INNOVATION AND CREATIVITY; WORKFORCE FOR THE NEW ECONOMY

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Introduction

Engineers Australia is the peak body responsible for accreditation of engineering education in Australia, responsible for setting standards for engineering practice in Australia and is the link between the engineering profession in Australia and globally. Engineers Australia is not involved in industrial matters or the business interests of engineering enterprises, whether large or small.

In the future economy, Engineers Australia believes occupations requiring technical expertise will increase. This conclusion has been supported by reputable Australian and overseas research which suggests that not only will the numbers employed in technical occupations increase substantially, the rewards available in these occupations will also increase.

We believe that the critical role of engineers in these analyses is often overlooked. Engineers Australia agrees that Australia needs to reverse the decline in technical foundation studies in science and mathematics at school. This foundation is critical to building Australia's scientific research capability but it is also critical to building our engineering capability. We argue that new ideas are essential to broaden our economy and for Australia to take advantage of the digital revolution. However, for new ideas to become economic realities they must be developed from laboratory into prototypes and from prototypes into commercial products suitable for the market. These are the functions carried out by engineers who in Australia work in almost every industry in the economy. Unless Australia fully develops its engineering capacity, we believe innovation will stall and Australia risks huge opportunities.

Accreditation of engineering courses

Since 1965, Engineers Australia has undertaken an accreditation program for university programs and courses in engineering. Every engineering school in Australia is reviewed on a five yearly cycle and accreditation of each degree program is confirmed or withheld, as appropriate, and development advice is offered. Australian engineering degrees are internationally benchmarked through the three international accords over-sighted by the International Engineering Alliance. The Washington accord covers professional engineers (at least a four year, full time bachelor degree in engineering); the Sydney Accord covers engineering technologists (at least a three year, full time degree in engineering) and the Dublin Accord covers associate engineers (at least a two year, full time associate degree or an advanced diploma in engineering). The three Accords recognise the substantial equivalence of accreditation systems and accredited programs across international boundaries. The link to International Engineering Alliance (IEA) can be found at *www.ieagreements.org*.

Engineering program standards are outcomes-based and applied at the graduation level to all applicable programs throughout Australia. They apply regardless of the entry standards to each program and changes to entry standards will not be reflected in program accreditation outcomes and the resulting graduate competencies.

The impact of entry standards will be most noticeable in the drop-out rates of students or transfers into other programs. Addressing these factors is the responsibility of education providers. Australian Tertiary Admission Rank (ATAR) scores are one indicator of likely student performance and broad experience has shown that they are an incomplete indicator, although they have certainly been useful over a long period of time. The renewed focus on admissions standards is timely given the rapid changes occurring globally in education and Engineers Australia is confident that the outcomes-based accreditation process that it managed will continue to ensure continued appropriate standards amongst graduates.

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Accreditation ensures academic institutions consistently meet national and international benchmarks, and engineering graduates of an accredited program are assured membership with Engineers Australia at the relevant career grade, and enjoy reciprocal privileges by equivalent professional bodies overseas. Countries such as the USA, United Kingdom, Hong Kong (SAR), New Zealand, Canada, South Africa and others that are co-signatories to international agreements on joint recognition offer international recognition.

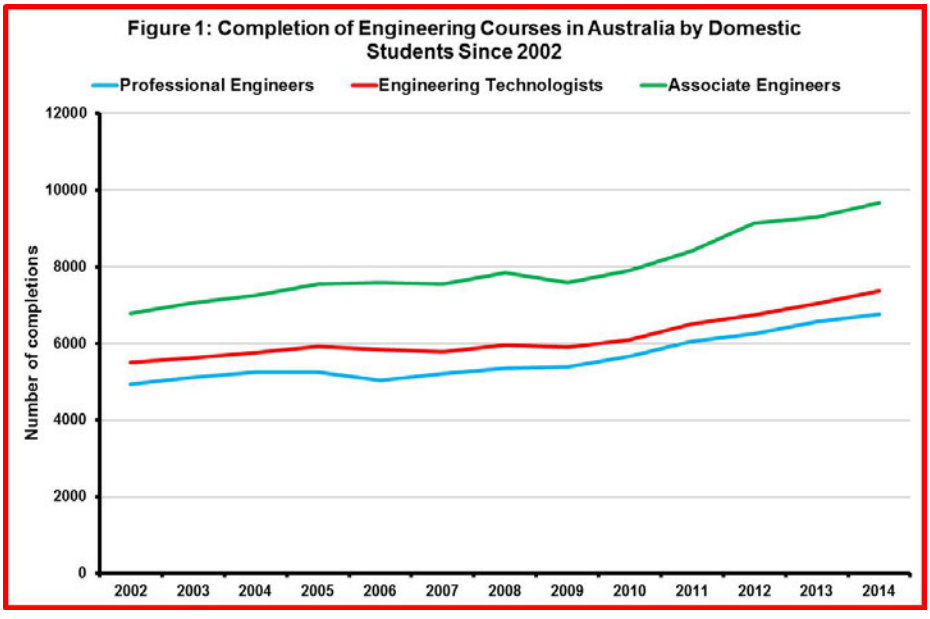
A consolidated list of currently accredited and previously accredited programs at the level of Professional Engineer, Engineering Technologist and Engineering Associate is available on the Engineers Website (http://www.engineersaustralia.org.au/sites/default/files/160127_web_listing_-_combined_v12_updated_27_january_2016.pdf

