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AUSTRALIAN COUNCIL
OF ENGINEERING DEANS

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To: House of Representatives Standing Committee on Education & Employment

ACED Response to the Inquiry on School to Work Transition

I write on behalf of the Australian Council of Engineering Deans (ACED), the incorporated association of leaders of the 35 Australian universities that provide externally accredited degree programs, research and consultancy services in engineering.

ACED welcomes this opportunity to contribute to your Inquiry. The ACED member faculties and schools play a central role in transitioning school leavers to positions in the engineering workforce. Some of our graduates progress to work in other areas, particularly in finance, where the generic quantitative problem solving skills they gained as engineering students are highly valued.

In this submission, we provide a brief background on the importance of engineering in Australia's future and highlight our key points. We then provide more extended commentary on the three questions posed in the Terms of Reference. To back up our observations, we have appended the recently published ACED Factsheet on higher education and research in the Australian Higher Education sector.

Background

Australia produces fewer engineers and technologists through post-school education and training than are likely to be required to meet Australia's future needs for technologically based and innovative physical and information based products, systems, infrastructure and services. This is evident from continuing need for migrant engineers to fill vacant positions, and the many predictions about the increased STEM content of future jobs[1].

There therefore need to be:

- greater encouragement for more school leavers (especially women) to progress to STEM-based careers via the tertiary education system;
- good support for engineering students during their tertiary studies to gain the range of skills needed for their future employment.

[1] The PWC report *Future-proofing Australia's workforce by growing skills in science, technology, engineering and maths* (STEM), April 2015, identified engineering professionals amongst the jobs least likely to be automated, and needing the largest growth rate (11.7% p.a.) to meet predicted demand by 2035.

The 35 ACED member universities currently produce almost all of the 10–11,000 domestic graduates of coursework programs per year, the majority with 4-year Bachelor of Engineering (Honours) degrees[2]. Most, but by no means all, of these graduates commenced their engineering studies on the basis of their secondary school qualification. Their university programs prepare them for entry to practice in the engineering workforce as professional engineers. These and other entry-level qualifications are accredited by the membership-based professional body, Engineers Australia (EA). Preparation of engineering graduates for the world of work is a key element of all accredited engineering qualifications, and is addressed further in our response to the third question.

School-leaver entry to ACED members' advanced diplomas, associate degrees, bachelor and master degrees (AQF Levels 6 – 9) requires adequate academic preparation, particularly in mathematics and science, and ideally, some understanding and motivation towards engineering. Enhancing the attractiveness of formal school curriculum in STEM subjects to increase tertiary study enrolments and employment pathways in engineering (including in relevant trades and technician occupations) is addressed further in our response to the first and second of the terms of reference.

The key outcomes from this Inquiry that ACED would seek are:

1. Recognition that Australia needs a higher proportion of its school leavers to progress to STEM careers, particularly in engineering and computing.
2. Support for initiatives to encourage higher levels of participation, especially by women, in senior school intermediate and advanced mathematics and physical sciences.
3. Support to commission ACARA to produce senior secondary curriculum in *Design and Technology*, and to encourage more senior school students to study in this subject area.
4. Maintenance of Commonwealth funding for foundation courses, bridging programs, and associate degrees that can provide pathways for students with aptitude for engineering, but who do not have the normal pre-requisites for direct entry to degree studies.
5. Support for exploring suitable incentives for employers of engineering students to take more students for industry experience and subsequent graduate training.

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1. Measurements of gain in school and how this contributes to supporting students to prepare for post-school education and training

We take the primary "measurement of gain" to be the secondary school certificate. Secondary students' attainment is measured primarily by the school leaver examination and certification processes operated by the Australian states and territories. Such subject-based assessment is consistent with the ACARA national curriculum. The aggregation of subject assessments across subjects, conversion into ATAR or OP rankings, and application of bonus points in university admission processes do, however, raise some concerns in the context of this Inquiry.

Our principal concern is that some school students choose senior subjects to maximise their ATAR or OP ranks, rather than to best prepare them for a future career area, or to match their interests and

[2] *ACED Factsheet*, April 2017, appended to this submission

abilities. This practice tends to reduce the numbers of school leavers choosing university STEM programs in areas where Australia needs more graduates.

