

Increasing the Participation of Women in Engineering Education

Improving engineering education is critical to recruiting and retaining more women in the engineering profession

The Vision

Engineered infrastructure, services, products and systems serve everyone, yet Australia's engineering profession does not reflect the country's gender balance. Higher numbers of women in engineering study and then practice will enhance the profession's capabilities to tackle future demands. The education of all engineers will benefit from being more inclusive of women and their perspectives.

Numbers and Issues

While engineering has expanded exponentially in technological scope and societal impact, the engineering profession in Australia has not achieved gender equality.

- In 2011, women were 14% of the 257,382 **engineering graduates** working in Australia¹. Many of these women were educated overseas or came to Australia to study.
- In 2015, women were 16% of the 20,544 **domestic students commencing study** in university programs (all award levels) in Engineering and Related Technologies²
- Over 2000 to 2015, the proportion of women in the **domestic undergraduate commencing** cohort (mostly in 4-year bachelor degrees) averaged 14.1%, with a slight increase to 15.2% in 2015. (The total cohort increased by 50% to 15,000 over this period.)
- Women's **participation in engineering study** more than tripled during 1983 to 2000, from 4.6% to 14.7%.

The participation of women in engineering differs amongst its branches. In 2015, women were 14.4% of the Australian **bachelors degree graduates in engineering**³, and about:

- half of the biomedical engineers;
- 25% of the mining and chemical engineers combined;
- 15.4% of the civil engineers (the largest branch);
- less than 10% of the graduates in aerospace, electrical and electronic, and mechanical and related branches.

These data indicate women's preferences for branches of engineering that focus on people and communities.

Increasing the participation of women in engineering (and STEM) degrees in Australia and similar countries has been a priority issue for three decades. It has been addressed by many university-based and other outreach programs to prospective school students.

¹ *Australia's STEM Workforce*, Office of the Chief Scientist, Australian Government, 2016

² Department of Education and Training, Australian Government. <https://www.education.gov.au/ucube-higher-education-data-cube>. The field of education 'Engineering & Related Technologies' includes aviation and spatial sciences and technologies.

³ Data compiled by ACED, see <http://www.engineersaustralia.org.au/aced/resources>

Perceptions that women have lower abilities and intrinsic interests in STEM have been countered by evidence⁴. Girls' lower participation rates at school and beyond are attributed to their lower levels of confidence in subjects such as mathematics. Furthermore they are more influenced (than boys) in their study decisions by their perceptions of identity and ability, and aspirations.

Women do (on average) graduate from engineering at higher rates and gain higher (median) starting salaries than their male peers. Yet women (on average) progress in engineering careers at lower rates, largely due to career breaks; many leave the profession early because of its non-inclusive work culture⁵. University employment offers engineering women better prospects. They occupy more than 20% of research-only positions in engineering, the pathway to an academic career. As yet, women hold only a small proportion of higher level academic positions.

Challenges

ACED and its members recognise that increasing the numbers of Australian women in engineering study needs to be tackled urgently. Three areas stand out for action.

Career preferences: clearly, women are differentially attracted to biomedical engineering and environmental engineering, but these, and similar emerging branches offer relatively fewer career opportunities. The work (and study) cultures of aerospace, electrical, electronics, mechanical and industrial engineering are evidently strongly masculine.

Pathways into engineering study: the conventional post-school path into engineering study is biased against women and compounded by other trends. For example, the proportion of girls taking the Year 12 Advanced Mathematics subject has declined over the past decade, alongside decline of total enrolments in that subject⁶. Making Advanced Mathematics (and Physics) prerequisite subjects for engineering limit the pool of women who might even consider taking engineering at university.

Curriculum inclusiveness: the interests of women (and other minority groups) must be incorporated in the design and implementation of the university engineering curriculum. This is likely to be achieved through curriculum that emphasises the social contexts of engineering practice, and is delivered by a gender-balanced academic staff team.

⁴ *Busting Myths about Women in STEM*, Office of the Chief Scientist, Occasional Paper 13, Australian Government, Nov 2016

⁵ J E Mills, et al, *Challenging Knowledge, Sex and Power: gender work and engineering*. Routledge 2014

⁶ F Barrington & M Evans (2014), Aust. Math. Sciences Institute. <http://amsi.org.au/publications/participation-year-12-mathematics-2004-2013/>

Recommendations for action

These issues and challenges were explored in an ACED-led project⁷ during 2008-11. ACED endorsed the recommendations, but despite much activity, the challenges persist. The following recommendations update ACED's position.

