CELEBRATING OUR CENTENARY

THE ENGINEERING PROFESSION

A Statistical Overview, Fourteenth Edition

June 2019

THE ENGINEERING PROFESSION: A STATISTICAL OVERVIEW
Fourteenth Edition, June 2019

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1. Introduction

1.1 Objective of the statistical overview

Engineers Australia's purpose is to advance the science and practice of engineering for the benefit of the community. Engineers Australia accredits university engineering courses in line with international standards, sets and maintains professional standards for its members consistent with international benchmarks, encourages the development of engineering knowledge and competencies, facilitates the exchange of ideas and information and informs community leaders and decision makers about engineers and engineering issues.

To facilitate the achievement of its purpose, especially in so far as it involves public policy advocacy, it is important to access the best information available. The Statistical Overview aims to contribute to an understanding of Australia's engineering profession by compiling statistics about engineers in Australia. The Statistical Overview fills a gap created by the fragmented nature of Australian official statistics as they relate to specific professions and occupational groups.

High quality statistics to inform macroeconomic labour market policy decisions have been available for many decades. However, the same cannot be said about statistics for professional and occupational groups that require specific educational qualifications. In 2015, the Australian Bureau of Statistics (ABS) recognised these problems and introduced changes into the Labour Force Survey (LFS) to overcome them. This positive development will need some time to build useful time series statistics. Even then, reliance on survey techniques combined with the relatively small size of the engineering profession means that only limited information will be available. Recourse to a range of statistical sources will continue to be necessary.

As far as possible the Statistical Overview uses the definitions and statistical classification systems used by the ABS. All statistical systems involve some compromise and over time can be overtaken by social and labour market developments. For example, in engineering, mechatronics is likely to play an important future role, but mechatronics is not included in either the official education or occupational classification systems. Offsetting this disadvantage is that ABS classification is the mainstay of statistics used in official advice to ministers and governments. All statistics involve this type of trade off and it is important that the limitations of definitions and classification systems are understood and considered when evaluating conclusions. Too literal an interpretation may well be less useful than more balanced consideration.

1.2 Engineers and engineering

Engineers and engineering are indispensable contributors to Australian prosperity and lifestyles. Engineering services are embodied in almost every good or service consumed, used or traded by Australians, now and in the future. Engineers are the enablers of productivity growth because they convert "brilliant ideas" into new commercial products, processes and services. Engineers also ensure that society gets the most out of existing facilities by optimising their operations and maintenance.

Fully competent engineers complete accredited engineering courses and then complete a process of professional formation that extends academic studies to engineering practice in chosen areas of specialisation. The time necessary to become an engineer is long; academic studies are specific, analytical and characteristically problem solving. Engineering practice continuously evolves over time, embodying new technologies, new methods, techniques and new materials. These attributes differentiate engineers from other professions and underscore why engineers cannot be replaced by politicians, accountants and lawyers.

Engineering is not homogeneous and there are numerous areas of engineering practice. Specialisation begins with academic studies, for example, students can choose between degrees in mechanical engineering, civil engineering or electrical engineering. Most specialisation, however, takes place through on-the-job practice during professional formation, for example, a graduate with a degree in civil engineering can choose to practice as a structural engineer, a geotechnical engineer, a coastal engineer or as a civil engineer. Furthermore, the evolution of technology has meant that the distinction between some specialisations has become blurred, for example, the distinction between mechanical and electrical engineers and the emerging field of mechatronics. More detail on engineering specialisations can be found at www.engineersaustralia.org.au/professional-development/what-engineering.

Engineering skills and expertise are unique and other skills are no substitutes. When well informed engineering decisions made by fully competent engineers are over-ruled or ignored by managers, administrators, politicians or professionals from other fields, outcomes become problematic. This has become particularly evident in government procurement of infrastructure and/or highly technical equipment by agencies where engineering positions have been abolished and not replaced by arrangements where the emphasis is to ensure that engineering decisions and recommendations are soundly based. Often short-term cost savings resulting from cutting corners are swamped by damaging and expensive medium to longer term remediation[1].

In contrast, the training, skills and experience of engineers are highly valued in and transferable to many other fields of work. Consequently, people with engineering qualifications contribute to the broader skills development of the Australian economy. In practice this means that only about 60% are employed in occupations closely related to engineering. The other 40% are employed in a range of other occupations where analytical and problem-solving ability is required. Retaining trained engineers in engineering is just as important as encouraging more people to study and complete engineering qualifications

1.3 The engineering team

In Australia, the engineering profession is organised into the engineering team. The engineering team comprises Professional Engineers, Engineering Technologists and Engineering Associates. The three groups are differentiated by educational qualifications, which in conjunction with the process of professional formation undertaken, shape the engineer's degree of conceptualisation and independent decision-making and so determine the complementarity between the groups in engineering practice. In detail, the roles of the three groups are:

Professional Engineers challenge current thinking and conceptualise alternative approaches, often engaging in research and development of new engineering principles, technologies and materials. Professional Engineers apply their analytical skills and well-developed grasp of scientific principles and engineering theory to design original and novel solutions to complex problems. Professional Engineers exercise a disciplined and systematic approach to innovation and creativity, comprehension of risks and benefits and use informed professional judgment to select optimal solutions and to justify and defend these selections to clients, colleagues and the community. Professional Engineers require at least the equivalent of the competencies in a four-year full-time bachelor's degrees in engineering.

Engineering Technologists exercise ingenuity, originality and understanding in adapting and applying technologies, developing related new technologies or applying scientific knowledge within their specialised environment. The education, expertise and analytical skills of Engineering Technologists equip them with a robust understanding of the theoretical and practical application of engineering and technical principles. Within their specialisation, Engineering Technologists contribute to the improvement of standards and codes of practise and the adaptation of established technologies to new situations. Engineering Technologists require at least the equivalent of the competencies in a three-year full-time bachelor's degree in engineering.

Engineering Associates apply detailed knowledge of standards and codes of practice to selecting, specifying, installing, commissioning, monitoring, maintaining, repairing and modifying complex assets such as structures, plant, equipment, components and systems. The education, training and experience of Engineering Associates equip them with the necessary theoretical knowledge and analytical skills for testing, fault diagnosis and understanding the limitations of complex assets in familiar operating situations. Engineering Associates require at least the equivalent of the competencies in a two-year full time Associate Degree in engineering or a two-year full time Advanced Diploma in engineering from a university or TAFE college.

1.4 Competent practicing engineers

In some countries the professional status and practice of engineering is legally defined and protected by law. Supporting arrangements vary and include regulation through government bodies and self-governing bodies

[1] See for example www.anao.gov.au

granted powers through legislation. In short, engineers are legally registered/regulated in some way. In Australia, only Queensland has similar legislation. Although some other Australian jurisdictions are actively considering legislated regulation of engineers, at present most current Australian arrangements are voluntary.

Engineers Australia's voluntary National Engineering Register (NER) is the uniform national benchmark standard of professionalism in engineering practice. The NER is a compliance benchmark that corresponds to the standards of competence required in legislated systems and identifies individuals who satisfy the following criteria:

- Recognised academic qualifications in engineering.
- Cumulative (five years in the past seven years) and current experience in their chosen area of engineering practice.
- Commitment to, and practice, of ethical standards in engineering practice.
- Commitment to, and practice of, an appropriate standard of continuing professional development.
- Have the benefit of professional indemnity insurance and demonstrate that they can maintain this benefit throughout the provision of engineering services.

The NER is a publicly searchable database providing a voluntary national system of registration for the engineering team in both the private and public sectors in Australia. The NER is open to both members and non-members of Engineers Australia and aims to provide consistency in standards of engineering practice across states and territories and to facilitate any new legislated approaches. In our view, the NER is an important indicator of Australia's engineering capability.

1.5 What's new in this edition?

It has been two years since the last edition of the Statistical Overview was released. Since then Engineers Australia has conducted analysis of the three population censuses in 2006, 2011 and 2016. Together with a range of other statistics, that analysis forms the basis of the statistics reported in past editions of the statistical Overview.

Chapter 2 gives an overview of important structural features of the engineering labour market based on the three census data bases mentioned above. These statistics cover the 10 years to 2016 and there have been changes since. Chapter 2 looks at time series statistics from the ABS Survey of Education and Work (SEW). This is an entirely different data set to the census and the two cannot be reconciled but the broad changes observed are consistent between them even if the numbers are somewhat different. The advantage of the SEW statistics is that they are available up to 2018.

It has been difficult to update statistics on mathematics and science subjects studied at school. Statistics on mathematics were updated to 2016, but more recent ones were unavailable. It was not possible to update statistics on science subjects studied. Considering the public and political attention given to science, Technology, engineering and mathematics (STEM) subjects, this is an astonishing situation.

Statistics on the transition from school to engineering education were updated to 2018 in Chapter 4, but education statistics could only be updated to 2017 in Chapter 5, although statistics on the transition offer a good guide to likely 2018 changes in course commencements. Education statistics were compiled to provide an updated perspective on how education completions contribute to increasing the supply of Australian engineers in Chapter 6. This Chapter also contains statistics on the experiences of new graduates from the Graduate Outcome Survey which has replaced the Australian Graduate Survey formerly undertaken by Graduate Careers Australia. The new survey is undertaken by an agency of the Australian National University (ANU) on behalf of the Department of Education and Training.

An updated perspective on how skilled migration adds to the supply of engineers is covered in Chapter 7. These statistics are a mixed bag; statistics on permanent visas granted to migrant engineers have not been updated by the Department of Home Affairs. During these years, the overall skilled migrant intake has been reduced. Statistics on temporary migrants have been updated to 2018.

Chapter 8 contains statistics on the distribution of qualified engineers across industry, comparing these changes to other segments of the Australian labour market. There is a more detailed discussion of the shift in employment between core engineering industries and non-core industries briefly raised in Chapter 2. This Chapter also reviews the top 20 employing industries for qualified engineers and how this list has changed over the years.

The Statistical Overview concludes with Chapter 9 which attempts an assessment of likely conditions in the engineering labour market in 2019. The first part of the Chapter looks at changes in several economic indicators since the 2016 census. The indicators are gross domestic product, engineering construction and vacancies for engineers. Following a recapitulation of supply and demand factors, changes in the indicators guide an assessment of engineering labour market conditions.

2. Structural features of the engineering labour force

2.1 Base line statistics

This chapter provides a range of statistics about the engineering labour force obtained from the three population censuses conducted by the ABS in 2006, 2011 and 2016. All statistics were extracted from the ABS on-line data bases using the TableBuilder Pro facility. Standard economic labour market definitions are used, and minimal commentary is provided. More detailed commentary can be found in the two reports cited in footnote 2. The basic statistics covered by this chapter are in Table 2.1 below.

Table 2.1: The Australian engineering labour market, 2006 to 2016

2006 Census	Australian Born			Overseas Born			Engineering Team		
Variable	Men	Women	Total	Men	Women	Total	Men	Women	Total
Employed	93284	8310	101594	81206	11776	92982	174490	20086	194576
Unemployed	1636	198	1834	3321	890	4211	4957	1088	6045
Engineering labour force	94920	8508	103428	84527	12666	97193	179447	21174	200621
Not in labour force	18578	2073	20651	18684	4928	23612	37262	7001	44263
Not stated	290	35	325	335	88	423	625	123	748
Population	113788	10616	124404	103546	17682	121228	217334	28298	245632
Employed in engineering occupations	65975	4970	70945	46311	5001	51312	112286	9971	122257

2011 Census	Australian Born			Overseas Born			Engineering Team		
Variable	Men	Women	Total	Men	Women	Total	Men	Women	Total
Employed	108496	10382	118878	116827	18806	135633	225323	29188	254511
Unemployed	2374	273	2647	5103	1619	6722	7477	1892	9369
Engineering labour force	110870	10655	121525	121930	20425	142355	232800	31080	263880
Not in labour force	22674	2462	25136	25160	7781	32941	47834	10243	58077
Not stated	194	11	205	256	91	347	450	102	552
Population	133738	13128	146866	147346	28297	175643	281084	41425	322509
Employed in engineering occupations	78292	6640	84932	69708	9273	78981	148000	15913	163913

2016 Census	Australian Born			Overseas Born			Engineering Team		
Variable	Men	Women	Total	Men	Women	Total	Men	Women	Total
Employed	119054	12969	132023	150319	27928	178247	269373	40897	310270
Unemployed	4519	516	5035	11083	3569	14652	15602	4085	19687
Engineering labour force	123573	13485	137058	161402	31497	192899	284975	44982	329957
Not in labour force	31312	3087	34399	39595	12922	52517	70907	16009	86916
Not stated	246	52	298	331	76	407	577	128	705
Population	155131	16624	171755	201328	44495	245823	356459	61119	417578
Employed in engineering occupations	82903	7991	90894	82175	12847	95022	165078	20838	185916

2.2 The scale of change

Two variables are of particular importance when gauging the scale of change in the engineering labour market. First, the engineering labour force measures the number of people who hold recognised engineering qualifications and who are actively engaged in the labour market, either by being employed, or by actively searching for a job if they are unemployed. Second, employment in engineering occupations measures the subset of the engineering labour force that is employed in engineering occupations. More detail about the definition of this measure is provided below; at this stage it is sufficient to say that some people who have engineering qualifications chooses to work jobs other than engineering.

Between 2006 and 2016, the engineering labour force grew by 64.5% from 200,621 to 328,957. This growth was part of a more general expansion of skilled workers[2] in Australia during this period, but the expansion in the number of engineers was proportionally larger, 64.5% compared to 55.8%. In contrast, the rest of the Australian labour force grew by just 6.6%. When these changes are considered in terms of shares of the overall Australia labour force, we observe the changes illustrated in Figure 2.1.

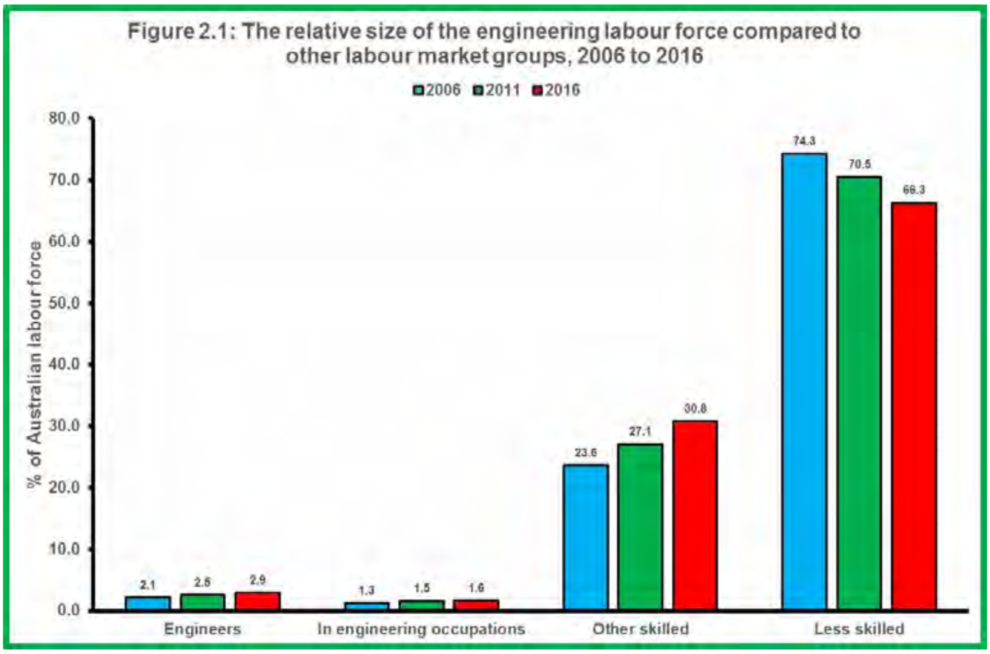


Figure 2.1: The relative size of the engineering labour force compared to other labour market groups, 2006 to 2016

The large increase in the engineering labour force did increase the share of engineers from 2.1% to 2.9%, but qualified engineers remain a small component of the overall Australian labour force. Other skilled workers increased their share of the Australian labour force from 23.6% to 30.8%. However, the share of less skilled workers, that is, workers with trade, sub-trade or no qualifications, fell from 74.3% to 66.3%.

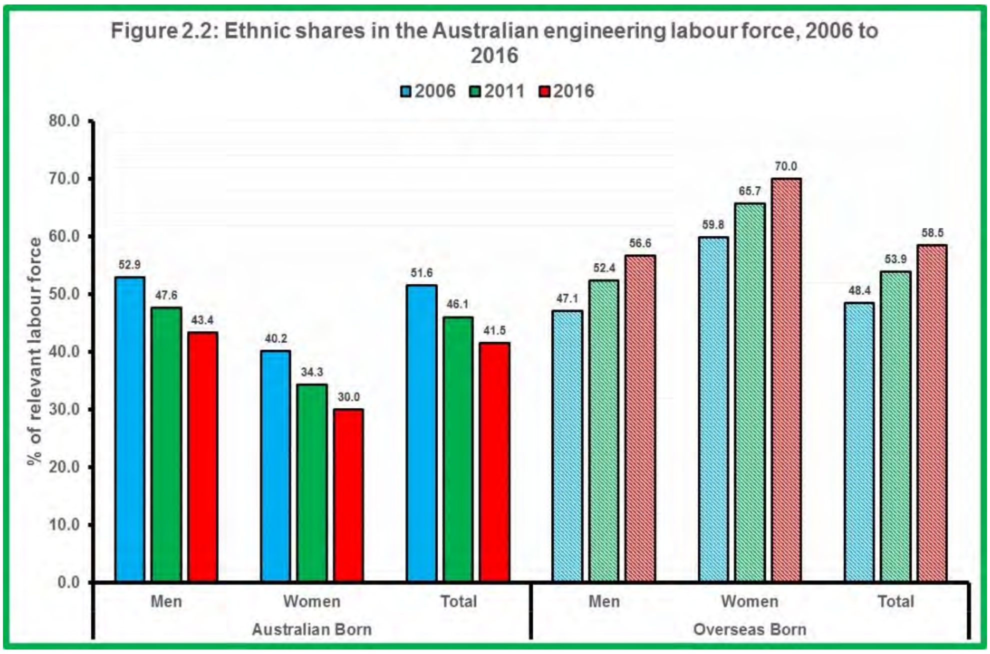
The number of qualified engineers employed in engineering occupations increased by 52.1% from 122,257 in 2006 to 185,916 in 2016. But, as Figure 2.1 shows, qualified engineers employed in engineering occupations enjoyed even lower shares of the overall Australian labour force; 1.3% in 2006, 1.5% in 2011 and 1.6% in 2016.

2.3 The ethnicity of the engineering labour force has changed

Table 2.1 divides the engineering labour force into two components: an Australian born component and an overseas born component. The overseas born component is not synonymous with skilled migrants because it includes some people born overseas who arrived in Australia as children and grew up and were educated here. However, when the overseas born component is examined by arrival in Australia, we observe that 95.5% of the increase in its size between 2006 and 2016 was the migration of qualified engineers. This close relationship together with the complexity involved in estimating statistics for migrant engineers has led us to employ the Australia/overseas born distinction for many statistical purposes.

The statistics in Table 2.1 show that the ethnic composition of the engineering labour force has changed. In 2006, 51.6% of the engineering labour force was Australian born and 48.4% was overseas born. With large scale skilled migration by 2016 the Australian born share had fallen to 41.5% and the overseas born share had increased to 58.5%. These changes are illustrated in Figure 2.2.

[2] Skilled workers are those with the same level of qualifications as engineers, that is, at least an associate degree or an advanced diploma in engineering. Other skills are this group less engineers.



The change in ethnicity was particularly pronounced for women qualified engineers. The proportion of Australian born women qualified engineers fell from 40.2% in 2006 to 30.0% while the proportion of overseas born women qualified engineers increased from 59.8% to 70.0%.

2.4 The number of women engineers has increased, but progress towards equity is slow

In 2006, there were 21,174 women qualified engineers in the engineering labour force. By 2016 this number had grown by 112.4% to 44,982. As shown in Figure 2.3, this numerically large increase translated in a relatively small change in the proportion of women in the engineering labour force, from 10.6% in 2006 to 13.6% in 2016. The main driver of change was through skilled migration. During this period, the number of Australian born women qualified engineers increased by 58.5% to 13,485. However, the overseas born component grew by 148.7% to 31,497. After these changes, the proportion of women in the Australian born component had increased from 8.2% to 9.8% while the proportion of women in the overseas born component increased from 13.0% to 16.3%.

The same pattern of change is observed in respect to employment in engineering occupations but at a smaller scale. The proportion of women in Australian born employment in engineering occupations increased from 7.0% in 2006 to 8.8% in 2016. For overseas born women, this measure increased from 9.7% in 2006 to 13.5% in 2016. Overall, the change was from 8.2% to 11.2%.

These statistics clearly demonstrate that the best measure of change in this area is absolute numbers rather that the share of women. While the latter is an important gauge of longer-term progress, large contemporary changes in numbers can be obscured by a focus on proportions alone.