Engineering education

In 2014, the latest year for which statistics are available, Australian educational institutions produced 9,667 engineers; approximately 70% were professional engineers, 6% were engineering technologists and 24% were associate engineers. There has been a substantial increase in annual numbers since 2002 as shown by the (stacked) trends in Figure 1. Only Australian citizens and permanent residents are included in Figure 1; overseas students studying in Australia can apply for on-shore visas on completion of courses, but undergoing this procedure means they are counted as part of Australia's skilled migration statistics covered below.

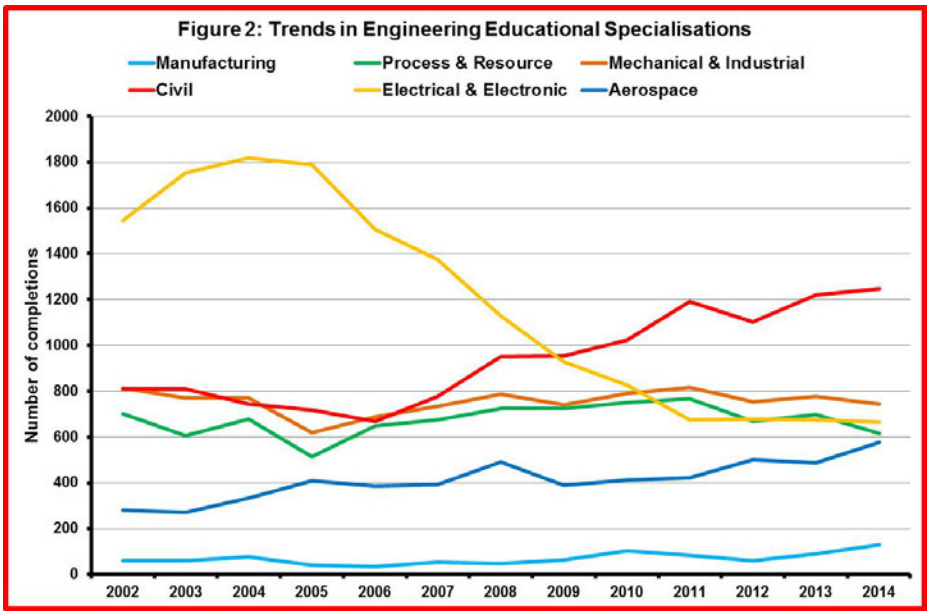
What is evident from this diagram is that most of the increase in annual completions has occurred since 2009. From about 2004 until then, annual completions were stagnant and actually fell in some cases. This lack lustre period was an important contributor to the shortage of engineers in resource and infrastructure industries during the five years prior to the global financial crisis.

Educational institutions did react to the demand pressures for more engineers, but the long lead times to produce engineering graduates has meant that the flow of graduates has lagged demand increases. The outcome in 2014 was the largest in Australian history, but, unfortunately, the demand for engineers collapsed from late 2012 and many of the new graduates have experienced significant difficulties in finding work.



Professional formation

All professions have arrangements whereby new graduates obtain the knowledge and experience necessary for professional practice. Engineers Australia sets standards for the application of this principle to engineers through an on-the-job process for which completing an entry level qualification in engineering is an essential requirement. The new graduate has an engineering qualification, but following completion of professional formation becomes a qualified, competent practicing engineer. This process may require three to four years.



Although the selection of entry level qualification has some bearing on career directions, engineers determine their area of specialisation in engineering practice as part of their professional formation process. The differentiation between engineering programs at educational institutions does not fully cover the large number of areas that engineers practice in; for example, a degree in civil engineering allows a new graduate to specialise in structural engineering, water engineering, sanitary engineering, ocean engineering, environmental engineering, as well as more general construction of civil works. Thus professional formation is critical to ensuring that Australia has sufficient engineers in all areas of engineering.

Most public discussion is about “engineering and engineers”, but these concepts are not as homogeneous as these discussions imply. There is limited substitutability between engineering specialisations and rather than a single labour market for engineers, there are different ones for each engineering specialisation. Figure 2 puts some numbers around this concept by illustrating the different scale and directions in trends for several common strands of engineering education that aggregate to the professional trend shown in Figure 1.

