content and the range of delivery methods in Australian universities and provide guidance on how they can be made more relevant to graduate and employer skills and knowledge needs. The project will also provide guidance in the development of new sustainable energy courses and programs in this critical area.

Funded from 2011

Assessing final year engineering projects (FYEPs): ensuring learning and teaching standards and AQF8 outcomes

Project Leader: Dr Mohammad Rasul (Central Queensland University)

Partner Institutions: Curtin University, Deakin University, RMIT University, University of Adelaide, University of Tasmania, University of Technology, Sydney

Abstract: Engineering schools in Australia are facing several urgent challenges in implementing FYEPs that meet the AQF8 definition of research outcomes, as well as the expectations of students and prospective employers. This project will develop tools and processes to ensure the required quality outcomes in these major areas: (i) tools to evaluate how well students can apply much of the knowledge gained during their university studies in solving a real life problem (i.e. a good practice guideline for assessment of FYEPs based on the threshold learning outcomes for engineering); (ii) clear definition of educational purposes and expectations of FYEP, particularly in the key area of research skills (AQF8); and (iii) benchmarking of these outcomes based assessment practices with industry partners and with the Engineers Australia Stage 1 Competency Standards for professional engineers.

Funded from 2012

Driving curriculum and technological change to support writing in the engineering disciplines

Project Leader: Assoc Prof Rafael Calvo (University of Sydney)

Partner Institutions: University of New South Wales, University of Western Sydney, University of Wollongong

Abstract: Written communication skills are essential for all Australian graduates to productively participate in their future work and lifelong learning. In engineering, there are ongoing concerns about discrepancies between students' communication skills and those required in the workplace. Whilst some improvements have been made, many engineering academics remain reluctant and resistant to change. The challenges pose a combination of technical, disciplinary and institutional risks. This collaborative project will develop an integration model addressing these risks through the use of online writing tools and communication, to support and sustain the integration of written tasks in undergraduate engineering and drive curriculum innovation. This will support academics' capacity to integrate written tasks and improvement in their students' written communication skills.

Funded from 2012

Other national projects

Australian National Engineering Taskforce (www.anet.org.au)

ANET was formed in 2009 to address the “market failure” of apparently good opportunities in engineering employment not translating into stronger supply of domestic undergraduates into engineering programs. ACED is a foundation member of the consortium, with APESMA, Consult Australia, Engineers Australia and ATSE. Together, ANET covers a wide breadth of engineering interests.

With government funding, ANET has undertaken a scoping study and has commissioned work on engineering occupations in road and rail infrastructure, and on pathways between VET/TAFE qualifications and university degrees. As part of that commission, ACED expanded the pathways study undertaken as one theme of an ALTC project reported earlier in this brochure. See <http://www.anet.org.au/wp-content/uploads/2011/06/ANET-Higher-Ed-pathways1.pdf>.

ANET and its members made substantial submissions to the 2012 Senate Inquiry on the Shortages of Engineering and Related Employment Skills, and since October 2012, ANET has been working with government towards implementation of the main recommendations of the Inquiry. These endorse the need for increased attention to STEM subjects in schools, and the importance of closer and more effective links between the curriculum and industry to improve graduates' employability.

National Resources Sector Workforce Strategy (NRSWS)

The National Resources Workforce Sector Workforce Strategy focuses on the skills shortages in the resources and related construction sectors. To implement one of its recommendations, the Australian Government has funded two projects through the Workforce Innovation Program.