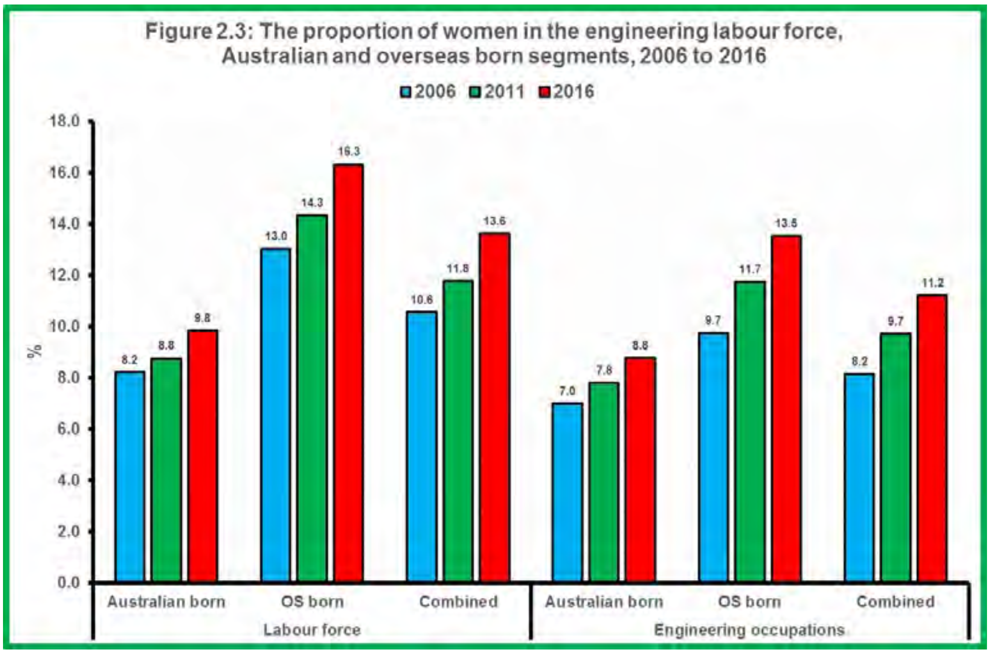


Figure 2.3: The proportion of women in the engineering labour force, Australian and overseas born segments, 2006 to 2016

Table 2.2: Utilisation of Australia's qualified engineers, 2006 to 2016

Labour market variable	Australian born			Overseas born			Combined		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
2006									
Employed in engineering	65975	4970	70945	46311	5001	51312	112286	9971	122257
Employed elsewhere	27309	3340	30649	34895	6775	41670	62204	10115	72319
Unemployed	1636	198	1834	3321	890	4211	4957	1088	6045
Labour force	94920	8508	103428	84527	12666	97193	179447	21174	200621
% in engineering occupations	69.5	58.4	68.6	54.8	39.5	52.8	62.6	47.1	60.9
2011									
Employed in engineering	78292	6640	84932	69708	9273	78981	148000	15913	163913
Employed elsewhere	30204	3742	33946	47119	9533	56652	77323	13275	90598
Unemployed	2374	273	2647	5103	1619	6722	7477	1892	9369
Labour force	110870	10655	121525	121930	20425	142355	232800	31080	263880
% in engineering occupations	70.6	62.3	69.9	57.2	45.4	55.5	63.6	51.2	62.1
2016									
Employed in engineering	82903	7991	90894	82175	12847	95022	165078	20838	185916
Employed elsewhere	36151	4978	41129	68144	15081	83225	104295	20059	124354
Unemployed	4519	516	5035	11083	3569	14652	15602	4085	19687
Labour force	123573	13485	137058	161402	31497	192899	284975	44982	329957
% in engineering occupations	67.1	59.3	66.3	50.9	40.8	49.3	57.9	46.3	56.3

2.5 Utilisation of qualified engineers

There is a common presumption that people who have recognised qualifications in engineering work as engineers. This section seeks to demonstrate that this is not the case and that the proportion of qualified persons employed in engineering occupations has fallen.

Earlier research by Engineers Australia apply several criteria to the 358 four-digit industries in the ABS ANZSCO classification of occupations in order to identify engineering occupations. The criteria were recognised qualifications, the occupation entailed work at levels 1 and 2 in the ABS classification of work and there was a sufficient degree of attachment of the occupation to engineering. The latter was measured on a five-point scale with five meaning complete attachment and one measuring almost no attachment. Only occupations with an attachment of three or more were included. There were 51 engineering occupations and the figures in Table 2.1

measure employment in this group of occupations in the three census years. More details of the methodology are available in another publication[3].

In Table 2.2 we examine how many qualified engineers are employed, or utilised, in engineering occupations. In 2006, 122,257 qualified engineers were employed in engineering occupations, 72,319 were employed in jobs outside engineering and 6.045 were unemployed. The proportion of the engineering labour force employed in engineering occupations was 60.9%.

In 2016, employment in engineering occupations had increased by 52.1% to 185,916 and employment in other jobs had increased by 72.0% to 124,354. At the same time unemployment increased to 19,687. The proportion of qualified engineers employed in engineering occupations fell to 56.3% having increased to 62.1% in 2011.

The proportions employed in engineering occupations are highest for Australian born men and lowest for overseas born women. Although they are lower for Australian born women than men, proportionally more Australian born women are employed in engineering occupations than overseas born men.

The analysis in Table 2.2 shows that insufficient qualified engineers is not the primary policy issue. When employers complain about engineering skill shortages the issue at stake is enough qualified engineers to work in engineering occupations. This number has grown much slower than the number of people with recognised qualifications and indicates that the more important policy issue is attracting qualified engineers into engineering jobs and then retaining them in engineering careers.

2.6 The relationship between supply and demand has changed

The period between 2006 and 2011 was largely characterised by high demand conditions for qualified engineers that brought forward policy responses that resulted in high supply growth. Late in 2012 the demand for qualified engineers collapsed primarily due to the end of the mining construction boom, but also due to a slowdown in infrastructure developments generally. The way this change impacted growth in supply of and demand for qualified engineers is set out in Table 2.3.

Table 2.3: Relative changes in the supply of and demand for qualified engineers

Average annual growth in (%)	Australian Born			Overseas Born			Engineering Team		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
2006 to 2011									
Supply of qualified engineers	3.2	7.6	5.3	4.6	10.0	8.0	3.3	7.9	5.6
Demand for qualified engineers	3.1	7.6	5.3	4.6	9.8	7.7	3.2	7.8	5.5
Employment in engineering	3.5	6.0	3.7	8.5	13.1	9.0	5.7	9.8	6.0
2011 to 2016									
Supply of qualified engineers	2.2	5.8	4.1	4.8	9.1	7.7	2.4	6.3	4.6
Demand for qualified engineers	1.9	5.2	3.6	4.6	8.2	7.0	2.1	5.6	4.0
Employment in engineering	0.9	3.8	1.4	3.4	6.7	3.8	2.2	5.5	2.6

Table 2.3 looks at supply and demand in terms of the average compound growth rates necessary to achieve the census end-points in 2006, 2011 and 2016. This method of estimation implies smooth transition when in reality there are always year on year variations and occasional crisis points such as the global financial crisis in 2008. Even allowing for this caveat, the estimates in Table 2.3 provide important insights into the changes that have taken place in the engineering labour market.

2.6.1 2006 to 2011

During the period 2006 to 2011 the supply of qualified engineers grew by an average 5.6% per year. Growth was slower in the Australian born component than in the overseas born component; average 5.3% per year compared to

[3] Engineers Australia, The Engineering Profession in Australia; A profile from the 2006 population census, September 2010.

average 8.0% per year. In both components the supply of women qualified engineers grew faster than the supply of men.

The demand for qualified engineers was almost in balance with supply. Supply and demand growth were equal in the Australian born component, both averaging 5.3% per year. This was slower than overall growth in the demand for qualified engineers which was average 5.5% per year. The difference was accommodated by higher growth in the demand for overseas born engineers which averaged 7.7% per year. Overall demand growth was slightly lower than supply and the incidence of the difference fell primarily on overseas born qualified engineers and was reflected in higher unemployment rates for this group.

The supply of qualified engineers satisfies demand from two directions. First, its main intention is to supply qualified engineers to work in engineering occupations, and second, because some people who complete engineering qualifications either choose alternative careers or through weight of circumstances are forced into alternative jobs, the supply of qualified engineers is a major contributor to general skilled employment in Australia. This is reflected in the comparison of growth rates in Table 2.3.

During 2006 and 2011, the demand for qualified engineers in engineering occupations was higher than growth in supply; average 6.0% per year compared to average 5.6% per year. When one takes into account the numerous engineering specialisations and geography in Australia, this difference is magnified. This was the basis for the claim during this period that Australia was experiencing an engineering skill shortage.

Demand for Australian born qualified engineers in engineering employment grew by average 3.7% per year, substantially slower than growth in average demand. This difference supports reliance on skilled migration to fill the gap. Demand for overseas born qualified engineers employed in engineering occupations grew by average 9.0% per year as a consequence.

2.6.2 2011 to 2016

The situation between 2011 and 2016 was quite different. When evaluating the figures in Table 2.3, consider the caveat set out earlier; the change that occurred was not nearly as sharply defined as the Table suggests.

During this period growth in the supply of qualified engineers slowed from an average 5.6% per year to an average 4.6% per year. There was some slowdown in each of the two components, but the impact was greater for the Australian born component. Growth in the latter slowed from average 5.3% per year to average 4.1% per year compared to a reduction from average 8.0% per year to average 7.7% per year for the overseas born component. These figures are consistent with a large reduction in labour force participation by Australian born men, particularly retirements in older age groups. In both components, supply continued to grow faster for women than for men.

Demand growth also slowed but to a greater extent than supply. Overall growth in the demand for qualified engineers slowed from average 5.5% per year to average 4.0% per year developing a substantial gap with supply. Table 2.3 shows that the incidence of the demand slowdown was particularly high for Australian born men where growth fell to an average 1.9% per year, mirroring the reduction in labour force participation that occurred. Once again, overall demand for qualified engineers was higher than growth in demand in the Australian born component providing evidence that skilled migration was still necessary to bridge the gap. As well the larger gap between supply and demand growth was reflected in higher unemployment rates.

The slowdown in demand for qualified engineers in engineering occupations was much greater than the slowdown in demand for qualified engineers generally. During 2011 to 2016, the demand for qualified engineers in engineering occupations slowed to average 2.6% per year, well below average 4.0% per year growth in demand for qualified engineers generally, reversing the relationship evident between 2006 and 2011. During the earlier period, there was clear evidence supporting the notion of an engineering shortage. During the second period this support comprehensively disappeared.

However, the incidence of most of the change fell on the Australian born component where demand or employment of qualified engineers in engineering occupations fell to average 1.4% per year, almost half the slower overall growth rate of average 2.6% per year. Clearly, the availability of Australian born qualified engineers to fill engineering occupations was growing much too slowly to fill the opportunities available. In other words, there is continuing support for overseas migration of qualified engineers to fill engineering occupations.

The statistics in this section support further consideration of two policy issues; first, retention in engineering is an entrenched problem that requires attention, and second, continuing support for skilled migration is for employment in engineering occupations which represents about half current growth in supply.

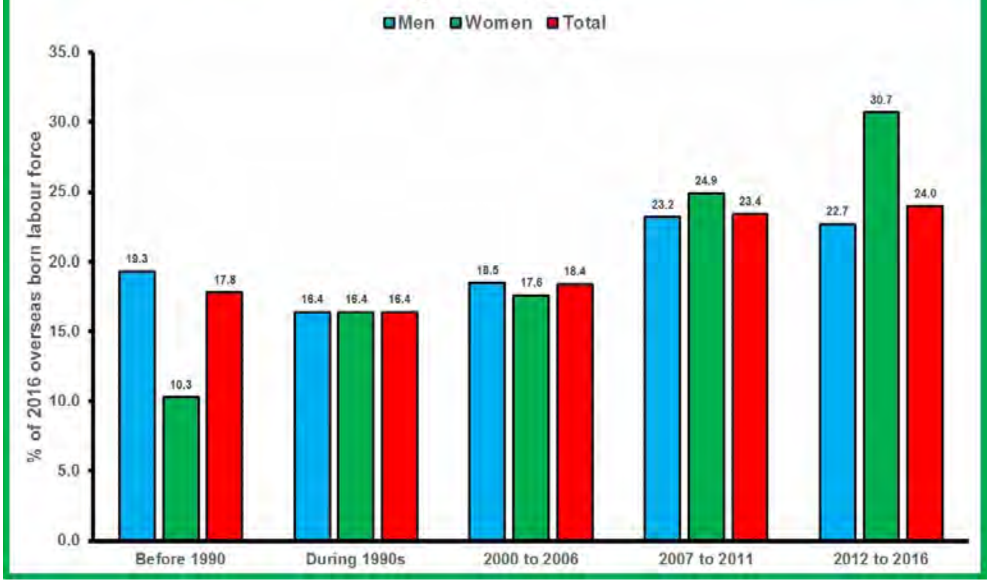
2.7 Arrival in Australia has a bearing on employment prospects

The overseas born component of the engineering labour force can be partitioned according to arrival of migrants in Australia. Figure 2.4 shows the arrival profile of migrant engineers who were in the engineering labour force in 2016. This illustration confirms that skilled migration of engineers has been a feature of the engineering labour market for some time. About one third of the overseas born engineering labour force arrived in Australia before the turn of the century, 17.8% arrived before 1990 and 16.4% arrived during the 1990s.

Since 2000, successive cohorts of arrivals have increased in size; 18.4% of the 2016 overseas born engineering labour force arrived in Australia between 2000 and 2006, 23.4% arrived in Australia between 2007 and 2011 and 24.0% arrived in Australia between 2012 and 2016. The illustration also shows how the proportion of women has increased in recent arrival cohorts.

We observed earlier that in 2016 49.3% of the overseas born component of the engineering labour force was employed in engineering occupations. Figure 2.5 illustrates how arrival in Australia contributed to this result. What the illustration shows is that the most recently arrived cohort has the lowest proportion of qualified engineers employed in engineering occupations at 40.3%. All other cohorts had proportions employed in engineering occupations above 50%. It also shows that migrant women have quite low proportions employed in engineering occupations and this result extends to every arrival cohort.

Figure 2.4: The overseas born engineering labour force in Australia in 2016 by time of arrival



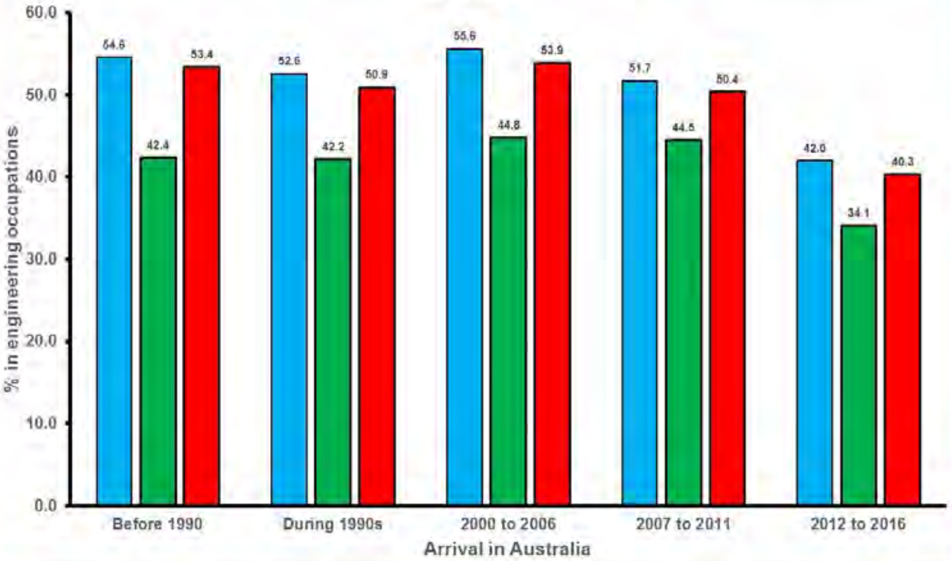


Figure 2.5: Employment in engineering occupation in 2016 by arrival in Australia

The statistics in this section show that skilled migration of engineers has not be well aligned with building Australia's engineering capability. A high proportion of migrant qualified engineers do not work in engineering occupations. This is an entrenched issue that has deteriorated further for recent arrival cohorts.

2.8 Australia sources migrant engineers from many countries but large numbers come from a smaller group

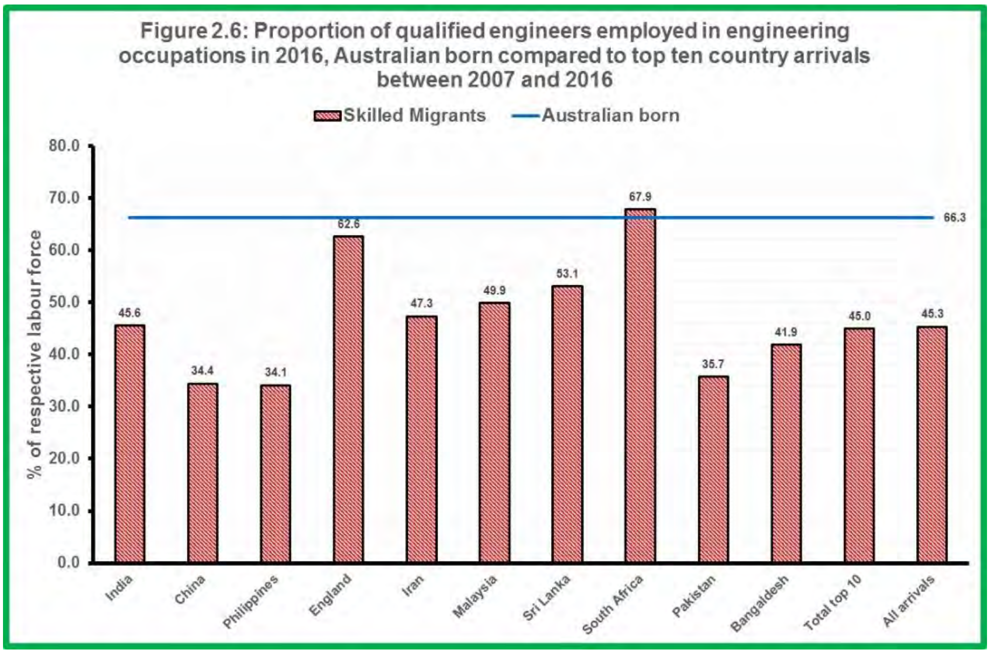
Australia has sourced its migrant engineers from about 166 countries from the 249 in the ABS classification. However, the top 10 source countries have accounted for over two-thirds of arrivals since 2007. Table 2.4 divides the overseas born component of the engineering labour force in 2016 by arrival in Australia for the top 10 source countries and compares arrivals for these countries to all arrivals in the various arrival periods.

Table 2.4: The top ten source countries for Australia's overseas born qualified engineers

Before 1990		1990s		2000 to 2006		2007 to 2011		2012 to 2016		All arrivals		Since 2007	
Country	Number	Country	Number	Country	Number	Country	Number	Country	Number	Country	Number	Country	Number
England	5483	China	3638	India	6958	India	9745	India	13472	India	34283	India	23217
Vietnam	2494	India	3028	China	4254	China	5472	China	4122	China	19907	China	9594
China	2421	England	2469	England	3148	Philippines	3684	Philippines	3266	England	15782	Philippines	6950
New Zealand	1754	Philippines	2110	Philippines	1963	England	2922	Iran	2598	Philippines	12505	England	4682
Malaysia	1699	Sri Lanka	1795	South Africa	1706	Iran	1972	England	1760	Sri Lanka	6842	Iran	4570
Philippines	1482	Hong Kong	1182	Malaysia	1548	South Africa	1849	Pakistan	1686	Malaysia	6822	Malaysia	2707
India	1080	South Africa	976	Sri Lanka	1223	Malaysia	1711	Sri Lanka	1084	South Africa	6086	Sri Lanka	2762
Sri Lanka	1062	New Zealand	949	New Zealand	927	Sri Lanka	1678	Columbia	1008	Iran	5999	South Africa	2672
Poland	958	Malaysia	870	Indonesia	697	Ireland	1032	Malaysia	994	New Zealand	5132	Pakistan	2451
Hong Kong	946	Vietnam	862	Iran	569	New Zealand	906	Bangladesh	979	Vietnam	4666	Bangaldesh	1805
Total top 10	19379	Total top 10	17879	Total top 10	22993	Total top 10	30971	Total top 10	30969	Total top 10	118024	Total top 10	61410
All arrivals	34360	All arrivals	31569	All arrivals	35425	All arrivals	45216	All arrivals	46299	All arrivals	192869	All arrivals	91515
% top 10	56.4	% top 10	56.6	% top 10	64.9	% top 10	68.5	% top 10	66.9	% top 10	61.2	% top 10	67.1

The earliest arrival cohort numbered 34,360 and 56.4% of them came from one of the top 10 sources with England at the top of the list. There were 31,569 arrivals during the 1990s and the top 10 countries accounted for 56.6% and the largest number of migrants came from China. There were more arrivals in the five years 2000 to 2006 than during the whole of the 1990s, 35,425 and India replaced China at the top of the list. The second observation to make about this arrival group is that the top 10 countries accounted for 64.9%, a steep rise relative to the previous arrival group.

The period 2007 to 2011 experienced the highest level of demand for qualified engineers, and accordingly, the number of qualified engineers arriving in Australia increased to 45,216, and the top 10 source countries accounted for 68.5% with India continuing to supply the most migrant engineers. There was a further increase in the intake between 2012 and 2016 to 46,299. The top 10 source countries continued to be dominant, but their share of the intake slipped slightly to 66.9%. India once again supplied the largest number of migrant engineers. To emphasize the concentration of migrant origin, since 2007, three countries, India, China and the Philippines contributed 43.5% of Australia's migrant engineers.