The numbers of graduates from electrical and electronic engineering courses has fallen substantially only plateauing out in recent years. This group of graduates go on to become electrical, electronic, software and computer engineers as well as important areas of specialisation associated with the digital economy. The number of graduates from civil engineering courses fell until around 2006 and has since followed a steadily increasing trend. The purpose of the diagram is to show that monitoring trends in the overall number of engineering graduates does not give an accurate picture of what is occurring. Engineering specialisations are critical and unless available in sufficient numbers could lead to barriers to economic progress that cannot be quickly overcome.

Employment in engineering

It should not be presumed that all engineering graduates work in engineering, or for that matter what might be described as 'traditional engineering jobs'. Over time as the economy has expanded and increased in sophistication the range of occupations in which engineering qualifications are demanded has increased. For example, the advent of public private partnerships to construct infrastructure means that engineers are required in both public and private sectors to handle different facets of the work.

In public sector agencies, engineers are employed to design the required infrastructure to tender specification stage, to evaluate tenders and to monitor construction in accordance with tender and to undertake post tender evaluations. In the private sector, engineers are employed by tender respondents to undertake detailed design work, construct tender responses and to oversight construction. The new approach to these projects also involves financial institutions and legal institutions where engineers are employed to verify that the technical requirements of the tender can be met with the financial arrangements put in place and that both technical and financial arrangements can be met through the legal contract put in place.

Another factor is that increased intermittency in engineering work resulting from the shift towards increased contract and project based work has meant that many engineers leave engineering work in favour of alternative and more regular careers that utilise their analytical and problem solving capacities. The falling numbers of school children studying mathematics and science limits the potential to grow the number of engineering graduates, but it has also led to higher demand for engineering graduates outside of engineering.

Engineers Australia has undertaken research that has identifies 51 of 358 occupations in the ABS ANZSCO occupational classification system as engineering occupations[1]. These occupations were selected using criteria that took into account progression through engineering careers and the breadth of engineering occupations in the labour market. The key issue was the occupations selected each had an appropriate level of attachment to engineering work. The subjectivity involved in the selection was tested by checking its sensitivity to the addition and subtraction of marginal occupations and showed that the degree of variation was minor and unlikely to affect conclusions.

The proportion of the engineering labour force or supply of qualified engineers, employed in these engineering occupations can be thought of as a measure of retention in engineering. When it comes to determining the engineering workforce needed to support an innovative Australian economy, the key issue is the number of engineers employed in engineering occupations rather than the number with engineering qualifications. Using ABS census statistics, we can show that in 2006, 60.9% of the engineering labour force was employed in engineering occupations with a slightly higher proportion of 62.1% in 2011. The proportion employed in engineering occupations differs by:

- *Gender*; 63.6% of men were employed in engineering occupations compared to 51.2% of women, and
- *Origin*; 55.5% of overseas born engineers were employed in engineering occupations compared to 69.9% of Australian born engineers.

Engineers Australia is undertaking a project to improve labour force diversity to assist in increasing the number of and retention of women in engineering. Increasing retention of migrant engineers may also be

[1] Engineers Australia, The Engineering Profession in Australia, A profile from the 2006 Population Census, September 2010, www.engineersaustralia.org.au

improved to some extent but more substantive change would require changes to Australia's skilled migration selection procedures discussed in the next section.

Skilled migration of engineers

Australia has and continues to follow a policy of high migration with an emphasis on skilled migration. We believe there is some confusion as to the objective of the component of the skilled migration program covering engineers. The objective purports to be about increasing the medium to long term engineering capacity of the Australian workforce, an objective we agree with. However, the selection mechanism used is not well directed to this end.

Prospective migrant engineers are presently selected on the basis of entry level qualifications with some priority given to individuals who demonstrate work experience either overseas or in Australia. We have no problems with entry level qualifications because Engineers Australia is the assessing authority used by the Department of Immigration and Border Protection (DIBP) and we apply the same criteria when assessing prospective skilled migrants as we apply to the accreditation of Australian engineering courses. However, the work experience provisions fall well short of Engineers Australia's criteria for qualified, competent practicing engineers.

We believe that in order to assist in effectively developing Australia's medium to long term engineering capacity, the assessment of skilled migrant engineers should be based on Engineers Australia's assessment criteria for qualified, competent practicing engineers. As matters stand, two skilled migrant engineers are needed for one to be employed in an engineering occupation. In other words, although intended to build future engineering capacity, the skilled migration is more about building up the average education level of the work force at large, a related but quite different objective. Engineers Australia has argued this position in a submission to DIBP dealing with a review of skilled migration visas and we have offered to work with them to develop a more effective approach.