Good levels of attainment in school mathematics and science subjects are reasonable predictors of good performance in a subsequent engineering degree. These subjects are invariably pre-requisites (or assumed knowledge) for students admitted to ACED members' degrees. However, success in engineering also requires good communication and teamwork skills and a creative mindset. These important generic areas are not tested explicitly in most secondary school subject assessments.

Nevertheless, ACED members are prepared to admit into engineering programs school leavers who do not have very strong mathematics and science in their secondary school certificates, and will provide appropriate subject support. Aptitude tests have been used in some universities. Bridging courses, foundation and pathway programs (including associate degrees) are available for such students to catch up and ultimately graduate from degree programs. Such approaches will continue to be needed if Australia is to raise the participation of school leavers in STEM study and subsequent careers, and particularly in engineering.

Two matters are limiting the flow of school leavers towards career paths in engineering:

(i) Participation rates in school advanced mathematics and in physical sciences are declining[3], especially by women. Reversing these trends requires broad and collaborative actions involving professional STEM communities, the school education systems and teacher education processes. Many initiatives in this area are in progress (see the response to Question 2), including by ACED[4] and its members; they need to be sustained and enhanced until the trends are firmly reversed;

(ii) Australia has been relatively slow to include modern design, technology and engineering material in the school curriculum. The national curriculum (ACARA) does not include senior curriculum (Years 11-12) in *Design and Technology* to build on the excellent F-10 curriculum that is currently being implemented. While most States and Territories do have good *Engineering Studies* subjects available, these are taken by relatively few students. ACED would urge the COAG Education Ministers Council charge ACARA with developing senior curriculum in *Design and Technology*. This would have strong content in topics such as engineering materials and systems thinking as well in creativity and computing techniques that are important for future employment in many areas. This would extend the scope and visibility of STEM in the senior curriculum, and potentially, would enhance school leavers' post-school options and employability.

[3] Engineers Australia (2017), *Engineers Make Things Happen: the need for an engineering pipeline strategy*.. https://www.engineersaustralia.org.au/resource-centre/resource/engineers-make-things-happen-report

[4] ACED Position Statement, *Increasing the Participation of Women in Engineering Education*, March 2017. https://www.engineersaustralia.org.au/sites/default/files/resource-files/2017-04/POSITION%20STATEMENT%20No%202A%20Promoting%20women%20in%20engineering%20education.pdf

2. Opportunities to better inform and support students in relation to post-school education and training, including use of employment outcomes of students who undertake school-based vocational education or post-school tertiary pathways

ACED recognises the importance of career advisors in schools, and ACED members and other bodies associated with engineering provide them with relevant information. Similarly, work experience programs undertaken in-school can be very useful to enhance students' knowledge of prospective jobs or careers. Many engineering employers offer some school students a limited "taste" of engineering. Nevertheless, what engineers actually do and how they do it is very remote from most school students.

School students' casual employment and/or in volunteering can be of great value in building knowledge of work, confidence in working with others, responsibility and independence. However, the nature of engineering work does not lend itself to providing such opportunities to school students.

ACED members contribute strongly to the many local, state and national initiatives that bring aspects of engineering to the awareness of school students – and especially women –through in-curriculum and extra-curriculum activities. The strong leadership from the Australian Office of the Chief Scientist for coordinating information about these initiatives should be acknowledged, and should be maintained.

Many students do not commence engineering degrees directly from school. Post-school tertiary pathways are recognised in higher education admission processes. Nationally in 2015, about 7 per cent of admissions into bachelor's degrees in engineering were on the basis of TAFE studies and 22.5 per cent on the basis of prior higher education studies.

Employment experience of immediate school leavers is not recognised for the purpose of granting credit on admission to a higher education qualification in engineering. However, prior engineering study, and adequately reported relevant experience, are routinely recognised for full or partial credit against university providers' program requirements for industry experience (see below).

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3. Other related matters that the Committee considers relevant.

Engineering degrees are designed to facilitate their graduates' transition into the workplace. An engineering graduate does not however gain full status as an independent engineering practitioner until she/he has gained suitable supervised experience in the workplace. Typically, an engineering graduate will reach this status (as a Registered Engineer or Chartered Engineer) after 3 – 5 years of employment. Many engineering companies support this process through graduate traineeship and professional development schemes.