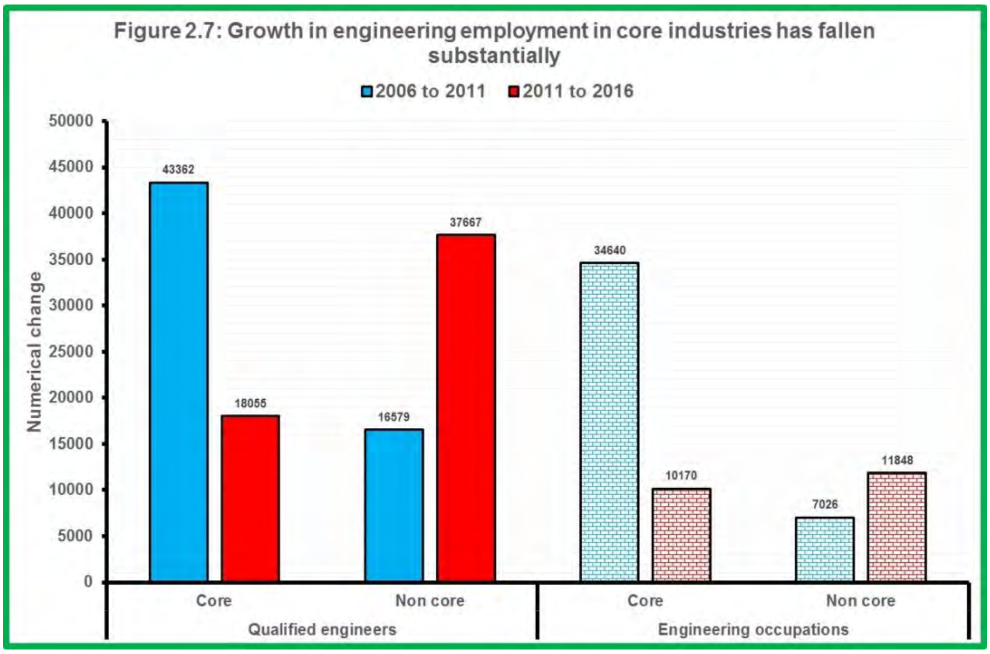
The proportions of migrant qualified engineers, working in engineering occupations, from arrival groups between 2007 and 2016 from the top 10 source countries are compared to the corresponding proportion of Australian born qualified engineers working in engineering occupations in Figure 2.6.

On average, 66.3% of Australian born qualified engineers were employed in engineering occupations between 2007 and 2016. Migrant engineers from only two of the top 10 source countries had similar shares, England with 62.6% and South Africa with 67.9%. There were substantial gaps in all other cases. This comparison reinforces earlier comments about Australia's skilled migration program and furthermore draws attention to the importance of providing more integration assistance to build Australia's engineering capability.

2.9 The change in demand for qualified engineers has an industry basis

Detailed statistics on the industry distribution of engineers are discussed in Chapter 8. It shows that qualified engineers are employed in almost every broad industry in the ABS ANZSIC classification. This conclusion also applies to the employment of qualified engineers in engineering occupations. However, further inspection of this measure shows that most engineering occupations occur in a restricted range of industries that we refer to as core engineering industries.

Core engineering industries are those where the proportion of qualified engineers employed in engineering occupations is higher than the national average and includes Mining, Manufacturing, Utilities, Construction, Information Media & Telecommunications, Professional Services and Public Administration. The remaining broad industries are referred to as non-core industries. In 2016, 73.1% of qualified engineers employed core engineering industries were employed in engineering occupations compared to 26.9% in the non-core industries.



In Figure 2.7 we examine how the increase in employment of qualified engineers and qualified engineers employed in engineering occupations has changed in core engineering industries and non-core industries for the two inter-census periods 2006 to 2011 (blue bars) and 2011 to 2016 (red bars).

Between 2006 and 2011 employment of qualified engineers increased by 59,941. The bulk of the increase, 43,362 or 72.3%, occurred in core engineering industries and the remaining 16,579 or 27.7% occurred in non-core industries. Similarly, the increase in employment of qualified engineers employed in engineering occupations was 41,666 and the bulk, 34,640 or 83.1%, occurred in core engineering industries with just 7,026 or 16.9% occurring in the non-core group.

This relationship changed dramatically between 2011 and 2016. Employment of qualified engineers increased by 55,722, almost as many as in the earlier period. However, in the core engineering industries the increase was 18,055 or 32.4% of the total, less than half the share between 2006 and 2011, while the increase in employment in non-core industries was 37,667 or 67.6%, about four times the increase in the earlier period.

3. Changes over time

3.1 Regular statistics to measure change

The availability of quality statistics has been a perennial barrier to assessing the status and progress of professions, including engineers. The approach used by Engineers Australia has been to utilise census statistics to analyse structural characteristics of the engineering labour market and to use ABS survey statistics to understand changes in the five-year interval between censuses.

In Australia, changes in the size and structure of the national labour market are usually measured using statistics from the ABS Labour Force Survey (LFS). There are two reasons why this approach is not straight-forward when applied to engineers:

The LFS is based on a sample of 0.32% of the civilian population[4] aged 15 years and over and on average in 2016-17 covered 26,000 private dwellings and 51,000 individuals. In turn the engineering labour force in turn is about 2.5% of the national labour force. This severely limits the number of variables unencumbered by excessive standard errors.

Until recently, the LFS did not include questions on educational qualifications, a vital requirement for a professional organisation that requires its members to hold mandated qualifications in engineering. This changed in May 2015,[5] but insufficient time has elapsed to construct meaningful time series statistics.

The first problem does not have a ready solution, but the second can be solved by instead using a related survey, the Survey of Education and Work (SEW) which has included educational attainment for almost two decades. When used in conjunction with other indicators, such as the censuses and vacancies statistics[6], useful indicators of change can be compiled about the demand for, and supply of, engineers.

The Survey of Education and Work (SEW) is a supplementary survey that draws on the LFS sample and is undertaken by the ABS annually in May[7]. Although closely related to the LFS sample, there are important differences in the scope of the surveys and response rates. Until 2008, the SEW sample was restricted to the 15 to 64 years age groups. From 2009 until 2012, age groups 65 to 74 years were included in the survey in situations where there was attachment to the labour force. From 2013, this ambiguity was clarified by including all individuals up to 74 years of age in the sample. These changes mean that some juggling is necessary to compile consistent time series. The most practical approach is to continue the earlier age range restriction, that is, to analyse the 15 to 64 years age range. Therefore, care is needed when comparing changes in SEW statistics to changes in census statistics which have an open age range. Another important issue is that the SEW sample is drawn from the civilian population which means that the defence forces, an important element of the engineering profession is excluded. There are other differences as well and together they mean that the two data sets cannot be reconciled, instead we look for similarities and differences in changes.

Against this background, the objective of this Chapter is to examine trends in SEW statistics relating to the engineering labour force, in particular to identify changes that have occurred since the 2016 census.

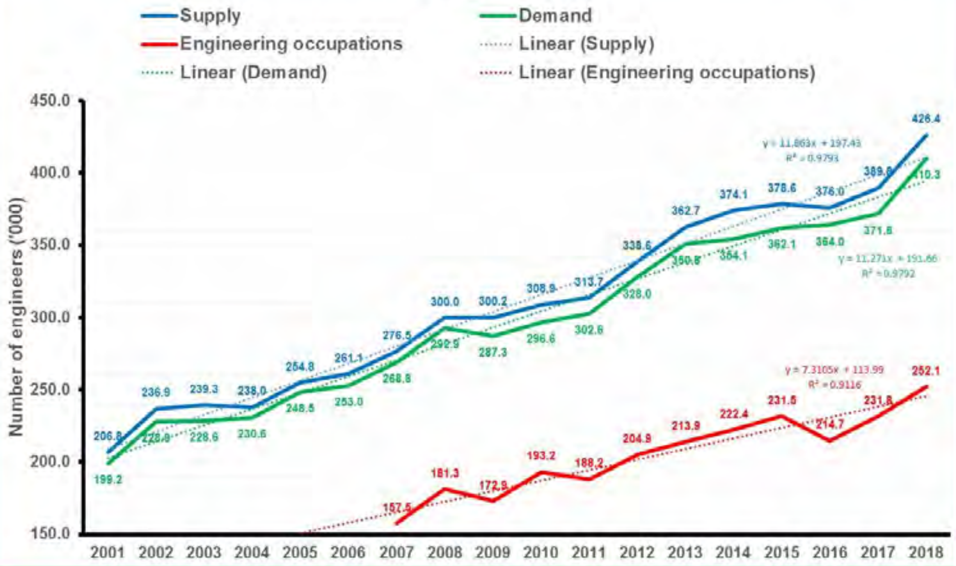
3.2 Changes in supply and demand

Trends in the supply of qualified engineers, the demand for qualified engineers and the demand for qualified engineers in engineering occupations are illustrated in Figure 3.1. This diagram also shows the trend lines for each variable. The statistics illustrated in Figure 1 are for qualified engineers aged 15 to 64 years. What is clearly evident in the diagram is the relatively high year on year variability in the survey data which complicates short term

[4] ABS, Labour Statistics: Concepts, Sources and Methods, February 2018, Cat No 6102.0.55.001, www.abs.gov.au
[5] ABS, Information Paper: Forthcoming Changes to Labour Force Statistics, October 2014, Cat No 6292.0, www.abs.gov.au
[6] See http://lmip.gov.au/default.aspx?LMIP/VacancyReport
[7] ABS, Education and Work, Australia, May 2014, Cat No 6227.0, www.abs.gov.au

analyses. The most prudent approach is to look at trends over a longer period and to allow for the effects of standard errors when assessing single year changes.

Figure 3.1: The supply of qualified engineers and two measures of demand for engineers



3.2.1 Supply of Qualified Engineers

Long term growth in the supply of qualified engineers has averaged 4.43% per year since 2001, increasing their number by 106.2% from 206,800 to 426,400 in 2018. After the global financial crisis (GFC), from 2009 through to 2018, average growth in the supply of qualified engineers slowed to well below the long-term average, to 3.63% per year, but this result comprises two parts.

From 2009 to 2013, supply grew more slowly but its growth was still relatively buoyant at 3.9% per year. However, in the three years 2014 to 2016, supply growth slowed to just 1.22% per year. The following two years, 2017 and 2018 were ones of recovery with the supply of qualified engineers growing at the breakneck rate of 6.5% per year. The years of slower growth were associated with below average labour force participation as many older engineers exited the labour market. Indeed, the statistics show that in 2016, the supply of qualified engineers actually contracted. These observations are consistent with those obtained from census statistics; between the 2011 and 2016 censuses, there was a substantial adjustment in the engineering labour market which involved lower participation and slower supply growth.

3.2.2 Demand for Qualified Engineers

Labour demand is usually measured by numbers employed. Over the long term, growth in demand for qualified engineers has matched supply growth, averaging 4.43% per year since 2001. Employment of qualified engineers increased from 199,200 in 2001 to 410,300 in 2018. However, as was the case for supply, the more interesting statistics are for shorter intervals within this period.

After the GFC, from 2009 through to 2013, the demand for qualified engineers grew by an average 3.7% per year while supply growth averaged 3.9% per year. In the following three years, 2014 to 2016, demand for qualified engineers collapsed to average 1.24% per year, no doubt prompting a discouraged worker effect which produced a commensurate fall in supply growth. Following this adjustment, the years 2017 and 2018 saw strong growth in the employment of qualified engineers averaging 6.2% per year.

In 2016, the census year, the demand for qualified engineers grew by just 0.5%, an outcome reflected in census statistics. Since the census, the strong recovery in demand may to some extent be influenced by the higher degree of variability in the SEW statistics, but even allowing for this it is apparent that people with engineering qualifications were once again in demand, but the critical question is if it was in engineering.

3.2.3 Demand for Qualified Engineers in Engineering Occupations

While the nature of the SEW sample cannot support statistics on individual occupations, it can support the collection of 51 occupations that make up the group of engineering occupations. Unfortunately, due to the late adoption of the ANZSCO classification in this survey this can only be achieved from 2007 onwards. The third trend line in Figure 3.1 shows the progress of employment of qualified engineers in these 51 engineering occupations.

Long term growth of employment in engineering occupations, the period 2007 to 2018, was 4.58% per year. From 2009, after the GFC to 2013, the demand for qualified engineers to be employed in engineering occupations has averaged somewhat less, growing by an average 3.6% per year, robust in most analysts' eyes. However, there was almost no growth during the three years 2014 to 2016 with growth averaging just 0.27% per year, largely on the back of a 7.3% decline in 2016.

In 2017 and 2018, the supply of qualified engineers increased by an average 6.5% per year, the demand for qualified engineers increased by an average 6.2% per year and the demand for qualified engineers employed in engineering occupations increased by more, averaging 8.4% per year. Once again, evaluation must take into account the greater variability inherent in SEW statistics, but even so this comparison suggests some tightness in the market for qualified engineers in engineering occupations at a time when large numbers of qualified engineers are choosing to work outside of engineering.

On average since 2007, SEW statistics show that 59.4% of the supply of qualified engineers was employed in engineering occupations. This proportion was typically higher in years of strong demand and lower at other times. In 2016, it was 57.1%, a little higher than the census result, but of the same order. The difference here is readily understood as resulting from comparison of two quite different data bases. Despite 2017 and 2018 showing such strong growth in demand for qualified engineers in engineering occupations, the proportion of the supply of qualified engineers in engineering occupations was a little below the long-term average.

When growth in demand for qualified engineers to be employed in engineering occupations exceeds growth in demand for qualified engineers, one is tempted to define the situation as a shortage of qualified engineers to undertake engineering work. However, in this case two other observations are pertinant; first the supply of qualified engineers grew faster than demand for qualified engineers, suggesting there were plenty of qualified engineers in the labour market. Second, in the two years an average of 40.7% of the supply of qualified engineers choose to work at something other than engineering. The problem here is one of retention in engineering, rather than an insufficient supply of qualified engineers.

3.3 Gender imbalance

Estimates of the proportion of women in the engineering labour force using SEW statistics are available from 2012 onwards and are illustrated in Figure 3.2. In some of those years the estimates have relatively high standard errors and should be treated with some caution.

There is considerable variability in the proportions of women qualified engineers illustrated in Figure 3.2. The Excel trend line shows a decreasing trend since 2012. What is unambiguously clear is that the proportion of women qualified engineers is NOT increasing. Consistent with census figure, the number of women qualified engineers has increased by 24.3% from 42,400 in 2012 to 52,700 in 2018, but this change has not yet been reflected in the proportion of women qualified engineers.

Figure 3.2: The proportion of women engineers since 2012

3.4 Changes in core engineering industries

Core engineering industries were defined in Chapter 2 and include mining, manufacturing, the utilities, construction, information media and telecommunications, transport, professional services and public administration.

Census statistics showed that between 2011 and 2016, employment growth for qualified engineers generally and for those employed in engineering occupations were much lower than between 2006 and 2011. We also observed above that 2016 was a poor year for supply and demand for qualified engineers. SEW estimates for individual broad industries in the ANZSIC system is as problematic as it is for individual occupations but for the core industries as a group reasonable estimates are possible. In Figure 3.3 we consider the changes in the demand for engineers in the core industries since the census.

Figure 3.3: Employment growth in core engineering industries since the 2016 census

Between 2016 and 2017, the employment of qualified engineers in core engineering industries barely changed, however, the employment of qualified engineers in engineering occupations grew by 7.56%. This is consistent with the surge in infrastructure development, particularly in NSW and Victoria.

4. The transition to engineering education

4.1 Mathematics and science at school

Low participation in school mathematics and science subjects has been very topical in recent years, highlighted by the work of the Chief Scientist. However, official statistics remain poor. In past editions of the Statistical Overview, we reported detailed statistics about the participation of year 12 students in mathematics and science subjects. This section provides a partial update on this material. Most of the statistics reported in the past were originally published by Kennedy, Lyons and Quinn[8] with most provided in personal correspondence with Mr Kennedy who was researching his PhD in this area. We are not able to update these statistics currently.

Professor Frank Barrington has compiled statistics on year 12 student participation in mathematics for some years and these are regularly reported by the Australian Mathematical Science Institute (AMSI)[9]. These statistics have been updated to 2016 and are here preferred to the Kennedy statistics which only go to 2012. Figure 4.1 shows the trends in participation in the three levels of year 12 mathematics identified in these statistics.

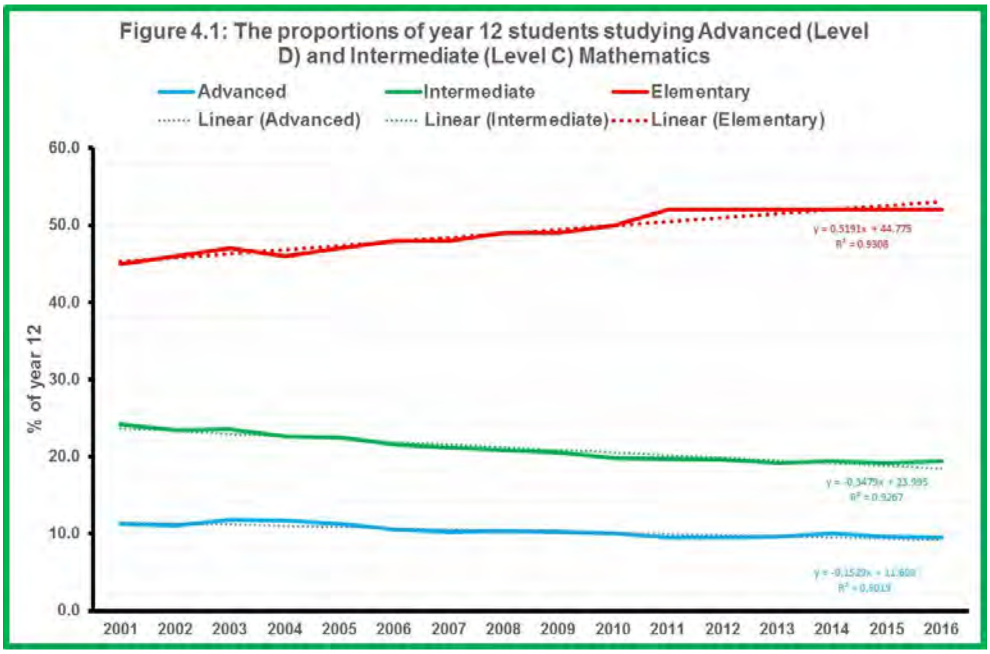


Figure 4.1: The proportions of year 12 students studying Advanced (Level D) and Intermediate (Level C) Mathematics

Participation in year 12 advanced mathematics has trended downwards since 2001. Since 2011 it has more or less plateaued at about 9.5% except for 2014 when it was 10.0%. The 2012 Barrington statistic is consistent with Kennedy's which gave a participation rate of 9.5% in 2012. In the publication "Engineers make things happen", ordinary least squares was used to project the Kennedy participation rates forward to 2015. The projection was that advanced mathematics participation in 2015 would be 8.7%. The Barrington statistics show that this result was overly pessimistic because it did not pick up the plateau effect. Plateauing of the advanced mathematics participation rate could be argued as a sign that policy to encourage more students into advanced mathematics is working, but it could just as easily be differences between the two statistical collections. However, viewed, participation in year 12 advanced mathematics is low.

Figure 4.1 also shows that the trend in participation in year 12 intermediate mathematics is downwards. It is more difficult to compare the Kennedy and Barrington statistics for this subject; for example, in the last year of the

[8] John Kennedy, Terry Lyons and Frances Quinn, The Continuing Decline of Science and Mathematics Enrolments in Australian High Schools, Teaching Science, Volume 60, Number 2, June 2014, accessed on-line,
[9] F Barrington and P Brown, Monitoring Participation in Year 12 Mathematics, www.amsi.org.au

Kennedy statistics (2012) he estimated intermediate mathematics participation to be 26.9% compared to 19.6% by Barrington. This difference could be due to the overlap between advanced and intermediate statistics which were treated differently by the two researchers. Barrington notes that most, but not all, advanced mathematics students also study intermediate mathematics and that his statistics define an intermediate student as one who is enrolled in intermediate mathematics but not enrolled in advanced mathematics[10]. The Barrington intermediate participation rate has varied about 19.2 to 19.4% since 2013 and was 19.4% in 2016.

Participation in elementary mathematics has trended upwards since 2001, but mirroring the plateaus in advanced and intermediate participation, this trend has stalled since 2011. Since the participation rate for intermediate mathematics has been 52.0%. Thus, in 2016, 80.9% of year 12 students participated in mathematics in some form, slightly higher than the 80.5% in 2001.