<http://www.innovation.gov.au/Skills/SkillsTrainingAndWorkforceDevelopment/NationalResourcesSectorWorkforceStrategy/Pages/default.aspx>

Enhancing industry engagement in engineering degree programs

Project Leader: Professor Robin King (ACED)

Partner Institutions: Australian Maritime College, Curtin University of Technology, Deakin University, James Cook University, Melbourne University, Queensland University of Technology, RMIT University, Swinburne University of Technology, University of South Australia, University of Southern Queensland, University of Technology, Sydney, University of Western Australia, Engineers Australia

Summary: This two year project addresses industry engagement within engineering degrees. Whilst all accredited degrees require students to gain some exposure to engineering practice, much of this takes place later in the curriculum, and it is of variable quality. This project provides a more systematic approach to increase and improve students' exposure to industry and engineering practice in order to enhance learning, increase students' motivation to study and retention rates, and enhance graduates' employability. The project commenced in mid-2012 with two themes:

- To develop, trial and evaluate revised guidelines for more effective exposure of undergraduate students to industry. A draft set of guidelines will be promulgated in mid-2013 after extensive consultation with employers and universities.
- To develop and trial a number of industry-linked projects in engineering degrees. These will be introduced into technically intensive areas of the second and third years of the engineering curriculum to demonstrate industry application of difficult concepts.

The project is supported by industry peak bodies and engineering and construction companies in the resources sector.

Minerals Industry National Associate Degrees (MINAD)

Project Leader: Dr Gavin Lind (Minerals Tertiary Education Council)

Project Participants (in mining engineering): University of Southern Queensland, University of South Australia

Summary: During 2011 the (MTEC) was awarded funding to develop and disseminate an Associate Degree program model for the minerals sector. A consortium of four VET and higher education institutions has been formed to develop and deliver two new Associate Degree programs in the disciplines of mining engineering and minerals geosciences. The consultative DYD process (described above) has been used to define the graduate outcomes for the new paraprofessional roles that will share industry workload with traditional four-year graduates.

To be completed with weblink

National Engineering Laboratory Survey

Project Leader: Professor David Lowe (University of Technology, Sydney)

Partner Institutions: Curtin University of Technology, Queensland University of Technology, RMIT University, University of South Australia

Laboratory experiences are a core component of engineering degree programs. Laboratory learning is usually expensive in terms of acquisition cost and maintenance, and access is often misaligned with students' the lifestyles. There is almost no sharing of laboratory facilities or design expertise between institutions or across educational sectors. During 2009-10, with funding from the Department of Education, Employment and Workplace Relations (DEEWR) the partners led a survey of the delivery of practical laboratory education at all 34 Australian universities offering undergraduate engineering programs. The survey elucidated responses on pedagogical and logistical factors in conventional laboratory learning, and raised the potential for greater exploitation of remote laboratories, some of which has been followed up.

Report: http://www.labshare.edu.au/media/img/labshare_report_panel_website.pdf

Energy Efficiency (Higher Education) Advisory Group

Convenor: Luiz Ribiero (Department of Resources, Energy and Transport)

Invited representatives from: ACED, Adelaide University, Australian National University, Curtin University of Technology, University of New South Wales, RMIT University, Queensland University of Technology Sydney, University of Southern Queensland, Wollongong University

Summary: The Department of Resources, Energy and Tourism (RET) seeks to drive improvements in Australia's industrial energy efficiency. One way it does this is by addressing information and skills barriers which prevent the greater uptake of energy efficiency projects. From 2010, the Department of Resources, Energy and Transport (RET) established the Energy Efficiency (Higher Education) Advisory Group (EEAG) to provide guidance on increasing engineering undergraduates' knowledge and skills in energy efficiency. The EEAG has provided advice on commissioned projects and future directions. Two project reports were published in 2012. These identify graduate attributes, learning outcomes and learning pathways needed by engineering students and graduates in relation to energy efficiency. This work was informed by Engineers Australia's Stage 1 and Stage 2 Competency Standards for professional engineers, and by input from Engineers Australia's Colleges (covering the main branches of engineering), and the mining and metallurgy engineering sectors. Interdisciplinary and discipline-specific (specialist) attributes have been identified. In early 2013 via a tender process, RET will commission a consortium of universities to develop and disseminate high quality education resources allowing lecturers to easily integrate energy efficiency content into their existing courses and units.

Reports may be downloaded from: <http://eex.gov.au/business-support/energy-efficiency-skills-and-training/engineering-skills-research-reports-and-information/>