The pathway to effective employment starts within the degree program. For many decades, the EA accredited qualifications in engineering have required students to gain "*exposure to professional practice*" during their programs. For the professional engineering qualifications, this requirement is "*the equivalent of 12-weeks full-time work in a professional engineering environment*", and most universities require their students to gain this all or most of this experience through an industry

placement. Students have to report on what they did, and what they learned before they can graduate. Most graduates rate their placement to be an important part of their learning experience, and many will find subsequent employment with the placement provider.

Providing all students with good industry experience is a major challenge to ACED members, as well as to industry. Over the last two decades changes in the nature of Australia's engineering industries (such as the privatisation of previously government-owned infrastructure, and globalisation of many major engineering companies) as well as the increasing number of domestic and international engineering students, have made it harder for education providers and students to acquire suitable placements. Industries do not gain directly from having students on placements. As most of these industry placements are additional to the academic curriculum, but are a "milestone" that students have to pass before they can graduate, they do not attract the CSP contribution or student fee to the education provider. Their management is therefore an unfunded load on the ACED member, and is not "core business" for engineering companies.

ACED, in collaboration with Engineers Australia and other professional and industry bodies, has promulgated the importance of maintaining industry focus in engineering qualifications[5]. ACED member institutions are working constructively with employers of engineers to ensure contemporary practice is included in the curriculum, and that industry experience placements are of good quality. The EA accreditation guidelines for exposure to practice are currently under review and renewal.

Alongside the above approach, a small number of engineering degree programs include longer industry experience, e.g. one or two full-time semesters, thereby extending the duration of the overall study period, and in some cases leading to a supplementary award, such as a "*Diploma in Professional Engineering Practice*". In general, these degree patterns have very strong employment outcomes for their graduates. They could not however, be operated for all engineering students.

While ACED strongly supports (and commends to other educational disciplines) these models of industry and employer engagement for improving the transition of graduates into the workplace, continuing to operate them alongside decreasing Commonwealth funding and increasing student contributions presents obvious financial and operational challenges to the educational providers and industry partners. For engineering companies employed on large government contracts, there could be a case for requiring tendering organisations to make specific provision for industrial training. Alternatively, engineering employers could benefit from tax reductions where they undertake industrial training. Such provisions could apply to both student experience and the initial period of post-graduation training.

Regarding supporting students with disability, ACED member faculties and schools adhere to their universities' non-discrimination access and student support policies.

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[5] ACED Position Statement, *Promoting engagement between industry and universities for improving engineering graduate capabilities and accelerating innovation*, Dec 2016. https://www.engineersaustralia.org.au/sites/default/files/content-files/ACED/position_statement_no_1.pdf

Conclusion

ACED is mindful of the many efforts that the engineering business and professional communities have put into supporting schools and post-school educational institutions to improve the transition of young people from school to work. Their continued collaboration will continue to be vital to ensure best possible outcomes.

ACED's desire to see the tertiary engineering education sector expand significantly goes beyond ACED's own interests and those of its members. Ultimately our prosperity and well-being as a nation will depend on it.

ACED will be pleased to provide further information as required, or attend an Inquiry hearing. .

Yours sincerely

Professor John L Wilson
ACED President

Appendix: ACED Factsheet, April 2017

Australian Council of Engineering Deans Inc.

Australian Engineering Education Factsheet — April 2017

An update on the status and trends in Australia's higher education system for engineering

Introduction

Australia has a mature university-based engineering education system that produces graduates qualified to commence supervised practice, and advance their knowledge and skills. The system provides higher degree research training and undertakes research in engineering science and practice. This Factsheet provides a national snapshot of the system, using the most recent national data.

System Size

Currently 35 public universities, several TAFE Institutes, and a small number of private colleges are providing higher education (HEd) qualifications in engineering[6] at levels 6-10 of the *Australian Qualifications Framework* (AQF).

Overall, in 2015, engineering had 106,210 enrolled students, some 7.5% of total national higher education enrolments. International students constitute 35.9% of the enrolments in engineering qualifications. The total 'engineering load' in 2015 was 71,201 equivalent full-time students, taking into account students' study patterns.

In 2015, there were more than 4,200 full-time equivalent academic staff (18% women) in the university engineering faculties and schools. Approximately 1,800 of the staff were in 'research-only' positions.