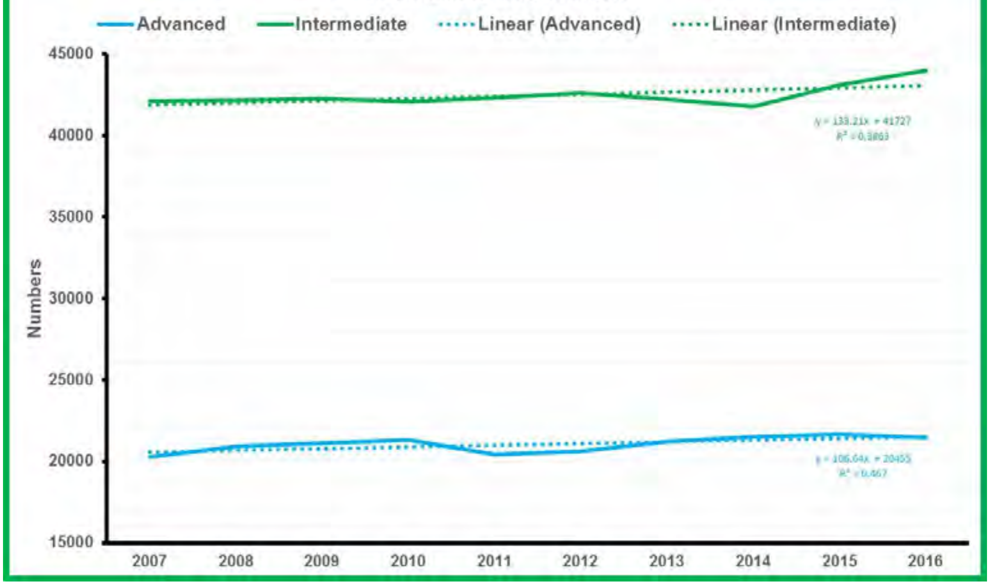
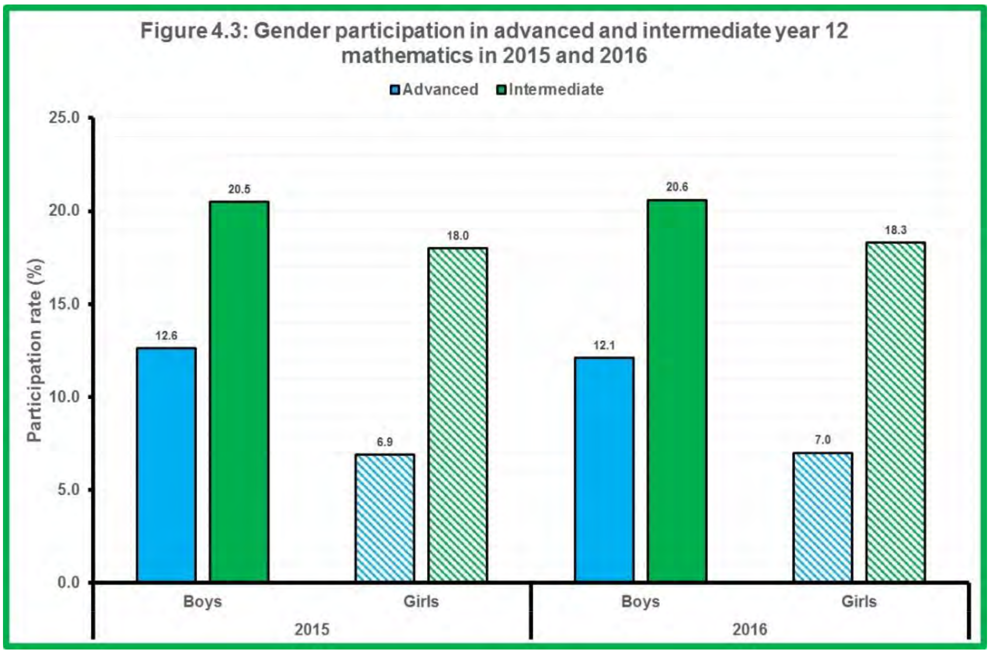


Figure 4.2: Numbers of year 12 students studying advanced and intermediate mathematics

So far as transition to tertiary studies in engineering is concerned, as well as year 12 participation rates in mathematics, absolute numbers of advanced and intermediate mathematics students are of great interest. Figure 4.2 shows the trends in these numbers. What is observed are slight upwards trends in both levels of mathematics, the result of interaction between the mathematics participation trends illustrated in Figure 4.1 and continuing increases in the retention of high school students to year 12. In 2001, 73.4% of year 10 students stayed on to year 12 and there were 193,694 year 12 students. In 2016, 84.3% of year 10 students continued to year 12 and there were 235,653 year 12 students. This trend is continuing and in 2017, 84.8% continued to year 12 increasing numbers to 239,689.

Increased retention to year 12 has meant that in 2016, the number of students studying advanced mathematics was 21,432 compared to 20,284 in 2001 and the number of students studying intermediate mathematics was 43,999 compared to 42,095 in 2001. It is these trends that underpin potential entry into tertiary courses in engineering. Engineers Australia's position is that advanced mathematics is preferable and bridging courses are likely to be necessary for lower level mathematics.

[10] In their latest AMSI publication Barrington and co-author Brown use National Curriculum language to separate Advanced Mathematics (Level D in the National Curriculum) and Intermediate Mathematics (Level C in the National Curriculum). Elementary Mathematics is Levels A and B in the National Curriculum.



While the trends illustrated in Figure 4.1 are disappointing, they do not convey the complete picture---gender remains an important issue. Barrington's AMSI paper provides illustrated trends for participation in advanced and intermediate mathematics by gender. However, actual data are provided for just 2015 and 2016, but this is sufficient to make the point illustrated in Figure 4.3.

Participation in year 12 mathematics by girls is substantially lower than for boys and has not improved. Participation by girls in year 12 advanced mathematics in the two years illustrated was about 7.0%. The participation rates illustrated indicate that in 2015 13,817 boys and 7,848 girls studied year 12 advanced mathematics. In 2016, the corresponding figures were 13,370 boys and 8,062 girls. Numbers studying year 12 intermediate mathematics are more evenly balanced. In 2015, 22,560 boys and 20,546 girls studied this subject with 22,845 and 21,154, respectively in 2016.

4.2 Transition from school to university engineering courses

Historically, most new engineering students progress from year 12 at school into university engineering courses through Tertiary Admission Centres (TACs). The numbers of other entrants to engineering courses were so small as to make little difference to trends. However, this has changed and now substantial numbers of prospective students apply directly to universities for places in engineering courses. These individuals have varied backgrounds including participation in other university courses, participation in TAFE courses and individuals who deferred further study when they left school.

The section uses statistics from the Department of Education and Training "Undergraduate Applications, Offers and Acceptances" between 2010 and 2018[11]. The official publication reporting these statistics contains only limited information on engineering. This difficulty has been overcome by the provision of unpublished statistics by Department staff in response to an Engineers Australia request[12].

The first part of the section focuses on students who move from year 12 into engineering courses. We consider trends in applications for places from these students, trends in the responses of universities with offers of places and trends in the acceptances of places offered. Acceptances translate into actual commencements in university engineering courses with a delay of some weeks. Although some individuals accepting places do not actually

[11] Department of Education and Training, Undergraduate Applications, Offers and Acceptances, various years, www.education.gov.au

[12] Engineers Australia thanks the Department and its staff for their cooperation in providing statistics requested.

commence courses, the differences are sufficiently small so as not to distort the subsequent trend in commencements.

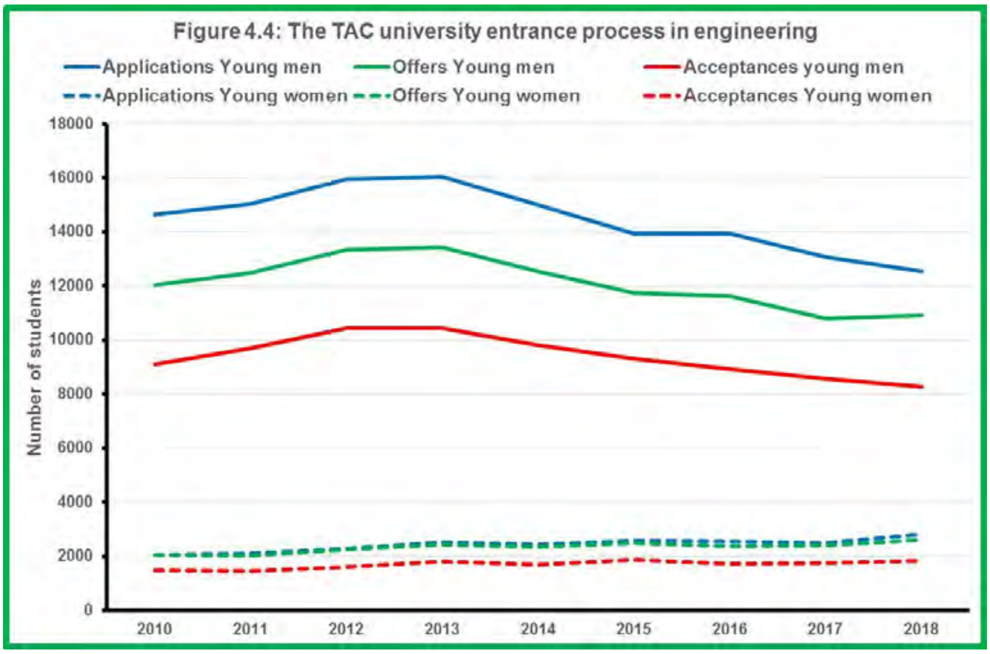
The second part of the section examines trends relating to students who apply directly to universities for places in engineering courses. In recent years there has been an upsurge in the numbers applying for places this way. Growth has been sufficient to now influence overall trends.

4.2.1 The TAC Process

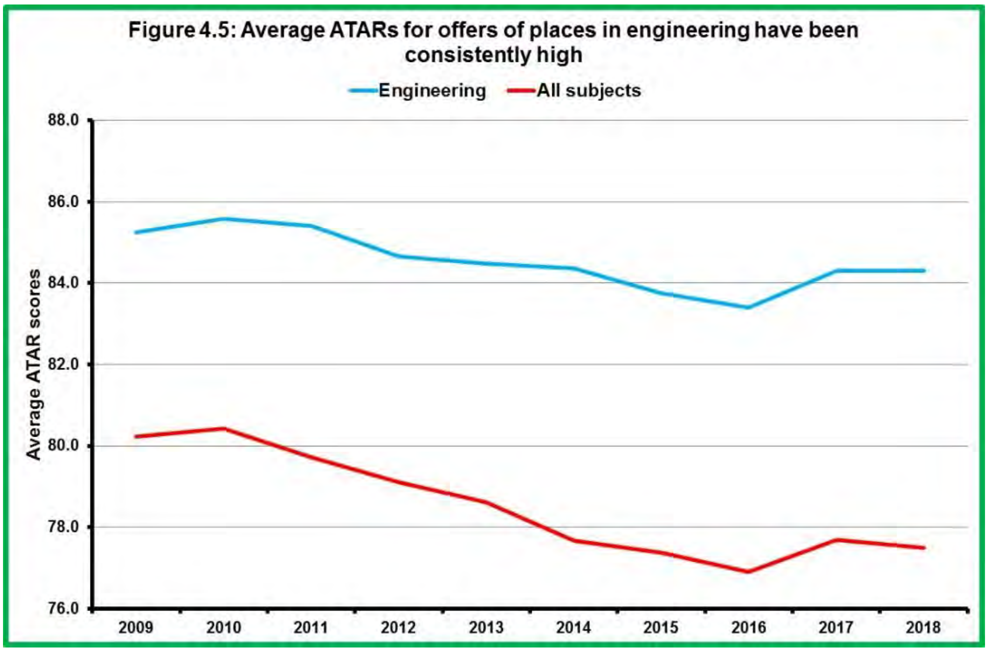
Applications for university places in engineering courses through the TAC process peaked at 18,570 in 2013. Since then, applications have fallen each year. In 2018, there were 15,360 applications, some 1.3% lower than the year before and 17.3% below the peak and 8.1% lower than applications in 2010 (when the statistical series began). Within this trend there has been a structural shift between genders. Applications from young men have fallen since 2013 in line with the overall trend, but the reduction since the peak was larger at 21.8%. In contrast, applications from young women plateaued between 2013 and 2017 and in 2018 experienced a sharp rise of 12.6% to 2,807, their highest ever level.

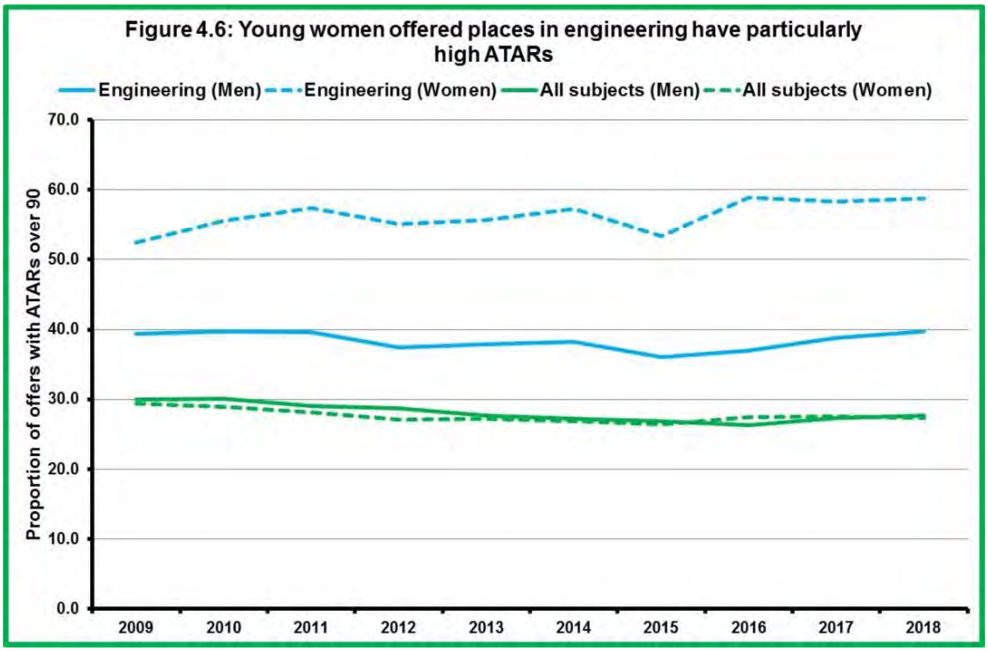
On average 83.7% of young men and 96.1% of young women who applied received offers of places in engineering from the universities. In 2018, an above average 86.8% or 10,901 of young men who applied for places were offered one. This compared to 13,424 offers to this group in 2013, in other words, 18.8% fewer offers. The lateay in applications from young women was mirrored by a similar one in offers made, but again there was a decisive increase in the number of offers in 2018 when 96.1%, or 2,622, of women applicants received offers. Since 2010, the number of offers made to young women has increased by 27.9%.

The higher offer rate for young women over young men reflects the efforts made by universities to address the gender imbalance in engineering. When evaluating this result it is important to bear in mind analysis that follows below which shows that this difference in offer rates also reflects a substantial gender difference in the ATAR ranks in favour of young women. In other words, favouring young women with a higher offer rate has in no way been at the expense of offers to lower ranked students.



On average 64.9% of young men and 69.8% of young women who originally applied for a place accept offers made by the universities. In 2018, 8,258 young men accepted an offer of a place in engineering. This was 20.9% fewer than the peak in acceptances of 10,438 in 2012 and 9.2% fewer than acceptances in 2010 when the statistical series began. There were 1,837 acceptances of offers from young women in 2018, 4.7% higher than in 2017 and 23.1% higher than in 2010. Over time the women's share of acceptances has increased from a low of 13.0% in 2011 to a record high of 18.2% in 2018. Despite this positive trend, overall acceptances in the TAC engineering process fell by another 2.2% since 2017 and are now at the lowest level since this data series commenced.





The use of ATAR as a means of managing university entrance has been criticised for a number of reasons, particularly the notion that the system can be gamed by student choice of subjects. At this stage, no alternative arrangement has been proposed and ATAR rankings remain a useful gauge of student capacity, faults and all. Over time, average ATAR rankings for offers of places made in engineering have fallen from 85.2 in 2009 to plateau at 83.4 since 2016. Figure 4.5 shows that despite these changes the average rankings for offers in engineering were almost 6 points higher than the average across all subjects.

We noted above the particularly high offer rate from universities to women applicants for places in engineering courses. While desire for greater gender equity no doubt plays a part in this decision, the more important reason is the high quality of women applicants. Figure 4.6 illustrates the proportion of men and women receiving offers of places in engineering who had ATAR rankings over 90. On average, 56.3% of women receiving offers of places had ATAR rankings over 90. Over time, this proportion has followed an upwards trend, and by 2018, it was 58.8%. In comparison, on average 38.2% of men who received offers of places in engineering had ATAR rankings over 90. The trend fell below average between 2012 and 2016, but the proportion with high ATARs has increased in 2017 and 2018 when it was 39.7. In other words, while gender equity may be important to universities, it is more likely they were attracted to the academic potential offered by female applicants for places in engineering.

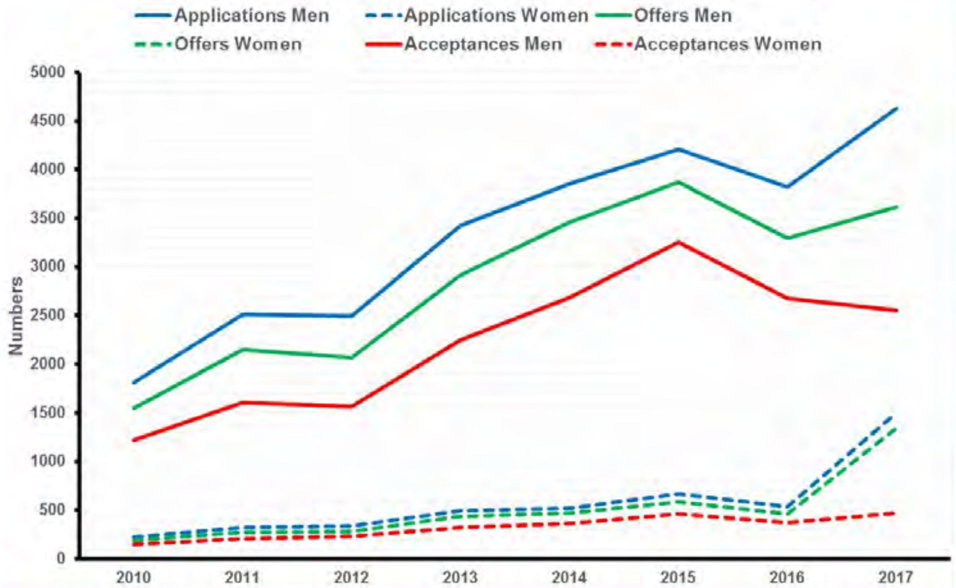
Furthermore, Figure 4.6 confirms that engineering continues to attract higher quality students. The proportion of offers in engineering with ATARs over 90 has been substantially higher than for offers across all subjects. In the case of men, the average difference has been 10 percentage points, that is, 38.4% of offers in engineering were to applicants with ATARs over 90 compared to 28.1% for offers in all subjects. The difference was even wider for women, on average 56.3% of offers to women in engineering had ATARs over 90 compared to 27.6% for all subjects.

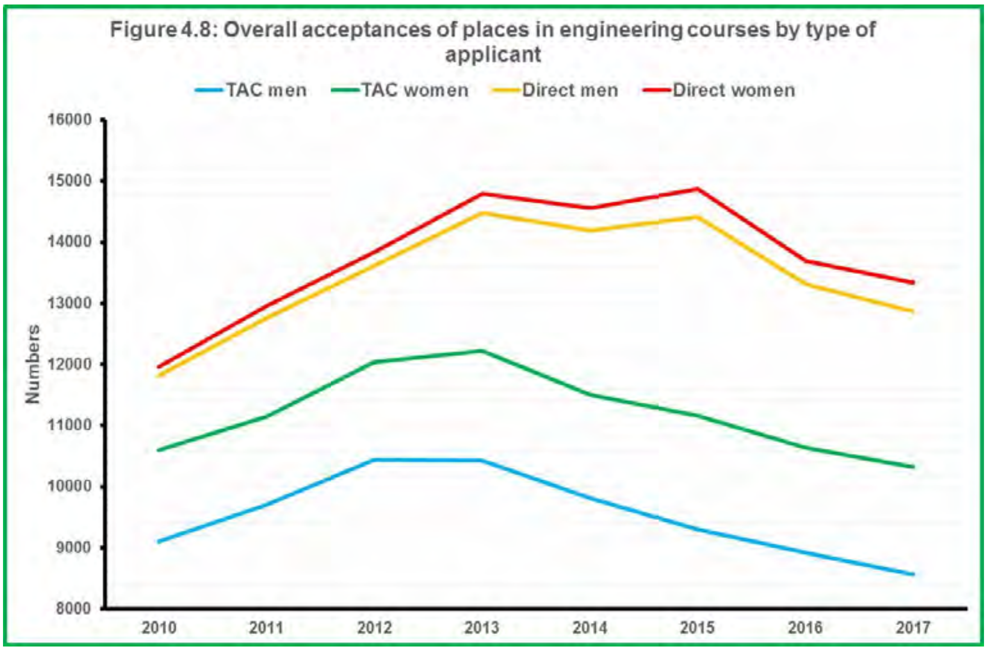
4.2.2 Direct Application Process

Since 2010, direct applications to universities for places in engineering courses have increased rapidly, but the rate of increase slowed last year. The increase between 2010 and 2017 was from 2,038 to 6,122 in 2017 or 22.2% per year but the increase to 2018 was just 0.8% to 6,132. Gender trends are illustrated in Figure 4.7. Applications from men increased from 1,812 in 2010 to 4,209 in 2015, dipped to 3,819 in 2016 before increasing sharply to 4,626 in 2017 and to 4,648 in 2018. Progress in direct applications from women was much slower until 2016, but almost trebled in 2017 and increased again in 2018 to 1,525.

Average offer rates for direct applicants are lower for women and higher for men than offer rates in the TAC process; 84.7% for men compared to 83.7% in the TAC process and 87.0% for women compared to 96.1% in the TAC process. However, the average offer rate for direct applicant women suggests that universities recognise them in a similar light to men.

Figure 4.7: The direct applications process for places in engineering





The positive picture in respect to offers is more mixed when it comes to acceptances. On average, acceptances of offers by direct applicant men was comparable to acceptances by TAC applicants, 66.3% compared to 64.9% in the TAC process. In the case of women, the acceptance rate from direct applicants was much lower than in the TAC process; 59.8% compared to 69.8% in the TAC process. Since the number of direct applicant women sharply increased in 2017, the acceptance rates have fallen sharply; to 31.2% in 2017 and 35.0% in 2018. Acceptances peaked at 3,715 in 2015 but fell to just over 3,000 in the subsequent two years. In 2018, there were 3,127 acceptances from direct applicants.

4.2.3 Combining TAC and direct entry processes

In Figure 4.8 we combine the acceptances from the TAC and direct application processes into stacked form to illustrate their relative significance. Numerically, we observe a rise and fall in acceptances of places in engineering from the TAC process. In 2010, there were 10,591 acceptances rising to a peak of 12,225 in 2013. Since then, acceptances from the TAC process have steadily fallen and were down to 10,095 in 2018. This outcome was lower than achieved in 2010. In contrast, acceptances from the direct application process have generally increased over time.

This rising trend in acceptances from direct applicants offset the decline in acceptances from the TAC process for some years so that the peak in total acceptances occurred in 2015 instead of 2013 when TAC acceptances peaked. However, stabilisation of acceptances from the direct applications process has meant that this offset has not continued. The result was that total acceptances have fallen in each of the last two years; to 13,338 in 2017 and to 13,222 in 2018. Total acceptances of places in university engineering courses are now lower than they were in 2012.