Before leaving this section it is pertinent to point out Australia's over-reliance on skilled migrant engineers and the future risks associated with it. Between the last two censuses, over 70% of the increase in Australia's engineering labour force was from skilled migration and meant that the composition of the engineering labour force changed from a majority of Australian born to a majority of 53.9% overseas born. This is far higher than is the case in other professions where the share of overseas born is 37.7%. Migration statistics confirm that this trend is continuing.

In and of itself, the high proportion of migrant engineers is not an issue. However, continued reliance on skilled migration poses a serious risk to the future supply of engineers. As source country economies grow, their demand for engineers will increase reducing the pool Australia can choose from. Should global economic recovery be strong, it could mean we cannot source as many engineers of suitable standard from overseas as we need. Engineers Australia believes that skilled migration will continue to be necessary in the future, but more attention needs to be given to the current imbalance in source of supply of new engineers as well as the way in which migrant engineers are selected. There is a serious risk in relying on skilled migration for such a high proportion of our engineers, a risk that can be mitigated by producing more Australian engineers.

Engineers and the future economy

The high demand for engineers in the resource sector and the upsurge in infrastructure construction by Australian governments between 2005 and 2010 encouraged more year 12 students to undertake engineering courses, directly contributing to the rising trends in Figure 1 from about 2009 onwards. We need these trends to continue if Australia is to have sufficient engineers in future while lessening our

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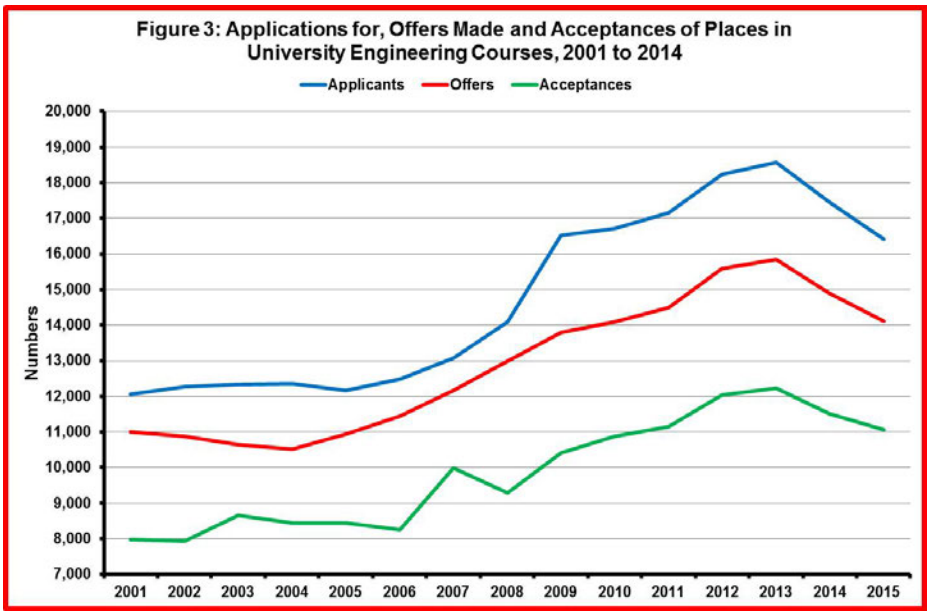
reliance on skilled migration. However, the boom-bust character of engineering employment is likely to make this objective very difficult to achieve.



Until 2013, applications by year 12 students for places in engineering degrees at Australian universities, the offers made in return by the universities and the final acceptances of places all increased[2]. In 2014 and 2015, all three fell quite sharply. The relevant trends are illustrated in Figure 3 and suggest that the rising trends shown in Figure 1 could continue for another two to three years and then turn down reflecting the change in Figure 3. This is precisely the opposite of what Australia needs to take advantage of an innovation future.

Engineers Australia believes the trends in Figure 3 are the result of too few school students studying mathematics and science at school and to a perception that opportunities for employment as engineers are related to the mining boom. We believe that in recent years governments have been primarily concerned about ensuring there are sufficient engineers for the resources sector and for infrastructure projects in cities and regional areas but have given insufficient attention to the broader roles engineers play in the Australian economy and its future.

Engineers are employed in almost every industry in Australia because practically every good and service traded in Australia domestically and internationally embodies the services of engineers. We believe that scientists and other researchers will be critical to discover the bright ideas that underpin innovation. But engineers are essential to develop new ideas into working prototypes. Engineers are also critical to commercialise new prototypes into forms suitable for the market place. Without these contributions, new ideas will not translate into tangible economic benefits to consumers and businesses, and through them, to our economy.

[2] Department of Education and Training, Undergraduate Applications, Offers and Acceptances 2015, www.education.gov.au

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