Coursework Programs

Engineering graduate numbers from each of the principal award categories, for 2005, 2010 and 2015, were:

award level	2005		2010		2015	
	Dom	Int	Dom	Int	Dom	Int
Masters	635	2,299	1,024	2,660	1,543	3,205
Other PG	363	195	672	279	848	160
Bach (4-yr)	5,680	2,396	5,775	2,571	7,219	3,239
Bach (3-yr)			452	395	524	251
Ass Deg/AD	141	49	320	97	570	129
TOTALS	**6,819**	**4,939**	**8,243**	**6,002**	**10,704**	**6,984**

Commencing student numbers for the same years were:

award level	2005		2010		2015	
	Dom	Int	Dom	Int	Dom	Int
Masters	876	2,579	1,541	2,770	2,091	5,473
Other PG	1,103	260	1,132	315	844	177
Bachelors	9,916	3,782	12,541	6,626	14,896	6,510
Ass Deg/AD	419	149	1,357	157	1,178	196
TOTALS	**12,314**	**6,770**	**16,571**	**9,868**	**19,009**	**12,356**

These data show:

- growth in domestic commencing enrolments in Bachelor degrees that is in line with the growth of total domestic commencing enrolments;
- expansionary growth in international enrolments in Master (ME) degrees, particularly into new, accredited, 'entry-to-practice' programs (see below).

The average **graduation rate** for students commencing an engineering Bachelor degree is approximately 65%. Graduation may be from a different institution than that of commencement, and may be up to a decade later, allowing for part-time study and study breaks.

The **basis of admission** of domestic students into Bachelor degrees has diversified over time. As the total number of commencements has increased, relatively fewer enter on the basis of schooling, and more have prior HEd studies:

Basis of Admission	2004	2011	2015
secondary school	71.1%	64.9%	58.3%
VET/TAFE	6.8%	7.4%	6.5%
higher education	14.4%	18.5%	22.5%
other	7.7%	9.0%	12.7%

External accreditation by the professional body, *Engineers Australia*, is valued by providers. The accreditation standards are set by the practicing profession, and are benchmarked to international agreements[7].

Since 1980, the standard accredited *professional engineering* qualification has been the 4-year degree, often awarded with a class of Honours. Since 2014, providers have made these degrees compliant with the requirements of the AQF level 8, Bachelor (Honours) degree specification.

Since the mid-2000's, an increasing number of providers have offered ME degrees that are accredited for entry-to-practice at the level of professional engineer. Two universities have ceased offering BE(Hons) degrees. Most of their students commence university study by taking the engineering major in a Bachelor of Science degree.

Three-year Bachelors degrees and 2-year Associate Degrees (and Advanced Diplomas) may be accredited at the qualification levels for the occupations of *engineering technologist* and *engineering associate*, respectively.

Bachelor degree commencing numbers for engineering therefore underestimate the numbers heading for an engineering qualification. The Master graduate numbers combine those from entry-to-practice degrees and from Masters degrees designed for qualified engineers.

[6] The data are for the field of education *Engineering and Related Technologies*. This includes civil aviation and surveying, areas that have small student enrolments.

[7] The Washington, Sydney and Dublin Accords, of the International Engineering Alliance. http://www.ieagreements.org/

The participation of women in engineering coursework programs has not increased substantially over the decade, indicated by these figures for commencing students:

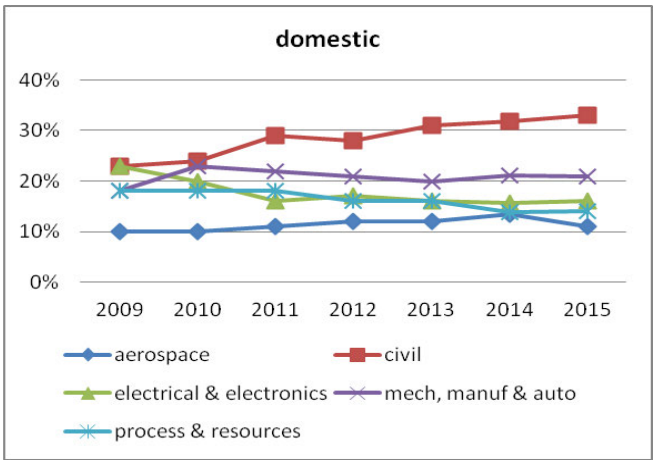
	2005		2010		2015	
	Dom	Int	Dom	Int	Dom	Int
Masters	17.0%	16.9%	16.7%	20.0%	18.7%	20.3%
Bachelors	12.7%	17.7%	14.4%	15.1%	15.2%	21.0%