In 2010, three-quarters of acceptances were from young men participating in the TAC process. By 2018, this share had fallen to 61.9%. In contrast, the proportion of acceptances from direct applicant men has increased from 10.2% to 19.4%. Acceptances from women participating in the TAC process have increased above the 2010 share, having fallen to well below it in the middle of the decade. In 2018, 13.8% of acceptances were from this group compared to 12.5% in 2010. With the increase in acceptances from women in the direct applications process, overall 17.8% of acceptances are from women compared to 13.7% in 2010. Slow progress, but progress never-the-less.

Various factors underpin these trends. There is no doubt that the hype that surrounded the demand for engineers during the resources and infrastructure booms encouraged more young people to become interested in engineering. In 2012, demand circumstances changed and the engineering labour market has endured strong adjustment forces. Prospects for young engineering graduates have become pessimistic and the backwash from these changes have influenced prospective students to re-evaluate their choice of university course. Another factor could be falling participation in mathematics and science at school.

5. University engineering education

5.1 Domestic students studying engineering

This section considers trends relating to domestic students. Domestic students are either Australian citizens or permanent residents eligible to participate in university loan schemes. Table 5.1 presents statistics on course commencements, Table 5.2 presents statistics on course enrolments and Table 5.3 provides statistics on course completions. The statistics cover all level of courses from undergraduate preparatory through to doctoral degrees. These statistics were provided on request by the Higher Education Division of the Commonwealth Department of Education and Training.

Commencements in university engineering courses have been falling for some years now. Commencements were static in 2013, growing by just 0.1% and have fallen by an average of 4.3% per years since. In 2017, the latest data year, commencements fell by 5.4%.

The decline has affected both entry level and post graduate courses. Entry level courses include bachelor degrees, associate degrees and advanced diplomas. Commencements in these courses began to fall earlier with a fall of 1.5% in 2013. Over the next three years the falls averaged 3.5% per year. In 2017, commencements in entry level engineering courses fell by 4.5%. Commencements in entry level courses are the largest group of courses and on average have accounted for 76.7% of domestic commencements in engineering. The share was slightly higher in 2017 at 78.5%.

Commencements in post-graduate courses have fallen faster than in entry level courses, but only during the past three years when the decline averaged 5.9% per year. In 2017, commencements fell by 8.3%. On average, commencements in post-graduate courses accounted for 19.2% of domestic commencements in engineering. In 2017, this share was lower at 18.1%.

The proportion of women commencing engineering courses has slowly increased. On average 14.1% of entry level commencements have been women with 16.4% in 2017. On average 19.1 of post-graduate commencements have been women with 19.7% in 2017. Overall, 15.3% of engineering commencements since 2001 have been women with 16.8% in 2017.

Table 2 shows that the domestic engineering student population increased to a peak of 68,028 in 2015 and has since fallen to 66,458 with annual falls accelerating. Over the 17 years since 2001, enrolments grew by an average of 2.2% per year but in 2016 they fell by 0.5% and in 2017 by 1.9%. This pattern is much the same for both entry level and post graduate enrolments and in view of the longer period during which commencements have been falling is likely to continue in future.

The decline of domestic commencements has now moved into course completions. The last time completion statistics were updated this had not yet occurred. However, completions across all course levels fell by 0.4% in 2016 and by 0.9% in 2017.

Table 5.1: Domestic Students Commencing Engineering and Related Technologies Courses

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	406	472	492	537	437	378	418	380	443	514	480	435	496	490	537	529	531
Research masters	272	292	246	269	232	211	179	143	247	244	171	174	179	208	204	162	133
Coursework masters	646	849	840	795	727	759	853	916	1211	1284	1287	1423	1447	1651	1699	1768	1596
Other postgraduate	906	823	947	850	901	841	791	864	937	909	490	530	938	934	689	564	479
Bachelors	9148	8792	8667	8574	8663	8913	9460	9698	10300	10731	11327	11739	12677	12800	12634	12136	11418
Ass degrees & advanced diplomas	212	232	233	240	331	349	459	759	849	1221	1155	1396	1715	1256	1051	974	941
Diplomas	26	67	42	45	46	45	155	163	200	259	274	332	353	478	415	460	565
Other undergraduate	208	519	547	496	366	394	421	137	172	294	742	726	295	255	0	112	8
Total	11824	12046	12014	11806	11703	11890	12736	13060	14359	15456	15926	16755	18100	18072	17229	16705	15671

Women

Doctoral	128	142	123	150	113	108	101	118	143	164	141	166	166	183	181	172	181
Research masters	52	74	76	78	60	46	55	44	51	59	48	57	55	50	49	52	43
Coursework masters	152	158	167	169	149	184	178	212	238	257	275	267	333	392	392	355	335
Other postgraduate	194	175	159	167	191	198	162	216	221	225	109	117	229	184	155	118	115
Bachelors	1638	1486	1422	1336	1257	1375	1591	1597	1752	1810	1827	1856	2140	2285	2262	2254	2318
Ass degrees & advanced diplomas	14	32	17	<10	42	42	65	83	81	136	102	140	175	114	127	115	100
Diplomas	0	4	3	<10	0	2	15	21	33	25	25	26	47	43	23	55	60
Other undergraduate	29	54	52	27	64	86	97	89	116	220	360	326	188	133	0	76	3
Total	2207	2125	2019	1936	1876	2041	2264	2380	2635	2896	2887	2955	3333	3384	3189	3197	3155

All domestic commencements

Doctoral	534	614	615	687	550	486	519	498	586	678	621	601	662	673	718	701	712
Research masters	324	366	322	347	292	257	234	187	298	303	219	231	234	258	253	214	176
Coursework masters	798	1007	1007	964	876	943	1031	1128	1449	1541	1562	1690	1780	2043	2091	2123	1931
Other postgraduate	1100	998	1106	1017	1092	1039	953	1080	1158	1134	599	647	1167	1118	844	682	594
Bachelors	10786	10278	10089	9910	9920	10288	11051	11295	12052	12541	13154	13595	14817	15085	14896	14390	13736
Ass degrees & advanced diplomas	226	264	250	240	373	391	524	842	930	1357	1257	1536	1890	1370	1178	1089	1041
Diplomas	26	71	45	45	46	47	170	184	233	284	299	358	400	521	438	515	625
Other undergraduate	237	573	599	523	430	480	518	226	288	514	1102	1052	483	388	0	188	11
Total	14031	14171	14033	13742	13579	13931	15000	15440	16994	18352	18813	19710	21433	21456	20418	19902	18826

Source: Data provided by the DET

Table 5.2: Domestic Students Enrolled in Engineering & Related Technologies Courses

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	1989	2058	2239	2365	2364	2314	2287	2212	2211	2271	2422	2497	2546	2513	2695	2800	2856
Research masters	778	810	741	747	673	635	590	491	561	615	564	547	514	535	559	519	463
Coursework masters	1459	1713	1874	1905	1880	1884	2076	2259	2626	3001	3205	3376	3650	3923	4189	4401	4389
Other postgraduate	1509	1494	1682	1662	1709	1717	1634	1715	1689	1731	916	1792	1754	1686	1402	1101	956
Bachelors	32934	32872	32769	32405	31994	32553	33759	35119	36852	38453	40009	41619	43618	44801	45157	44876	43850
Assoc degrees & advanced diplomas	628	618	593	624	651	799	1070	1501	1897	2458	2716	5006	3396	3093	2932	2661	2462
Diplomas	46	87	68	56	69	73	191	196	281	374	402	469	533	668	631	680	783
Other undergraduate	247	580	579	526	414	450	449	172	210	324	1112	355	360	317	93	83	9
Total	39590	40232	40545	40290	39754	40425	42056	43665	46327	49227	51347	53661	56371	57536	57658	57121	55768

Women

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	562	562	599	636	635	621	630	640	655	711	761	807	843	859	922	988	1021
Research masters	159	158	173	187	184	162	142	131	136	154	140	142	148	149	153	141	127
Coursework masters	314	343	376	390	388	429	460	505	538	629	651	685	784	899	970	957	953
Other postgraduate	327	346	334	344	363	405	374	407	396	422	202	211	423	365	296	227	219
Bachelors	5896	5839	5675	5416	5117	5069	5299	5574	5874	6203	6380	6464	6929	7334	7598	7846	8035
Assoc degrees & advanced diplomas	35	54	45	29	53	81	132	180	198	282	264	305	356	308	308	276	257
Diplomas	0	4	3	1	1	4	18	32	44	43	469	38	66	63	48	64	75
Other undergraduate	34	61	60	34	72	102	113	109	136	230	246	444	216	158	75	92	3
Total	7327	7367	7265	7037	6813	6873	7168	7578	7977	8674	8904	9096	9765	10135	10370	10591	10690

Domestic students

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	2551	2620	2838	3001	2999	2935	2917	2852	2866	2982	3183	3304	3389	3372	3617	3788	3877
Research masters	937	968	914	934	857	797	732	622	697	769	704	689	662	684	712	660	590
Coursework masters	1773	2056	2250	2295	2268	2313	2536	2764	3164	3630	3856	4061	4434	4822	5159	5358	5342
Other postgraduate	1836	1840	2016	2006	2072	2122	2008	2122	2085	2153	1118	2003	2177	2051	1698	1328	1175
Bachelors	38830	38711	38444	37821	37111	37622	39058	40693	42726	44656	46389	48083	50547	52135	52755	52722	51885
Assoc degrees & advanced diplomas	663	672	638	653	704	880	1202	1681	2095	2740	2980	5311	3752	3401	3240	2937	2719
Diplomas	46	91	71	57	70	77	209	228	325	417	871	507	599	731	679	744	858
Other undergraduate	281	641	639	560	486	552	562	281	346	554	1358	799	576	475	168	175	12
Total	46917	47599	47810	47327	46567	47298	49224	51243	54304	57901	60251	62757	66136	67671	68028	67712	66458

Source: Data provided by DET

Table 5.3: Domestic Students Completing Courses in Engineering & Related Technologies

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	261	317	333	335	357	390	410	389	380	370	306	382	403	416	463	440	478
Research masters	119	114	120	125	102	105	100	102	81	76	64	81	103	80	74	80	82
Coursework masters	529	511	551	538	521	487	548	564	649	834	873	969	1116	1158	1244	1290	1310
Other postgraduate	344	279	337	327	298	350	347	413	485	526	302	250	629	621	692	528	453
Bachelors	5034	4753	4847	5005	4732	5062	4931	5184	5161	5320	5649	5777	6016	6258	6546	6610	6588
Assoc degrees & advanced diplomas	135	122	90	92	87	83	121	155	254	285	300	475	440	473	516	463	457
Diplomas	27	54	51	23	47	35	62	51	55	100	120	133	132	244	221	264	261
Other undergraduate	108	279	206	443	168	218	156	0	0	0	328	315	0	0	0	26	0
Total	6557	6429	6535	6888	6312	6730	6675	6858	7065	7511	7942	8382	8839	9250	9756	9701	9629

Women

Doctoral	63	65	89	88	96	98	111	124	102	104	94	113	133	156	140	163	159
Research masters	28	33	28	25	31	34	35	25	18	23	34	19	29	23	34	36	23
Coursework masters	107	113	112	107	114	89	138	126	139	190	172	176	239	268	299	277	280
Other postgraduate	65	55	74	82	65	77	100	109	112	146	56	54	134	173	156	115	92
Bachelors	1027	968	984	975	948	964	855	893	902	917	1011	1018	1028	1134	1088	1133	1154
Assoc degrees & advanced diplomas	5	<10	14	9	7	<10	12	20	24	35	27	43	35	52	54	55	36
Diplomas	0	<10	1	0	0	<10	11	9	5	9	10	8	20	20	18	21	30
Other undergraduate	4	13	6	1	5	3	4	0	0	0	78	83	0	0	0	0	0
Total	1299	1257	1308	1287	1266	1271	1266	1306	1302	1424	1482	1514	1622	1824	1789	1800	1774

All domestic completions

Doctoral	324	382	422	423	453	488	521	513	482	474	400	495	536	572	603	603	637
Research masters	147	147	148	150	133	139	135	127	99	99	98	100	132	103	108	116	105
Coursework masters	636	624	663	645	635	576	686	690	788	1024	1045	1145	1355	1426	1543	1567	1590
Other postgraduate	409	334	411	409	363	427	447	522	597	672	358	304	763	794	848	643	545
Bachelors	6061	5721	5831	5980	5680	6026	5786	6077	6063	6237	6660	6795	7044	7392	7634	7743	7742
Assoc degrees & advanced diplomas	140	122	104	101	94	83	133	175	278	320	327	518	479	523	570	518	493
Diplomas	27	54	52	23	47	35	73	60	60	109	130	141	152	264	239	285	291
Other undergraduate	112	292	212	444	173	221	160	0	0	0	406	398	0	0	0	26	0
Total	7856	7686	7843	8175	7578	8001	7941	8164	8367	8935	9424	9896	10461	11074	11545	11501	11403

Source: Data provided by DET

At this stage the decline is more evident among post-graduate courses than entry level courses. Completions of entry level courses peaked at 8,261 in 2016 and it was only in 2017 when the first fall of 0.3% was registered. Completions of post-graduate courses began in 2016 (-5.6%) and continued into 2017 (-1.8%).

On average the proportion of women completing engineering courses has been slightly higher than the corresponding commencements. For entry level courses, on average 15.9% of completions were by women compared to 14.1% of commencements. In 2017, 16.4% of course commencements were women compared to 14.5% of completions. On average 19.3% of post-graduate completions were by women compared to 19.1% of commencements. These shares were maintained in 2017.

5.2 Overseas students studying engineering

This section considers statistics for overseas students. Although many overseas students now apply on-shore for permanent migration visas during the final stages of their courses, the facts are that they must complete immigration formalities before joining the engineering labour market, hence their inclusion in migration statistics. Never-the-less, these students are an important factor in university engineering education and are included for this reason. Using the same format as for domestic students, commencements are reported in Table 5.4, enrolments in Table 5.5 and completions in Table 5.6.

After a lull between 2010 and 2013, commencements in engineering courses by overseas students accelerated strongly. Long term average growth was 8.8% per year, growth over the past three years averaged 12.9% and in 2017 it was 12.7%.

Growth was strongest for commencements in post-graduate courses. The long-term average was 11.8% per year, it was faster averaged over the past three years at 18.1% per year and even faster in 2017 at 20.7%. In 2017, there were 9,911 commencements by overseas students in post-graduate engineering courses; 8,101 or 81.7% in coursework master degrees and 1,428 or 14.4% in doctoral courses.

The number of post-graduate commencements is now higher than entry level course commencements. Growth in entry level commencements by overseas students was substantially higher than it was for domestic students, averaging 5.6% per year over the long term, 7.9% per year over the past three years and a drop to 5.4% in 2017. In 2017, there were 7,726 entry level commencements, 96.8% of whom started bachelor degrees.

The proportion of engineering commencements by women overseas students has increased over time and is higher than for domestic student commencements. The long-term proportion of women for entry level courses was 17.6% with 20.0% in 2017. For post-graduate courses these proportions were 19.1% and 21.4%, respectively.

Table 5.4: Overseas Students Commencing Engineering & Related Technologies Courses

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	190	186	207	213	222	272	336	413	579	600	654	773	830	832	868	819	1035
Research masters	97	117	133	173	137	135	144	131	144	164	165	160	144	156	120	111	151
Coursework masters	1089	1442	2443	2344	2142	1940	2101	2084	2580	2217	1962	2243	2966	3679	4360	5347	6461
Other postgraduate	194	219	128	134	260	269	251	255	316	257	206	156	201	108	139	115	144
Bachelors	2818	3206	3564	3283	3109	3184	3523	3679	4385	4628	4624	4331	4426	4867	5143	5742	5964
Ass degrees & advanced diplomas	15	29	14	23	40	47	159	129	181	144	264	184	166	183	184	206	218
Diplomas	1	29	12	17	64	48	345	274	415	590	565	601	923	1115	1256	1319	1374
Other undergraduate	2	9	46	34	41	63	34	50	45	53	69	63	0	0	18	72	68
Total	4406	5237	6547	6221	6015	5958	6893	7015	8645	8653	8509	8511	9656	10940	12088	13731	15415

Women

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	47	40	50	51	50	89	95	162	225	198	253	255	297	329	284	313	393
Research masters	24	23	25	30	40	43	54	49	64	54	67	65	55	55	43	50	53
Coursework masters	216	303	407	443	437	355	427	468	520	553	473	515	626	838	1113	1417	1640
Other postgraduate	27	38	20	28	35	53	50	54	49	61	32	25	48	21	38	38	34
Bachelors	556	653	716	653	669	670	766	786	926	998	965	892	991	1096	1367	1352	1518
Ass degrees & advanced diplomas	1	1	1	2	1	2	3	4	10	13	9	14	38	9	14	30	26
Diplomas	0	18	0	0	44	67	86	39	60	81	53	57	82	120	145	198	220
Other undergraduate	3	1	17	8	10	10	19	13	15	12	23	18	0	0	5	5	11
Total	874	1077	1236	1215	1286	1289	1500	1575	1869	1970	1877	1844	2137	2468	3009	3403	3895

All overseas commencemenrs

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	237	226	257	264	272	361	431	575	804	798	907	1028	1127	1161	1152	1132	1428
Research masters	121	140	158	203	177	178	198	180	208	218	232	225	199	211	163	161	204
Coursework masters	1305	1745	2850	2787	2579	2295	2528	2552	3100	2770	2435	2758	3592	4517	5473	6764	8101
Other postgraduate	221	257	148	162	295	322	301	309	365	318	238	181	249	129	177	153	178
Bachelors	3374	3859	4280	3936	3778	3854	4289	4465	5311	5626	5589	5223	5417	5963	6510	7094	7482
Ass degrees & advanced diplomas	16	30	15	25	41	49	162	133	191	157	273	198	204	192	198	236	244
Diplomas	1	47	12	17	108	115	431	313	475	671	618	658	1005	1235	1401	1517	1594
Other undergraduate	5	10	63	42	51	73	53	63	60	65	92	81	0	0	23	77	79
Total	5280	6314	7783	7436	7301	7247	8393	8590	10514	10623	10384	10352	11793	13408	15097	17134	19310

Source: Data provided by the DET

Table 5.5: Overseas Students Enrolled in Engineering & Related Technologies Courses

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	560	617	704	791	901	1001	1113	1284	1620	1903	2242	2684	3000	3185	3274	3365	3543
Research masters	197	213	232	306	320	338	334	309	297	340	351	354	341	367	345	292	313
Coursework masters	1647	2193	3674	4051	4109	3662	3743	4065	4532	4617	4196	4088	5055	6543	8170	10397	12950
Other postgraduate	278	332	219	208	335	359	332	346	406	389	286	283	280	188	178	161	178
Bachelors	6673	7815	9045	9613	9683	9931	10507	11414	12471	13899	14728	14971	15470	15900	16503	17870	19116
Assoc degrees & advanced diplomas	29	43	31	43	55	73	180	233	311	291	408	471	394	384	386	426	461
Diplomas	1	36	32	40	82	94	526	527	652	927	997	962	1312	1699	1952	2176	2198
Other undergraduate	2	12	53	42	48	72	36	54	46	54	82	72	0	0	18	81	90
Total	9387	11261	13990	15094	15533	15530	16771	18232	20335	22420	23287	23818	25852	28266	30826	34768	38849

Women

Doctoral	134	137	157	193	210	263	310	423	568	682	834	971	1038	1111	1144	1185	1298
Research masters	38	47	49	54	81	90	112	111	126	136	136	151	145	140	125	118	114
Coursework masters	379	457	660	758	803	682	690	861	934	1019	947	929	1077	1411	1908	2626	3313
Other postgraduate	43	51	33	32	45	63	59	66	65	74	49	37	68	47	48	44	37
Bachelors	1394	1682	1919	2025	2061	2125	2284	2449	2645	2963	3123	3153	3325	3525	3880	4282	4766
Assoc degrees & advanced diplomas	2	2	3	3	1	2	5	7	13	19	18	29	53	31	30	37	53
Diplomas	0	18	31	31	51	112	167	110	86	120	104	91	122	172	218	281	330
Other undergraduate	4	1	18	10	12	12	20	14	15	14	26	23	0	0	5	7	13
Total	1994	2395	2870	3106	3264	3349	3647	4041	4452	5027	5239	5387	5828	6437	7358	8580	9924

Overseas students

Doctoral	694	754	861	984	1111	1264	1423	1707	2188	2585	3076	3655	4038	4296	4418	4550	4841
Research masters	235	260	281	360	401	428	446	420	423	476	487	505	486	507	470	410	427
Coursework masters	2026	2650	4334	4809	4912	4344	4433	4926	5466	5636	5143	5017	6132	7953	10078	13023	16263
Other postgraduate	321	383	252	240	380	422	391	412	471	463	335	320	348	235	226	205	215
Bachelors	8067	9497	10964	11638	11744	12056	12791	13863	15116	16862	17851	18124	18795	19425	20383	22152	23882
Assoc degrees & advanced diplomas	31	45	34	46	56	75	185	240	324	310	426	500	447	415	416	463	514
Diplomas	1	54	63	71	133	206	693	637	738	1047	1101	1053	1434	1871	2170	2457	2528
Other undergraduate	6	13	71	52	60	84	56	68	61	68	108	95	0	0	23	88	103
Total	11381	13656	16860	18200	18797	18879	20418	22273	24787	27447	28526	29205	31680	34703	38184	43348	48773

Source: Data provided by DET

Table 5.6: Overseas Students Completing Courses in Engineering & Related Technologies

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	78	84	86	127	154	173	207	152	181	255	294	340	423	527	481	581	566
Research masters	45	36	35	59	59	104	75	76	64	65	86	80	83	87	71	93	93
Coursework masters	718	870	1441	1610	1909	1539	1607	1785	1906	2162	2256	1823	1934	2195	2580	3065	3691
Other postgraduate	93	128	121	103	156	207	181	194	200	235	197	129	184	133	126	112	114
Bachelors	1373	1424	1618	1794	1958	1904	1836	2036	2115	2375	2701	2842	3250	3187	2809	3070	3429
Assoc degrees & advanced diplomas	16	19	12	12	21	10	24	67	87	85	56	133	127	85	113	122	142
Diplomas	1	17	13	21	21	42	188	239	204	263	353	329	367	634	679	903	891
Other undergraduate	1	4	41	10	13	28	8	11	15	0	82	63	0	0	0	34	55
Total	2325	2582	3367	3736	4291	4007	4126	4560	4772	5440	6025	5739	6368	6848	6859	7980	8981