Recruiting and supporting women students

To double the current commencing student participation rate to 30% will not be possible without effort. Most of the university-based *Women in Engineering (WiE)* programs were disbanded during the last decade. Arguably, they – or their functions – need to be reinstated strongly. They:

- engaged enrolled women students in outreach, mentoring, peer tutoring and leadership roles, thereby developing their confidence and capabilities for subsequent participation in the workforce;
- contributed, often very significantly, to student recruitment initiatives;
- attracted diverse stakeholders who bring valuable resources to universities;
- explicitly demonstrated how the presence and contribution of women at all levels can be valued, sending clear messages to students and staff about faculty commitment to equality of opportunity.

ACED recognises that reinstated *WiE* programs will need to incorporate current thinking on gender equity. Female students are likely to have and perceive diverse needs. However, initiatives may benefit all students and contribute to faculty collegiality and performance. A mainstreamed *WiE* program would address the earlier points, and:

- have responsibility for recruiting and supporting women students, against agreed metrics;
- contribute to marketing and other publications to frame engineering as a field that requires a broad range of skills, has strong social and human dimensions, and connects to many other disciplines and professions;
- provide students and academics with diversity training that explicitly addresses sexual harassment and gender-bias that can impede students' learning;
- contribute to workshops on learning styles, and to ensuring that faculty and school policies, processes, and documents are gender-neutral, and inclusive;
- provide leadership in the design and implementation of gender-neutral and inclusive curricula, and capacity to provide gender equity critique and analysis in reviews of programs and course units.

In addition, ACED supports its members to consider widening admission criteria to attract women (and others) with the potential to succeed in engineering, and ensure suitable curriculum support.

Recruiting and supporting women academic staff

The importance of having more female role models amongst the engineering staff cannot be overstated, and ACED endorses relevant measures including:

- proactive recruitment of women academics;
- ensuring women staff have adequate opportunities for being mentored for their career development;
- valuing contributions to gender inclusivity and equity in academic promotion and appointments;
- utilising the skills of female professional engineers on a career break for short term academic duties.

ACED strongly supports its members to engage with the SAGE (*AthenaSWAN*) initiative⁸, introduced recently into most universities to support women in STEM disciplines.

Improving the curriculum

The engineering curriculum is never static, under pressure from new science, new technological tools and the demands of employers for graduates with 'job ready skills'. ACED's member universities will continue to provide a wide range of accredited engineering degree programs that reflect their institution's philosophy, regional needs, and student demography. Such variety of curricula is a strength of the system provided by ACED's member universities.

The low participation of women in engineering study exposes a systemic weakness in curriculum with over-emphasis on fundamental science and technological application. Rather, the curriculum needs to reflect these and the social contexts of engineering application. Greater emphasis on human-centred design and sustainable development will reflect contemporary needs for all engineers, and attract more women.

ACED supports its members to develop coursework programs and research in academic cultures that respond to these demands, and that use a wider palate of pedagogies, assessments, physical spaces and resources, including engagement with industry. . by increasing the inclusivity of their learning environments.

The way ahead

A major increase in the proportion of women in engineering study will not be easily won. Within the engineering faculties and schools, dominant cultures prevail and their members can be blind to their own assumptions. Engineering, often and accurately stereotyped as a masculine profession, conducted in a masculine organisational environment, has a long way to go.

By taking the actions proposed in this paper, ACED and its members will make a positive difference to the engineering profession, for the benefit of society at large.

⁸ Science in Australia Gender Equity (SAGE) project. <https://www.sciencegenderequity.org.au/science-in-australia-gender-equity-sage-pilot-2015/>

⁷ E Godfrey & R King (2011) *Curriculum specification and support for engineering education: understanding attrition, academic support, revised competencies, pathways and access*. <http://www.olt.gov.au/project-curriculum-specification-support-uts-2008>

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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.

Contact: Prof Doug Hargreaves AM, ACED Executive Officer.
d.hargreaves@qut.edu.au