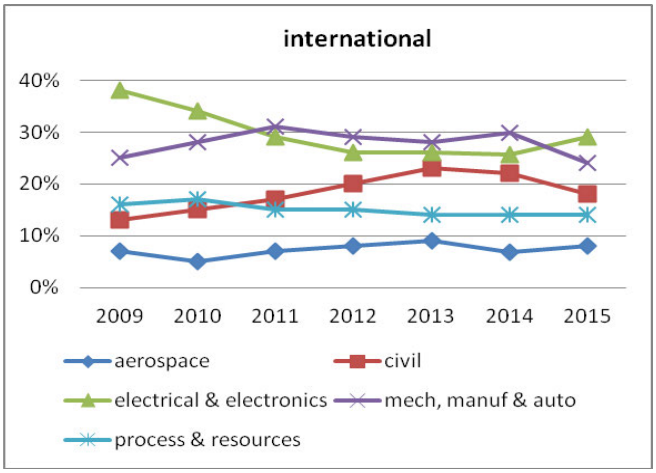
Women constitute slightly higher proportions of the graduate cohorts, as a result of their stronger academic performance.

The numbers of Indigenous students and graduates in engineering is very small. In 2015 there were only 49 Indigenous graduates recorded as having graduated from engineering with any higher education qualification.

Engineering has distinct areas of practice that are reflected by strongly differentiated degree programs. New branches, such as environmental engineering and biomedical engineering, are created from time to time, reflecting industrial, economic, technological and social needs.

The following charts show graduations in five established branches, aggregated over all undergraduate awards, for 2009-15. The relative proportions may reflect perceptions of Australian, regional and global demand for engineers.





Graduate employment rates and starting salaries have been consistently higher than those of graduates of other STEM-based areas for many years.

The 2015 Bachelor degree graduates in engineering ranked 4th on median starting salary at $62,000. Women earned $3,000 more than men. At 80%, the engineers' average full-time employment rate was 20% higher than the average for graduates from all fields of education.

The median salary for engineering Master degree graduates completing in 2015 was $100,000. This figure is probably dominated by mature individuals already employed in engineering.

Higher Degrees by Research (HDR)

The engineering faculties and schools have nearly doubled their production of HDR graduates since 2005, mostly from increasing numbers of international students:

award	2005		2010		2015	
	Dom	Int	Dom	Int	Dom	Int
PhD	452	185	474	318	603	656
Master	133	75	99	97	108	121
TOTALS	**585**	**260**	**573**	**415**	**711**	**777**

The 2015 engineering total represents 14.8% of total HDR graduations. The strong internationalisation of Australia's engineering research effort is reflected by continuing increases in higher degree commencements.

The proportion of women in both domestic and international cohorts has been around 25% for several years. This will potentially increase the proportion and numbers of women in the academic and research engineering workforce.

Research

The faculties and schools contribute to Australia's research outcomes. For engineering, external research income in four categories for 2013 and three research outcome metrics are shown in the following table. The share of the national total for each measure is also provided.

Research income (2013) / Research metric (HERDC data)	Engin'ing	% of nat total
Cat 1 Australian competitive grants	$ 153.8 M	8.9%
Cat 2 Other public sector income	$ 73.6 M	8.6%
Cat 3 Industry & other research inc.	$ 106.0 M	13.6%
Cat 4 CRC research income	$ 34.5 M	33.0%
Research commercialisation inc. (2013)	$ 4.9 M	8.4%
Patents granted (2011-13)	293.3	31.3%
Research esteem factors (2011-13)	312.9	6.3%

The importance of CRC and industry funding for engineering research is evident. Engineering produced nearly one third of the national patents granted.

The high quality of the engineering research can be deduced from national Excellence in Research Australia (ERA) data. In the 2015 ERA report, 27 universities had at least one area of engineering rated at level 4 (performance above world standing) or higher. Six institutions had five or more engineering areas rated at level 5. This level was attained in materials engineering by 14 institutions, and by 10 institutions in electrical & electronic engineering.

Australian Council of Engineering Deans Inc.

The membership of the Inc. (ACED) is a senior academic representative of each of the 35 Australian universities that provide professional engineering degrees accredited by Engineers Australia. ACED's mission is to promote and advance engineering education, research and scholarship on behalf of the Australian higher education system.

More data and trends on engineering enrolments and staffing are on the ACED website: www.aced.edu.au

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