Women

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	19	15	23	24	31	35	46	32	45	63	91	117	156	169	175	174	214
Research masters	15	5	11	14	16	22	20	25	22	32	35	32	30	28	50	35	28
Coursework masters	198	201	275	332	390	291	293	403	440	498	529	436	469	517	625	799	1067
Other postgraduate	15	22	24	16	37	31	31	47	41	44	22	16	35	31	34	25	22
Bachelors	285	324	379	426	438	439	454	548	474	537	620	624	724	794	674	748	872
Assoc degrees & advanced diplomas	0	0	0	2	0	0	1	4	4	9	0	10	11	12	16	5	23
Diplomas	0	0	10	23	7	43	80	77	32	32	51	31	32	77	111	121	145
Other undergraduate	0	1	11	2	5	5	2	5	3	0	31	9	0	0	0	7	8
Total	532	568	733	839	924	866	927	1141	1061	1215	1380	1277	1457	1628	1685	1914	2379

All overseas completions

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	97	99	109	151	185	208	253	184	226	318	385	457	579	696	656	755	780
Research masters	60	41	46	73	75	126	95	101	86	97	121	112	113	115	121	128	121
Coursework masters	916	1071	1716	1942	2299	1830	1900	2188	2346	2660	2785	2259	2403	2712	3205	3864	4758
Other postgraduate	108	150	145	119	193	238	212	241	241	279	219	145	219	164	160	137	136
Bachelors	1658	1748	1997	2220	2396	2343	2290	2584	2589	2912	3321	3466	3974	3981	3483	3818	4301
Assoc degrees & advanced diplomas	16	19	12	14	21	10	25	71	91	94	56	143	138	97	129	127	165
Diplomas	1	17	23	44	28	85	268	316	236	295	404	360	399	711	790	1024	1036
Other undergraduate	1	5	52	12	18	33	10	16	18	0	113	72	0	0	0	41	63
Total	2857	3150	4100	4575	5215	4873	5053	5701	5833	6655	7405	7016	7825	8476	8544	9894	11360

Source: Data provided by DET

Table 5.7: Students Commencing Engineering & Related Technologies Courses, by Country of Domicile

Domestic students

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	534	614	615	687	550	486	519	498	586	678	621	601	662	673	718	701	712
Research masters	324	366	322	347	292	257	234	187	298	303	219	231	234	258	253	214	176
Coursework masters	798	1007	1007	964	876	943	1031	1128	1449	1541	1562	1690	1780	2043	2091	2123	1931
Other postgraduate	1100	998	1106	1017	1092	1039	953	1080	1158	1134	1187	647	1167	1118	844	682	594
Bachelors	10786	10278	10089	9910	9920	10288	11051	11295	12052	12541	13154	13595	14817	15085	14896	14390	13736
Ass degrees & advanced diplomas	226	264	250	240	373	391	524	842	930	1357	1257	1536	1890	1370	1178	1089	1041
Diplomas	26	71	45	45	46	47	170	184	233	284	299	358	400	521	438	515	625
Other undergraduate	237	573	599	523	430	480	518	226	288	514	514	1052	483	388	0	188	11
Total	14031	14171	14033	13742	13579	13931	15000	15440	16994	18352	18813	19710	21433	21456	20418	19902	18826

Overseas students

Doctoral	237	226	257	264	272	361	431	575	804	798	907	1028	1127	1161	1152	1132	1428
Research masters	121	140	158	203	177	178	198	180	208	218	232	225	199	211	163	161	204
Coursework masters	1305	1745	2850	2787	2579	2295	2528	2552	3100	2770	2435	2758	3592	4517	5473	6764	8101
Other postgraduate	221	257	148	162	295	322	301	309	365	318	327	181	249	129	177	153	178
Bachelors	3374	3859	4280	3936	3778	3854	4289	4465	5311	5626	5589	5223	5417	5963	6510	7094	7482
Ass degrees & advanced diplomas	16	30	15	25	41	49	162	133	191	157	275	198	204	192	198	236	244
Diplomas	1	47	12	17	108	115	431	313	475	671	618	658	1005	1235	1401	1517	1594
Other undergraduate	5	10	63	42	51	73	53	63	60	65	<5	81	0	0	23	77	79
Total	5280	6314	7783	7436	7301	7247	8393	8590	10514	10623	10386	10352	11793	13408	15097	17134	19310

All commencing students

Doctoral	771	840	872	951	822	847	950	1073	1390	1476	1528	1629	1789	1834	1870	1833	2140
Research masters	445	506	480	550	469	435	432	367	506	521	451	456	433	469	416	375	380
Coursework masters	2103	2752	3857	3751	3455	3238	3559	3680	4549	4311	3997	4448	5372	6560	7564	8887	10032
Other postgraduate	1321	1255	1254	1179	1387	1361	1254	1389	1523	1452	1514	828	1416	1247	1021	835	772
Bachelors	14160	14137	14369	13846	13698	14142	15340	15760	17363	18167	18743	18818	20234	21048	21406	21484	21218
Ass degrees & advanced diplomas	242	294	265	265	414	440	686	975	1121	1514	1532	1734	2094	1562	1376	1325	1285
Diplomas	27	118	57	62	154	162	601	497	708	955	917	1016	1405	1756	1839	2032	2219
Other undergraduate	242	583	662	565	481	553	571	289	348	579	514	1133	483	388	23	265	90
Total	19311	20485	21816	21178	20880	21178	23393	24030	27508	28975	29196	30062	33226	34864	35515	37036	38136

Source: Data provided by the DET

Table 5.8: Students Enrolled in Engineering & Related Technologies Courses, by Country of Domicile

Domestic

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	2551	2620	2838	3001	2999	2935	2917	2852	2866	2982	3183	3304	3389	3372	3617	3788	3877
Research masters	937	968	914	934	857	797	732	622	697	769	704	689	662	684	712	660	590
Coursework masters	1773	2056	2250	2295	2268	2313	2536	2764	3164	3630	3856	4061	4434	4822	5159	5358	5342
Other postgraduate	1836	1840	2016	2006	2072	2122	2008	2122	2085	2153	1118	1224	2177	2051	1698	1328	1175
Bachelors	38830	38711	38444	37821	37111	37622	39058	40693	42726	44656	46389	48083	50547	52135	52755	52722	51885
Assoc degrees & advanced diplomas	663	672	638	653	704	880	1202	1681	2095	2740	2980	3311	3752	3401	3240	2937	2719
Diplomas	46	91	71	57	70	77	209	228	325	417	871	507	599	731	679	744	858
Other undergraduate	281	641	639	560	486	552	562	281	346	554	1358	1578	576	475	168	175	12
Total	46917	47599	47810	47327	46567	47298	49224	51243	54304	57901	60251	62757	66136	67671	68028	67712	66458

Overseas

Doctoral	694	754	861	984	1111	1264	1423	1707	2188	2585	3076	3655	4038	4296	4418	4550	4841
Research masters	235	260	281	360	401	428	446	420	423	476	487	505	486	507	470	410	427
Coursework masters	2026	2650	4334	4809	4912	4344	4433	4926	5466	5636	5143	5017	6132	7953	10078	13023	16263
Other postgraduate	321	383	252	240	380	422	391	412	471	463	335	320	348	235	226	205	215
Bachelors	8067	9497	10964	11638	11744	12056	12791	13863	15116	16862	17851	18124	18795	19425	20383	22152	23882
Assoc degrees & advanced diplomas	31	45	34	46	56	75	185	240	324	310	426	500	447	415	416	463	514
Diplomas	1	54	63	71	133	206	693	637	738	1047	1101	1053	1431	1871	2170	2457	2528
Other undergraduate	6	13	71	52	60	84	56	68	61	68	108	95	0	0	23	88	103
Total	11381	13656	16860	18200	18797	18879	20418	22273	24787	27447	28526	29205	31680	34703	38184	43348	48773

All students

Doctoral	3245	3374	3699	3985	4110	4199	4340	4559	5054	5567	6259	6959	7427	7668	8035	8338	8718
Research masters	1172	1228	1195	1294	1258	1225	1178	1042	1120	1245	1191	1194	1148	1191	1182	1070	1017
Coursework masters	3799	4706	6584	7104	7180	6657	6969	7690	8630	9266	8999	9078	10566	12775	15237	18381	21605
Other postgraduate	2157	2223	2268	2246	2452	2544	2399	2534	2556	2616	2560	1544	2525	2286	1924	1533	1390
Bachelors	46897	48208	49408	49459	48855	49678	51849	54556	57842	61518	64240	66207	69342	71560	73138	74874	75767
Assoc degrees & advanced diplomas	694	717	672	699	760	955	1387	1921	2419	3050	3408	3811	4199	3816	3656	3400	3233
Diplomas	47	145	134	128	203	283	902	865	1063	1464	1540	1560	2030	2602	2849	3201	3386
Other undergraduate	287	654	710	612	546	636	618	349	407	622	580	1673	576	475	191	263	115
Total	58298	61255	64670	65527	65364	66177	69642	73516	79091	85348	88777	91962	97816	102374	106212	111060	115231

Source: Data provided by DET

Table 5.9: Students Completing Courses in Engineering & Related Technologies, by Country of Domicile

Domestic

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Doctoral	324	382	422	423	453	488	521	513	482	474	400	495	536	572	603	603	637
Research masters	147	147	148	150	133	139	135	127	99	99	98	100	132	103	108	116	105
Coursework masters	636	624	663	645	635	576	686	690	788	1024	1045	1145	1355	1426	1543	1567	1590
Other postgraduate	409	334	411	409	363	427	447	522	597	672	358	304	763	794	848	643	545
Bachelors	6061	5721	5831	5980	5680	6026	5786	6077	6063	6237	6660	6795	7044	7392	7634	7743	7742
Assoc degrees & advanced diplomas	140	122	104	101	94	83	133	175	278	320	327	518	479	523	570	518	493
Diplomas	27	54	52	23	47	35	73	60	60	109	130	141	152	264	239	285	291
Other undergraduate	112	292	212	444	173	221	160	0	0	0	406	398	0	0	0	26	0
Total	7856	7686	7843	8175	7578	8001	7941	8164	8367	8935	9424	9896	10461	11074	11545	11501	11403

Overseas

Doctoral	97	99	109	151	185	208	253	184	226	318	385	457	579	696	656	755	780
Research masters	60	41	46	73	75	126	95	101	86	97	121	112	113	115	121	128	121
Coursework masters	916	1071	1716	1942	2299	1830	1900	2188	2346	2660	2785	2259	2403	2712	3205	3864	4758
Other postgraduate	108	150	145	119	193	238	212	241	241	279	219	145	219	164	160	137	136
Bachelors	1658	1748	1997	2220	2396	2343	2290	2584	2589	2912	3321	3466	3974	3981	3483	3818	4301
Assoc degrees & advanced diplomas	16	19	12	14	21	10	25	71	91	94	56	143	138	97	129	127	165
Diplomas	1	17	23	44	28	85	268	316	236	295	404	360	399	711	790	1024	1036
Other undergraduate	1	5	52	12	18	33	10	16	18	0	113	72	0	0	0	41	63
Total	2857	3150	4100	4575	5215	4873	5053	5701	5833	6655	7405	7016	7825	8476	8544	9894	11360

All student completions

Doctoral	421	481	531	574	638	696	774	697	708	792	785	952	1115	1268	1259	1358	1417
Research masters	207	188	194	223	208	265	230	228	185	196	219	212	245	218	229	244	226
Coursework masters	1552	1695	2379	2587	2934	2406	2586	2878	3134	3684	3830	3404	3758	4138	4748	5431	6348
Other postgraduate	517	484	556	528	556	665	659	763	838	951	577	449	982	958	1008	780	681
Bachelors	7719	7469	7828	8200	8076	8369	8076	8661	8652	9149	9981	10261	11018	11373	11117	11561	12043
Assoc degrees & advanced diplomas	156	141	116	115	115	93	158	246	369	414	383	661	617	620	699	645	658
Diplomas	28	71	75	67	75	120	341	376	296	404	534	501	551	975	1029	1309	1327
Other undergraduate	113	297	264	456	191	254	170	16	18	0	519	470	0	0	0	67	63
Total	10713	10836	11943	12750	12793	12874	12994	13865	14200	15590	16829	16912	18286	19550	20089	21395	22763

Source: Data provided by DET

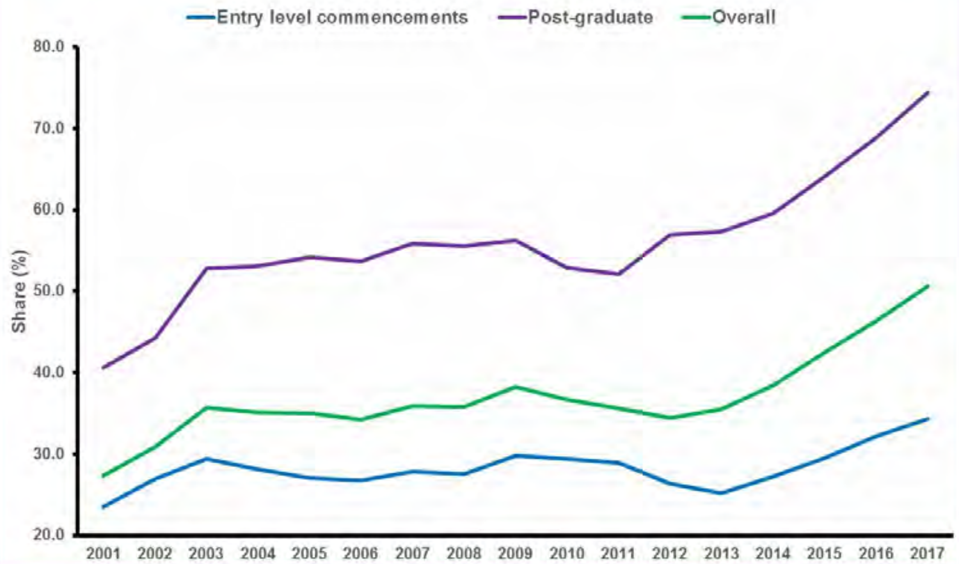
5.3 Overall situation

The next set of statistics in Tables 5.7 to 5.8 inclusive, show the overall situation for university engineering education in Australia Overall commencements in university engineering courses continue to grow, but growth has slowed in the past three years. Long term commencements

have grown by 4.4% per year, but during the past three years, and in 2017, this was 3.0% per year. Commencements in entry level courses have stalled and in 2017 have declined. There has been relatively strong growth in commencements by overseas students, but commencements in these courses by domestic students have been falling since 2013. The net result is that long term growth in entry level course commencements of 2.9% per year has turned into a decline of -0.2% per year over the past three years and -1.3% in 2017.

Overall growth in university engineering commencements is primarily due to growth in commencements in post-graduate courses, driven primarily by commencements of overseas students. Growth in the overseas sector has always been stronger; long term commencements in post-graduate courses by domestic students has averaged 2.3% per year compared to 11.8% per year for overseas students. The past three years emphasize this contrast further. Post-graduate commencements by domestic students have declined by 5.9% per year, whereas commencements by overseas students have accelerated to 18.1% per year. This contrast was even more graphic in 2017 with a fall of 8.3% for domestic students compared to an increase of 20.7% for overseas students combining for an overall result of 11.7%.

Figure 5.1: The shares of overseas student in engineering course commencements has increased



The outcome of these changes is illustrated in Figure 5.1 which shows that in 2017 just over half of all commencements in university engineering courses was by overseas students. Since 2001, overseas students have increased their share of entry level commencements from 23.5% to 34.3%. This change, however, pales compared to the extraordinary growth in post-graduate commencements. In 2001, overseas students accounted for 40.6% of commencements in post-graduate engineering courses and by 2017 this share had increased to 74.4%.

The engineering student population has grown substantially over the past 17 years (see Table 8). In 2001, there were 58,298 students enrolled in some type of university engineering course. By 2017, this had increased by 97.7% to 115,231. In 2001, 19.5% of students were overseas students and consistent with the trends in commencements, this share grew to 42.3% in 2017.

Although still growing, the growth of the university engineering population has slowed. Over the long-term growth averaged 4.4% per year, but over the past three years this slowed to 4.0% per year and to 3.0% in 2017 influenced mainly by the slowdown in entry level students.

Trends in completions of university engineering courses lag commencements and have continued to grow, accelerating in recent years. For completions of courses of all levels, the long-term growth rate was 4.9% per year, increasing to an average 5.2% per year over the past three years and to 6.4% in 2017.

Completions of entry level courses has grown more slowly than completions of post-graduate courses and the share of the latter in all completions has increased. Over the long-term completions of entry level courses have increased by 3.1% per year and their share has fallen from 73.5% in 2001 to 55.8% in 2017. In 2017, these completions increased by 4.1%. The long-term completion growth of post-graduate courses was 7.9% per year and the share of these courses increased from 25.2% in 2001 to 38.1% in 2017. Consistent with trends already discussed in 2017, post-graduate course completions increased by 11.0%.

The number and shares of overseas students completing university engineering courses have both increased over the past 17 years. In 2017, overseas students accounted for 35.2% of entry level completions, 66.8% of post-graduate course completions and 49.9% of all course completions.

5.4 Distribution between states and territories

Tables 5.10 and 5.11 set out the distributions for domestic and overseas student commencements in entry level engineering courses from 2010 to 2017. For this purpose, entry level is defined to include bachelor degrees, associate degrees and advanced diplomas. Corresponding distributions for completions of entry level courses are in Tables 5.12 and 5.13.

Table 5.10: Distribution of domestic entry level commencements between States & Territories

Year	NSW	Victoria	Queensland	SA	WA	Tasmania	NT	ACT
2010	3700	3036	3792	980	1847	278	81	184
2011	3971	3235	3634	1017	1987	310	88	169
2012	4288	3493	4155	1167	1275	284	107	191
2013	4611	3970	4721	1306	1294	446	106	178
2014	4607	3756	4829	1284	1292	402	116	168
2015	5277	3669	4203	1234	1015	382	107	181
2016	5122	3649	3974	1151	1037	305	95	188
2017	4930	3441	3697	1113	1026	333	83	192

Participation in entry level courses is dominated by the three largest jurisdictions, NSW, Victoria and Queensland. In 2017, they accounted for 81.5% of domestic commencements and 78.4% of overseas commencements. Their shares of the corresponding completions were slightly lower but still dominant. They accounted for 80.4% of domestic entry level completions and 71.9% of overseas entry level completions.

Table 5.11: Distribution of overseas entry level commencements between States& Territories

Year	NSW	Victoria	Queensland	SA	WA	Tasmania	NT	ACT
2010	1418	1941	480	617	968	266	5	83
2011	1486	1880	485	663	1006	236	20	86
2012	1416	1907	492	545	804	101	20	82
2013	1482	2049	566	510	764	138	17	84
2014	1580	2143	650	600	876	188	8	109
2015	1839	2538	647	424	972	155	20	100
2016	2224	2709	591	447	983	198	31	146
2017	2434	3007	618	558	745	223	16	124

Table 5.12: Distribution of domestic entry level completions between States & Territories

Year	NSW	Victoria	Queensland	SA	WA	Tasmania	NT	ACT
2010	1745	1877	1392	560	751	115	15	98
2011	1787	1932	1559	525	899	156	20	105
2012	1792	2118	1766	470	872	156	13	118
2013	1903	2154	1706	581	925	144	8	96
2014	2115	2079	1910	579	954	167	15	94
2015	2220	1997	2090	668	913	181	23	100
2016	2314	2041	2162	687	760	191	22	104
2017	2331	2079	2205	668	663	166	19	95

Table 5.13: Distribution of overseas entry level completions between States & Territories

Year	NSW	Victoria	Queensland	SA	WA	Tasmania	NT	ACT
2010	689	1082	253	450	408	94	0	26
2011	701	1282	264	399	597	94	0	38
2012	742	1396	320	438	558	78	0	73
2013	880	1706	338	465	595	51	5	65
2014	990	1413	345	567	613	64	5	73
2015	896	1311	341	391	524	72	7	64
2016	1005	1388	361	414	570	142	7	100
2017	1038	1738	429	406	592	164	8	85

The recent trend in domestic entry level commencements has been downwards in the five largest jurisdictions and static in the three smallest. The indications are that universities in NSW and Victoria have expanded intakes of overseas students in entry level courses to offset the decline in the number of domestic commencements. The picture is more varied in the other jurisdictions but in 2017, overseas student commencements in entry level courses increased in South Australia and Tasmania following falls in previous years.

National completions of entry level courses plateaued in 2016 and 2017. This was largely mirrored in jurisdictional outcomes with any increases being quite small and within the range of variability in past years. Given commencement trends this picture is likely to change very soon. Completions of entry level courses by overseas students increased nationally and the three largest jurisdictions plus Western Australia and Tasmania contributed to this result. Outcomes plateaued in the other jurisdictions.

The dominance of the three largest jurisdictions is also evident in statistics relating to post-graduate studies in engineering. In 2017, just over three-quarters of domestic commencements were in these jurisdictions and a much higher share of overseas commencements at 85.7%. There was a similar skew in post-graduate completions, but several percentage points lower. The skew in post-graduate studies favouring the three largest jurisdictions is higher for overseas students, the opposite to the skew favouring domestic students in respect to entry level courses. Another feature of post-graduate commencements was the strength of the substitution of large numbers of overseas students to offset the decline in the number of domestic students studying post-graduate courses in engineering. In 2017, there were almost three times as many overseas students starting post-graduate courses as domestic students. There were similar trends in all jurisdictions allowing for differences in jurisdictional size and the dominance of the east coast three.

6. The supply of engineers from domestic sources

6.1 Introduction

This chapter examines in detail the flow of new engineering graduates from Australian universities and TAFE colleges into the engineering labour force and how this transition has changed in recent years. The focus is on domestic graduates. Although many new graduates take advantage of on-shore migration visa application processes and often appear to transition into the labour force in much the same way as domestic students, there is a vital difference. Graduating international students must complete immigration formalities which do not apply to domestic students. The flow of international students into the engineering labour force is part of Australia's skilled migration intake which is covered in Chapter 7. They are not included in this Chapter to avoid double counting.

In Chapter 5, we defined entry level courses along traditional lines as bachelor degrees, associate degrees and advanced diplomas. However, the situation is more complex than this. Some universities have moved to a double degree format in which the first degree is a bachelor's degree in science, mathematics or a commercial or legal area, followed by an engineering degree at masters level. In available statistics, completions of these programs are included in post-graduate completions rather than entry level completions. Advice from the Department of Education and Training indicates that it is impossible to separate out completions in these new programs from more traditional coursework masters degrees that are undertaken following completion of an engineering undergraduate degree.

The chapter provides statistics on specific engineering specialisations. These statistics are compiled in accordance with the ABS Australian Standard Classification of Education (ASCED)[13] and relate to the specialisation of courses just completed. When statistics are reported by universities to the Department there is often inconsistencies in the process from one year to the next with completions credited to a specific specialisation in some years and to "general or other" categories in others. This means that we need to limit the degree of disaggregation of statistics to avoid disjoint step-type trends. Through experience, we have found that the best approach is to present the statistics at the three-digit level of the ASCED classification which overcomes this problem as far as is possible. The following key explains how the categories used in this approach relate to more familiar engineering specialisations:

- Engineering and Related Technologies (not further defined); a "general" category
- Process and Resource Engineering includes
    - Chemical Engineering
    - Mining Engineering
    - Materials Engineering
    - Food Processing Technology
- Mechanical and Industrial Engineering includes
    - Mechanical Engineers
    - Industrial engineers
- Civil Engineering includes
    - Civil Engineers
    - Construction Engineers
    - Building Services Engineers
    - Water and Sanitary Engineers
    - Transport Engineers
    - Geotechnical Engineers
    - Ocean Engineers
- Electrical and Electronic Engineering includes

[13] See www.abs.gov.au

    - Electrical Engineers
    - Electronic Engineers
    - Computer Engineers
    - Communication Technologies
- Aerospace Engineering includes
    - Aerospace Engineers
    - Aircraft Maintenance Engineers
- Maritime Engineering includes
    - Maritime Engineers
    - Maritime Construction Engineers
- Other Engineering includes
    - Environmental Engineers
    - Biomedical Engineers
    - Naval Architects
    - Other Engineers

When comparing the statistics below to those in Chapter 5 bear in mind that they are from a different statistical collection and that small discrepancies may occur. In nearly all cases the differences are too small to affect trend directions.

6.2 The experiences of new graduates

Past editions of the Statistical Overview have reported statistics describing the labour market experience of new engineering graduates. These statistics were sourced from the Australian Graduate Survey undertaken annually by Graduate Careers Australia since 1974[14]. The last survey in this series was undertaken in 2015. From 2016, the Australian Graduate Survey (AGS) was replaced by the Graduate Outcome Survey (GOS) administered independently by the Social Research Centre[15], a subsidiary of the Australian National University, for the Australian Department of Education and Training. The Department has included the GOS as part of its suite of surveys for the quality indicators of learning and teaching (QILT)[16].

Any change in the collection of statistics results in some discontinuity and this change is no exception. Several important changes were made; first, the GOS is based on the ABS labour force statistics framework, second there were changes to the survey questionnaire, and finally, there were changes to the construction of the survey population and how the survey was administered. Some of the changes reflected developments in the labour market over time; for example, the AGS was based on the notion that further full-time study following graduation was mutually exclusive with employment. Today it is common for students to combine full time study with labour market participation. The GOS collected survey responses only on-line compared to a multi-modal collection (hard copy, on-line and telephone) under the AGS. A further difference is that the GOS sample frame was determined centrally using completion records from the Department's higher education management information system instead of independent selection by individual institutions of their contribution to a national sample under the AGS.

The GOS surveyed students on-line from 40 universities and 56 non-university higher education institutions. In 2016, 104,208 valid survey responses were obtained representing a response rate of 39.7%. In 2017, 120,747 valid responses were received representing an increased response rate of 45.0%. The 2018 response rate fell slightly to 43.0% but there were 120,564 valid responses.

The 2016 National Report[17] provided an extensive account of a comparison between AGS and GOS in Appendix 3. In 2015, a trial was undertaken under which both the AGS and GOS survey instruments were administered in parallel at each of three participating universities. An Appendix discussed the results in some detail and urged "readers to exercise caution" when comparing GOS results with earlier AGS statistics emphasizing that, despite all

[14] See www.graduatecareers.com.au

[15] See www.srcentre.com.au

[16] The information and statistics used in this paper were obtained from the 2016 Graduate Outcomes Survey, National Report, November 2016 and the 2017 Graduate Outcomes Survey, National Report, January 2018. Both reports are available from www.qilt.edu.au

[17] See footnote 3.

efforts, there is a discontinuity between the two surveys. With this caveat, we utilise combined survey statistics for trends in full time employment, overall employment and median salaries in a longer time series framework.

6.2.1 The relationship of GOS statistics to labour force concepts

Many GOS statistics are reported as proportions of different kinds. Although the survey uses ABS labour force concepts and definitions, how these combine into reported proportions is very specific and somewhat different to how statistics about the engineering labour force have been reported in Engineers Australia work. Before proceeding further, it is important to be clear about this issue.

Every year the pool of graduates completing their courses can choose to work or not to participate in the labour market. The GOS participation rate is the proportion of those who want to work to the overall pool of graduates. This definition is common to Engineers Australia's work.

Graduates who choose to work fall into a number of categories as follows:

- A is the number of graduates who want to work full time and are in full time work.
- B is the number of graduates who want to work full time but have only found part time work.
- C is the number of graduates who want to work full time work but who are unemployed.
- D is the number of graduates who want to work part time and are working part time and are satisfied with the hours they work.
- E is the number of graduates who want to work part time, have a part time job but want more hours of work.
- F is the number of graduates who want to work part time but are unemployed.

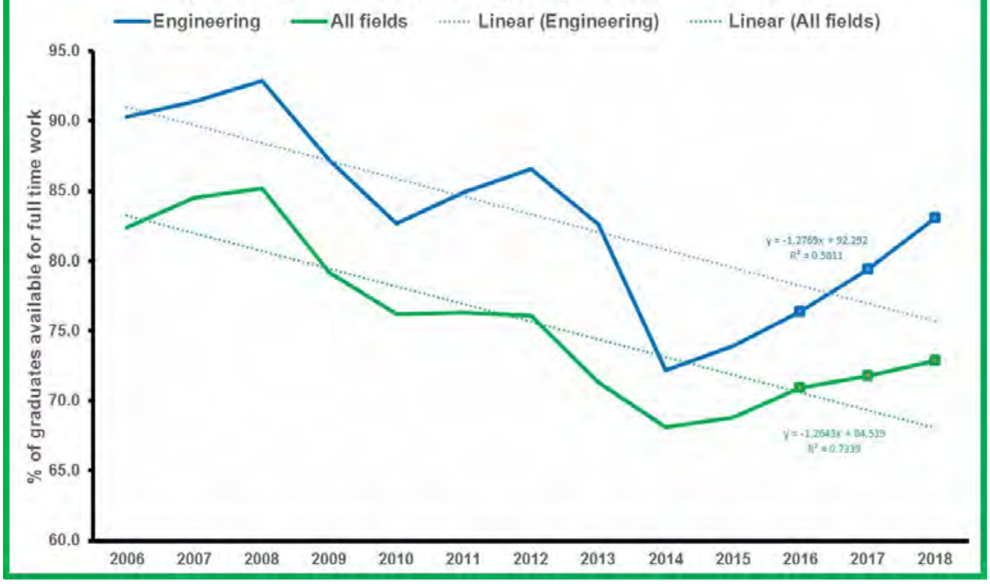
The annual labour force of graduates is the sum of A through F.

The **full-time employment rate** is an important GOS statistic and is defined as the proportion of graduates working full time to those who want to work full time. That is, A divided by the sum of A, B and C expressed as a proportion.

The **overall employment rate** is a parallel GOS statistic and is defined as all employed graduates as a proportion of graduates available for employment irrespective of whether employment is full or part time. That is, the sum of A, B, D and E divided by the sum of A through F expressed as a proportion.

Some graduates who want full time work are working part time and those that prefer to work part time includes graduates who are satisfied with their hours of work and graduates who want more hours. That is, part time employment is the sum of B, D and E and the **part time employment rate** is this sum expressed as a proportion of the sum of A through F, that is, the annual labour force.

Figure 6.1: Trends in the proportion of graduates who want to work full time actually working full time, engineering compared to all fields, 2006 to 2017



6.2.2 Full time employment trends for recent engineering graduates

Engineering has historically been a profession with high levels of full-time employment, especially in engineering occupations. In the 2006 census 88.8% of employment in engineering occupations was full time, 89.2% in 2011 and 89.1% in 2016[18]. For new graduates, full time employment is important to enable them to satisfactorily complete professional formation in engineering practice which is undertaken on-the-job. In Figure 6.1 we illustrate the trend in the full-time employment rate for new engineering graduates, that is, the proportion of engineering graduates who want to work full time actually doing so. We compare this trend to the corresponding full-time employment rate for graduates in all fields.

Statistics up to 2015 are from the AGS and statistics from the GOS are shown for the subsequent three years and are distinguished using markers. Full time employment was defined as graduates who were usually or actually in paid employment for at least 35 hours in the week before the survey.

The full-time employment rate has been consistently higher for new engineering graduates than for new graduates across the board. In 2006, over 90% of engineering graduates who wanted to work full time had a full-time job compared to 82.4% for all graduates. Figure 6.1 shows that this gap has been maintained over time, but that both trends have fallen over the past decade. By 2015, the last AGS survey, the full-time employment rate was down to 73.9% for engineering and 68.8% for all graduates. In the three years of the GOS survey, both proportions have recovered; engineering to 83.1% and all graduates to 72.9%. At this stage it is impossible to say whether this recovery is the product of the change in survey methodology or a change in labour market experience. Bearing in mind the caveat about data discontinuity, the 2018 results still show a marked reduction in the proportion of graduates who want full time work succeeding in getting it.

Ordinary least squares trend lines are included in Figure 6.1 to gauge the direction of the longer-term trends. In both cases, the full-time employment proportion has fallen by an average 1.3% per year. When the trend lines are recalculated excluding the three years of GOS statistics, these statistics become average of 2.0% per year for engineering graduates and average 1.9% per year for all graduates.

These trends are consistent with other work that shows a shift away from full time work in favour of other options[19]. They are also consistent with reduced proportions of qualified engineers employed in engineering occupations in younger age groups[20]. As the full-time employment proportion falls, it becomes increasingly difficult for new graduate engineers to secure full time jobs to allow them to complete professional formation. It may be possible to

[18] Engineers Australia, Australia's Engineering Capability; How the last ten years will influence the future, July 2018, p46.

[19] See Table 2.6 on p45 in Engineers Australia, Australia's Engineering Capability, op cit

[20] See Figures 2.16 and 2.17 on p43 in engineers Australia, Australia's engineering Capability, op cit.

undertake professional formation via part time work, but this course will inevitably be slower and take longer. Observed lower proportions of qualified engineers employed in engineering occupations are a manifestation of these changes which are evident among both Australian born and migrant engineers already in the labour market and now among new graduate engineers.

The upwards movement in the full time proportion for engineers in the past three years is encouraging and is consistent with the modest economic recovery evident in vacancies statistics[21], but there remains a substantial gap between the results for 2006 and 2018 and restoration of the earlier situation will require the recovery to persist for some time yet. The situation illustrated in Figure 6.1 suggests that progression from engineering education to professional formation has changed with serious implications for the future development of the engineering profession.

6.2.3 Overall employment trends for recent engineering graduates

The overall employment rate is defined as all employed graduates as a proportion of graduates available for employment irrespective of whether employment is full or part time. That is, the sum of A, B, D and E divided by the sum of A through F expressed as a proportion or the conventional ratio of all employment to the labour force. In Figure 6.2 we illustrate the trend in the overall employment rate for new engineering graduates and compare it to the corresponding trend for all new graduates.

Figure 6.2: Trends in the proportion of graduates who want to work in any type of job actually working, engineering compared to all fields, 2006 to 2017

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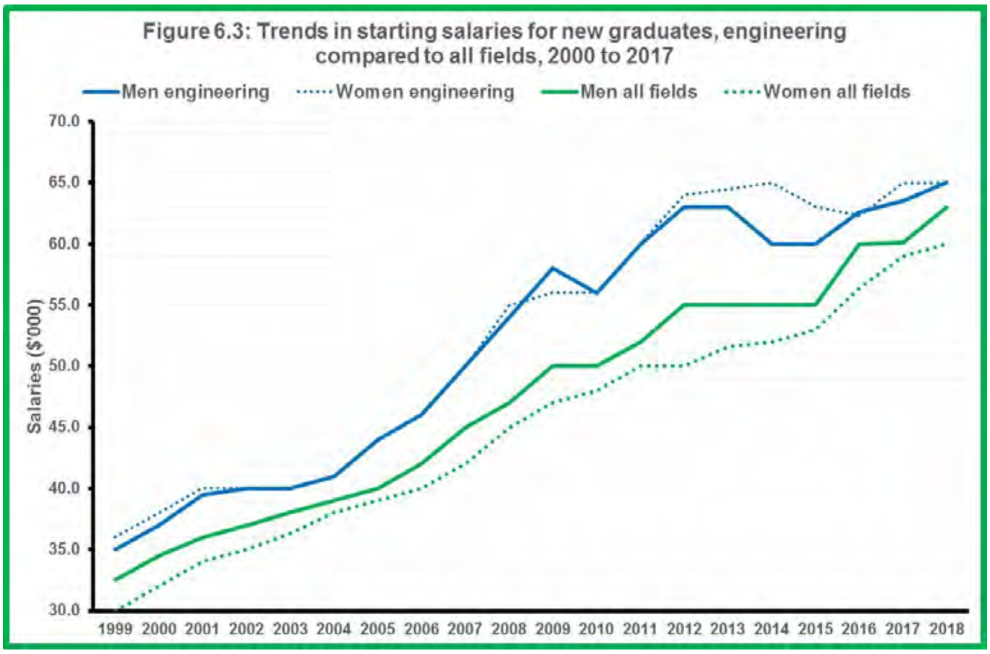
[21] Engineers Australia, Engineering Vacancies Report, June 2018 Update, August 2018, www.engineersaustralia.org.au



When interpreting the proportion of overall employment, it is important to bear in mind that the denominator is all graduates who want to work, in effect, the annual graduate labour force which is altogether different to the denominator for the full time employment proportion where the denominator is restricted to graduates who want to work full time. While it is tempting to see the difference between the full-time employment proportion and the overall employment proportion as the proportion of new graduates working part time, this is inappropriate because some graduates who want to work full time can only secure part time work.

In general, the overall employment proportion is substantially higher than the full-time employment proportion. However, whereas there was a large gap between the full-time employment proportions for engineers and graduates in general, the overall employment trends were more closely aligned. The similarity between the two trends is evident in Figure 6.2; between 2006 and 2013, but from 2013 and 2016 the engineering trend fell well below the trend for all graduates. This change coincides with the collapse in demand for engineers that necessitated significant adjustment in the engineering labour market.

Both trend lines in Figure 6.2 display robust downwards trends. The overall employment proportion for engineers has fallen by an average 0.9% per year and by 0.8% per year for graduates in general. Once again, the GOS statistics show some recovery but only in 2017 and 2018, but at this stage it is not possible to distinguish this change from other similar fluctuations since 2006. These trends suggest that employment prospects for all graduates, including engineers, have deteriorated since 2006.

6.2.4 Median salaries for recent graduates

Median salaries statistics relate to graduates employed full time. Bearing in mind earlier comments about the discontinuity between GDS and GOS statistics, Figure 6.3 illustrates the trends in median salaries for men and women graduate engineers compared to the median salaries for recent graduates in general.

Figure 6.3 shows that engineering graduates have been better remunerated than other graduates. Since 1999, median salaries for engineers have typically ranked third or fourth highest of 21 fields of education included in the surveys. The gap between engineering and other graduate salaries widened between 2004 and 2013, when demand for engineers was at its highest. Demand collapsed in late 2012 and we observed in Figure 6.2 the resultant deterioration in the overall employment proportion for engineers. This change was also observed as falls in the median salaries of engineers in 2014 and 2015. Engineering median salaries increased again in the three years since. The salaries trend for graduates in general continued as before and by 2018 the gap between the two trends returned to the difference a decade ago.

Much has been said in the media about a salaries gap between men and women in Australia. Figure 6.3 corroborates this perspective in respect to graduates overall. There is a clear-cut gap between median salary for men and women graduates in general. However, in engineering there is no corresponding salary gap in favour of men, indeed, since 2012, the opposite was the case. There was a pronounced dip in the median trend for men between 2013 and 2016 but a smaller and shorter one for women. In 2018, median salaries for men and women engineering graduates were equal at $65,000 per year compared to $63,000 and $60,000 for men and women graduates in general.

6.3 New graduates in occupational categories

In Chapter 1 we outlined the three occupational categories that make up the engineering team. In this section we consider statistics on the numbers of three-year degrees, four-year degrees and double degrees completed in engineering. We also consider TAFE completions of advanced diplomas and university associate degree completions in engineering.

6.3.1 Three-year degrees in engineering

The number of three-year degrees in engineering completed between 2001 and 2017 are shown in Table 6.1 for four-digit ASCED specialisations explained earlier.

Table 6.1: Domestic Students Completing Three Year Bachelors Degrees in Engineering

Men

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	66	59	64	62	63	59	45	54	42	20	16	9	8	10	12	30	8
0301	Manufacturing Engineering & Technology	18	14	3	3	5	4	5	0	< 5	< 5	< 5	<5	6	<5	0	0	0
0303	Process & Resource Engineering	43	27	32	18	19	54	19	23	23	17	24	15	16	16	28	10	7
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	1	9	< 5	6	<5	<5	<5	0	<5	6
0307	Mechanical & Industrial Engineering & Technology	34	49	30	21	22	35	9	13	< 5	6	6	5	<5	<5	0	12	20
0309	Civil Engineering	14	13	7	19	23	39	13	18	12	5	< 5	0	<5	<5	<5	0	0
0311	Geomatic Engineering	42	65	75	48	23	22	17	18	26	16	31	24	22	32	<5	<5	<5
0313	Electrical & Electronic Engineering & Technology	124	106	102	110	159	203	130	112	73	61	31	28	23	12	12	22	27
0315	Aerospace Engineering & Technology	79	102	111	109	147	175	140	171	130	127	139	189	196	245	180	217	208
0317	Martime Engineering & Technology	2	3	4	2	6	0	2	1	< 5	< 5	< 5	<5	<5	25	26	9	29
0399	Other Engineering & Technology	109	102	96	96	94	100	110	91	115	84	115	142	119	142	154	135	128
03	Total	531	540	524	488	561	691	490	502	439	346	377	419	400	488	415	465	455

Women

0300	Engineering & Related Technologies	18	4	12	7	15	3	7	1	< 5	5	< 5	0	<5	<5	<5	<5	<5
0301	Manufacturing Engineering & Technology	2	3	5	4	13	10	8	23	29	44	43	29	56	81	<5	<5	<5
0303	Process & Resource Engineering	18	20	14	10	<10	31	12	20	10	7	7	11	<5	10	9	6	8
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	< 5	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	3	3	2	1	2	2	1	1	0	0	0	0	0	0	0	0	<5
0309	Civil Engineering	0	2	4	0	4	12	0	<10	0	0	0	0	0	0	0	0	0
0311	Geomatic Engineering	10	24	16	17	12	14	9	12	11	5	9	<5	5	<5	<5	<5	0
0313	Electrical & Electronic Engineering & Technology	12	9	6	18	52	41	34	24	29	21	13	8	5	<5	<5	<5	<5
0315	Aerospace Engineering & Technology	14	22	19	23	28	29	31	39	25	25	32	31	28	41	39	47	47
0317	Maritime Engineering & Technology	1	1	0	0	1	0	0	0	0	0	0	0	<5	0	<5	<5	<5
0399	Other Engineering & Technology	20	13	10	8	7	14	5	9	7	10	11	15	14	19	24	19	24
03	Total	98	101	88	88	139	156	109	130	116	117	117	99	112	155	82	85	90

All domestic graduations

0300	Engineering & Related Technologies	84	63	76	69	78	62	52	55	46	25	18	9	9	11	12	30	8
0301	Manufacturing Engineering & Technology	20	17	8	7	18	14	13	23	30	48	47	31	62	83	0	0	0
0303	Process & Resource Engineering	61	47	46	28	19	85	31	43	33	24	31	26	19	26	37	16	15
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	1	10	< 5	6	<5	<5	<5	0	0	6
0307	Mechanical & Industrial Engineering & Technology	37	52	32	22	24	37	10	14	< 5	6	6	5	<5	<5	0	12	20
0309	Civil Engineering	14	15	11	19	27	51	13	18	12	5	< 5	0	<5	<5	0	0	0
0311	Geomatic Engineering	52	89	91	65	35	36	26	30	37	21	40	28	27	34	0	0	0
0313	Electrical & Electronic Engineering & Technology	136	115	108	128	211	244	164	136	102	82	44	36	28	13	12	22	27
0315	Aerospace Engineering & Technology	93	124	130	132	175	204	171	210	155	152	171	220	224	286	219	264	255
0317	Maritime Engineering & Technology	3	4	4	2	7	0	2	1	< 5	< 5	< 5	<5	<5	25	26	9	29
0399	Other Engineering & Technology	129	115	106	104	101	114	115	100	122	94	126	157	133	161	178	154	152
03	Total	629	641	612	576	700	847	599	632	555	463	494	518	512	643	497	550	545

Source: Data supplied by DET

Note: Cells <5 are the result of the Department's confidentiality policy and do not add into totals. Totals are correct.

In 2017 there were 545 three-year degrees in engineering completed, 455 by men and 90 by women. The largest specialisation is aerospace engineering just under half of the graduates. A further 28% of graduates were in the other engineering category. Additionally, there were small numbers in several familiar categories; process and resource engineering produced 15 graduates; mechanical and industrial engineering produced 20 graduates; electrical and electronic engineering produced 27 graduates and maritime engineering 29 graduates. Other than a short period of enhanced activity in 2005 and 2006, completion numbers for these degrees have been static, showing no obvious trend.

6.3.2 Four-year degrees in engineering

Completions of four-year degrees in engineering are presented in two Tables; Table 6.2 present completions of conventional four-year degree programs and Table 6.3 presents statistics on completion of four-year degrees in double degree programs. In 2016, there were 5,303 completions of four-year degrees and a further 1,561 completions of double degrees for a total of 6,864 completions. In 2017, the composition changed to 5,132 completions of four-year degrees and 1,752 double degrees with a marginally higher total of 6,884. These results compare to 5,438 completions in 2001. In Chapter 5 we observed that entry level commencements have been falling for several years and this is now evident in a slowing of trend in completions. Contracting trends are already evident in some jurisdictions.

Two ASCED categories distort understanding of these statistics. They are ASCED 0300 "engineering and related technologies not further defined" and ASCED 0399 "other engineering and related technologies". Universities coded 38% of four-year degree completions to these categories in 2016 and 2017 and over 70% of double degree completions. This result means that the statistics for specific specialisations included in the two Tables are rudimentary indicators at best.

Coding issues also limit the value of the statistics in Table 6.3. The proportion of completions in the two general categories (ASCED 0300 and 0399) are particularly high. In the last three years they were 60.0% in 2015, 73.1% in 2016 and 72.3% in 2017. Tables 6.2 and 6.3 combined show statistics for completions of four-year degrees in engineering that enable those concerned to become professional engineers. In each of the last three years the two general categories account for an average 46.1% of completions. Figure 6.5 shows the trends for the main engineering specialisations of the combined statistics.

Table 6.2: Domestic Students Completing Four Year Bachelors Degrees in Engineering

Men

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	98	134	90	59	215	246	286	273	356	321	545	638	682	758	761	731	706
0301	Manufacturing Engineering & Technology	13	10	16	23	19	17	21	12	8	< 5	< 5	<5	12	28	25	27	49
0303	Process & Resource Engineering	410	332	285	319	281	271	346	378	413	441	401	355	367	333	330	301	301
0305	Automotive Engineering & Technology	0	0	0	3	19	20	22	22	28	28	19	21	20	16	8	16	24
0307	Mechanical & Industrial Engineering & Technology	503	556	528	553	475	527	574	610	560	567	599	596	631	554	624	622	604
0309	Civil Engineering	585	574	554	502	488	448	573	706	712	746	845	803	849	873	956	1079	930
0311	Geomatic Engineering	118	113	94	117	113	120	128	121	106	90	79	88	71	80	6	<5	<5
0313	Electrical & Electronic Engineering & Technology	1007	992	1136	1111	1062	796	811	703	621	535	456	490	476	468	516	446	531
0315	Aerospace Engineering & Technology	124	118	117	151	169	130	165	190	158	172	176	187	176	185	177	134	159
0317	Martime Engineering & Technology	11	12	2	23	11	23	13	16	14	10	24	19	36	20	50	92	57
0399	Other Engineering & Technology	540	472	450	441	458	581	478	617	677	715	801	861	866	964	984	1023	944
03	Total	3409	3313	3272	3302	3310	3179	3417	3648	3653	3626	3945	4061	4186	4279	4437	4598	4436

Women

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	9	26	23	11	46	34	41	36	44	54	77	133	127	134	96	90	110
0301	Manufacturing Engineering & Technology	5	3	5	2	2	3	5	0	-	< 5	0	0	<5	<5	<5	<5	<5
0303	Process & Resource Engineering	135	137	128	126	99	98	106	110	116	120	123	104	110	105	87	97	103
0305	Automotive Engineering & Technology	0	0	0	0	0	2	<10	0	< 5	< 5	< 5	<5	0	0	<5	0	<5
0307	Mechanical & Industrial Engineering & Technology	56	57	66	58	44	32	43	51	55	48	50	47	46	47	49	46	54
0309	Civil Engineering	140	122	90	98	89	81	88	102	120	94	134	122	114	145	161	199	144
0311	Geomatic Engineering	22	20	15	29	18	23	13	22	18	12	10	<5	5	5	8	<5	<5
0313	Electrical & Electronic Engineering & Technology	140	143	181	180	150	101	79	53	48	49	44	44	44	43	42	56	63
0315	Aerospace Engineering & Technology	19	24	23	20	30	16	18	24	15	21	29	21	19	20	20	22	18
0317	Maritime Engineering & Technology	0	0	0	1	0	1	0	2	-	< 5	0	0	<5	5	5	5	<5
0399	Other Engineering & Technology	169	124	132	111	126	137	112	123	135	140	129	150	160	152	170	179	192
03	Total	691	656	663	636	604	528	506	523	552	542	595	624	627	659	641	705	696

All domestic graduations

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	107	160	113	70	261	280	327	309	400	375	622	771	809	892	857	821	816
0301	Manufacturing Engineering & Technology	18	13	21	25	21	20	26	12	8	< 5	< 5	<5	13	31	25	27	49
0303	Process & Resource Engineering	545	469	413	445	380	369	452	488	529	561	524	459	477	438	417	398	404
0305	Automotive Engineering & Technology	0	0	0	3	19	22	22	22	29	30	20	22	20	16	8	16	24
0307	Mechanical & Industrial Engineering & Technology	559	613	594	611	519	559	617	661	615	615	649	643	677	601	673	668	658
0309	Civil Engineering	725	696	644	600	577	529	661	808	832	840	979	925	963	1018	1117	1278	1074
0311	Geomatic Engineering	140	133	109	146	131	143	141	143	124	102	89	92	76	85	14	0	0
0313	Electrical & Electronic Engineering & Technology	1147	1135	1317	1291	1212	897	890	756	669	584	500	534	520	511	558	502	594
0315	Aerospace Engineering & Technology	143	142	140	171	199	146	183	214	173	193	205	208	195	205	197	156	177
0317	Maritime Engineering & Technology	11	12	2	24	11	24	13	18	14	11	24	19	37	25	55	97	57
0399	Other Engineering & Technology	709	596	582	552	584	718	590	740	812	855	930	1011	1026	1116	1154	1202	1136
03	Total	4100	3969	3935	3938	3914	3707	3923	4171	4205	4168	4540	4685	4813	4938	5078	5303	5132

Source: Data supplied by DET

Note: Cells <5 are the result of the Department's confidentiality policy and do not add into totals. Totals are correct.

Table 6.3: Domestic Students Completing Four Year Double Bachelors Degrees in Engineering

Men

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	136	162	261	320	481	372	375	400	406	502	495	488	561	594	649	563	649
0301	Manufacturing Engineering & Technology	27	28	28	40	2	-	13	11	22	52	32	26	15	17	9	11	8
0303	Process & Resource Engineering	63	129	120	151	83	132	124	128	130	130	146	143	149	102	108	128	172
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	<5	0	<5	<5
0307	Mechanical & Industrial Engineering & Technology	207	126	125	115	64	76	89	82	100	146	131	92	88	117	132	126	157
0309	Civil Engineering	135	75	126	102	86	66	74	87	86	142	171	134	211	184	202	230	206
0311	Geomatic Engineering	22	<10	<10	12	<10	6	<10	5	< 5	9	15	10	9	8	0	0	0
0313	Electrical & Electronic Engineering & Technology	388	252	271	337	320	325	298	182	132	146	114	88	114	123	122	152	175
0315	Aerospace Engineering & Technology	26	14	2	30	36	61	37	49	48	59	36	63	59	75	52	56	52
0317	Martime Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	<5	31	17	29	16	12
0399	Other Engineering & Technology	141	146	140	172	161	221	199	199	195	200	184	310	282	324	326	359	380
03	Total	1100	900	1051	1215	1195	1192	1165	1082	1069	1348	1324	1355	1519	1562	1629	1292	1432

Women

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	30	28	51	49	117	79	73	69	74	88	79	70	93	90	154	99	124
0301	Manufacturing Engineering & Technology	2	4	3	4	0	0	1	0	< 5	< 5	< 5	<5	<5	0	<5	0	<5
0303	Process & Resource Engineering	24	55	28	55	33	64	69	52	33	34	60	52	54	49	59	58	66
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	37	21	19	22	13	15	19	13	26	24	24	15	11	25	26	30	20
0309	Civil Engineering	30	23	30	22	27	22	28	19	23	36	39	42	48	44	50	49	57
0311	Geomatic Engineering	<10	0	0	<10	<10	0	0	-	0	6	< 5	<5	<5	<5	0	0	0
0313	Electrical & Electronic Engineering & Technology	56	43	56	61	45	40	24	22	25	14	17	20	12	19	13	13	13
0315	Aerospace Engineering & Technology	<10	<10	<10	<10	<10	9	<10	12	13	8	6	10	10	9	5	15	11
0317	Maritime Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	<5	<5	0	0
0399	Other Engineering & Technology	62	45	66	59	52	70	67	72	46	53	66	103	81	111	83	120	114
03	Total	238	211	233	251	275	280	274	247	234	258	297	311	311	349	393	269	320

All domestic graduations

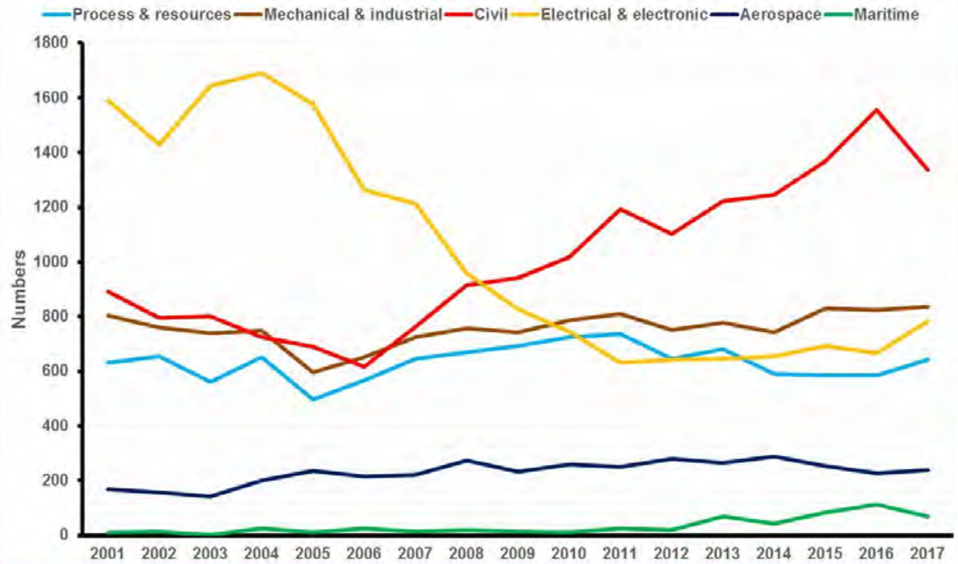
ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	166	190	312	369	598	451	448	469	480	590	574	558	654	684	803	662	773
0301	Manufacturing Engineering & Technology	29	32	31	44	2	-	14	11	26	55	35	29	16	17	9	11	8
0303	Process & Resource Engineering	87	184	148	206	116	196	193	180	163	164	211	185	203	151	167	186	238
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	<5	0	0	0
0307	Mechanical & Industrial Engineering & Technology	244	147	144	137	77	91	108	95	126	170	160	107	99	142	158	156	177
0309	Civil Engineering	165	98	156	124	113	88	102	106	109	178	213	176	259	228	252	279	263
0311	Geomatic Engineering	22	0	0	12	0	6	0	5	< 5	15	22	11	10	9	0	0	0
0313	Electrical & Electronic Engineering & Technology	444	295	327	398	365	365	322	204	157	160	131	108	126	142	135	165	188
0315	Aerospace Engineering & Technology	26	14	2	30	36	70	37	61	61	67	46	73	69	84	57	71	63
0317	Maritime Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	<5	31	18	29	16	12
0399	Other Engineering & Technology	203	191	206	231	213	291	266	271	241	253	292	413	363	435	409	479	494
03	Total	1338	1111	1284	1466	1470	1472	1439	1329	1303	1606	1621	1666	1830	1911	2022	1561	1752

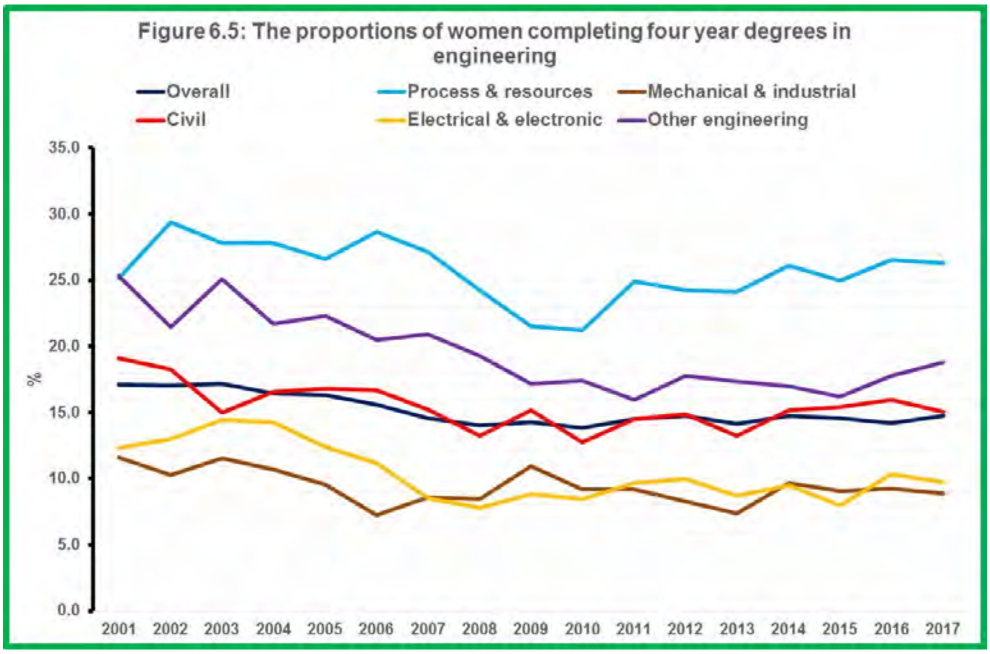
Source: Data supplied by DET

Note: Cells <5 are the result of the Department's confidentiality policy and do not add into totals. Totals are correct.

Excluding the two general categories, Figure 6.4 illustrates the trends in completions for the six largest categories of completions of four-year degrees in engineering combining Tables 6.2 and 6.3. There are two important trends to note; first, the strong upwards trend in civil engineering which has increased completions from 890 in 2001 to a peak of 1,557 in 2016. In 2017, four-year completions in civil engineering contracted back to 1,337. The second important trend to note is the strong downwards trend in electrical and electronic engineering which has seen a reduction in completions from 1,591 in 2001 to 631 in 2011. Over the next five years these completions have fluctuated in the 600s, but there was a more clear-cut increase in 2017 to 782 completions.

Figure 6.4: Trends in completions of four year degrees in traditional fields of engineering





The trends in other categories are as follows; process and resource engineering, slowly increasing with completions increasing from 632 in 2001 to 6424 in 2017 with a peak of 735 in 2011; mechanical and industrial engineering, upwards with completions increasing from 803 to 835 over the same period with a low point of 596 in 2005; aerospace engineering, slowly upwards with completions increasing from 169 to 240, but with a peak of 289 in 2014; and maritime engineering, upwards increasing from 11 to 69.

Engineering has been a male dominated profession for some time and there is considerable interest in encouraging more women to become engineers. Figure 6.5 illustrates the proportion of completions of four-year degrees in engineering by women. Overall, since 2001, the trend in the proportion of completions by women has been downwards. In 2001, 17.1% of completions were by women and in 2017 the share was 14.8%. Figure 6.5 shows considerable variability between engineering specialisations. The highest shares of women occurred in process and resource engineering and other engineering which includes environmental and biomedical engineering. However, both specialisations show downwards trends; only slight in the case of process and resources and more obvious for other engineering. In 2017, 26.3% of process and resources completions were by women and 18.8% of other engineering completions were by women.

All specialisations shown in Figure 6.5 show declining women's shares of completions. In civil engineering, the fall was from 19.1% in 2001 to 15.0% in 2017; in mechanical and industrial engineering it was from 11.6% to 8.9%; in electrical and electronic engineering it was from12.3% to 9.7%. There was a lesser decline in aerospace engineering where the 2017 share was 12.1% and there were almost no women in maritime engineering.

6.3.3 Associate qualifications in engineering

Associate qualifications include associate degrees and advanced diplomas in engineering. Comparatively few students undertake these courses at universities and completions from 2001 to 2017 are presented in Table 6.4.

Table 6.4: Domestic Students Completing Associate Degrees and Advanced Diplomas in Engineering at Universities

Men

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	13	11	<10	13	14	<10	11	20	24	35	55	65	33	61	65	60	38
0301	Manufacturing Engineering & Technology	<10	<10	<10	0	0	0	0	0	0	0	0	0	0	<5	<5	0	0
0303	Process & Resource Engineering	0	0	0	13	0	0	0	0	< 5	< 5	< 5	<5	<5	5	<5	<5	0
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	14	21	10	<10	<10	<10	<10	<10	14	16	< 5	57	64	61	36	8	8
0309	Civil Engineering	18	15	13	<10	12	<10	<10	<10	< 5	11	24	83	149	152	102	44	52
0311	Geomatic Engineering	14	<10	15	<10	<10	<10	<10	<10	0	< 5	0	0	0	<5	0	0	0
0313	Electrical & Electronic Engineering & Technology	21	24	14	15	13	10	11	11	7	16	10	14	40	28	25	7	26
0315	Aerospace Engineering & Technology	24	<10	<10	0	0	0	0	0	27	5	18	17	34	19	15	9	21
0317	Martime Engineering & Technology	<10	16	22	26	32	31	28	24	32	33	46	48	<5	<5	<5	<5	<5
0399	Other Engineering & Technology	22	11	<10	<10	<10	22	51	82	148	166	142	189	115	117	265	358	311
	Total	135	122	90	92	87	83	121	155	254	285	300	475	437	445	515	488	457

Women

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	0	0	0	<10	0	0	<10	<10	0	< 5	< 5	5	<5	6	<5	8	6
0301	Manufacturing Engineering & Technology	0	0	<10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0303	Process & Resource Engineering	0	0	0	0	0	0	0	0	< 5	0	0	0	<5	<5	0	0	0
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	0	<10	0	<10	0	0	0	0	< 5	0	0	<5	0	<5	<5	<5	0
0309	Civil Engineering	<10	<10	<10	<10	<10	<10	0	0	< 5	0	< 5	11	14	15	13	8	<5
0311	Geomatic Engineering	<10	<10	<10	<10	0	0	<10	0	0	0	0	0	0	0	0	0	0
0313	Electrical & Electronic Engineering & Technology	0	<10	<10	<10	<10	0	0	0	0	< 5	0	<5	<5	<5	<5	<5	<5
0315	Aerospace Engineering & Technology	<10	<10	0	0	0	0	<10	0	< 5	< 5	0	0	<5	6	<5	0	<5
0317	Maritime Engineering & Technology	<10	<10	<10	0	<10	<10	<10	<10	< 5	< 5	< 5	<5	0	0	0	0	0
0399	Other Engineering & Technology	0	<10	<10	0	<10	<10	<10	16	16	27	22	20	17	25	28	31	23
	Total	<10	<10	14	<10	<10	<10	12	20	24	35	27	40	35	58	50	55	36

All domestic graduations

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	13	11	0	13	14	0	11	20	24	38	57	70	37	67	65	68	44
0301	Manufacturing Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	<5	0	0	0
0303	Process & Resource Engineering	0	0	0	13	0	0	0	0	< 5	< 5	< 5	2	<5	6	0	0	0
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	14	21	10	0	0	0	0	0	16	16	< 5	59	64	65	36	8	8
0309	Civil Engineering	18	15	13	0	12	0	0	0	< 5	11	26	94	163	167	115	52	52
0311	Geomatic Engineering	14	0	15	0	0	0	0	0	0	< 5	0	0	0	<5	0	0	0
0313	Electrical & Electronic Engineering & Technology	21	24	14	15	13	10	11	11	7	17	10	15	41	29	25	7	26
0315	Aerospace Engineering & Technology	24	0	0	0	0	0	0	0	30	6	18	17	36	25	15	9	21
0317	Maritime Engineering & Technology	0	16	22	26	32	31	28	24	33	36	47	49	<5	<5	0	0	0
0399	Other Engineering & Technology	22	11	0	0	0	22	51	98	164	193	164	209	132	142	293	389	334
	Total	135	122	104	92	87	83	133	175	278	320	327	515	471	503	565	543	493

Source: Data supplied by DE

Note: Cells <5 are the result of the Department's confidentiality policy and do not add into totals. Totals are correct.

Completion numbers were very low in 2001 and grew slowly through to 2009 when the number of completions became more evident. In 2017, there were 493 completions of associate qualifications in engineering courses offered by universities and three-quarters were in the two general fields of engineering discussed earlier. Very few women undertake these courses and their share of 2017 completions was just 7.3%.

Associate degrees and advanced diplomas in engineering are also offered by Australian TAFE colleges. Completions of these courses are set out in Tables 6.5. Overall completions of these courses increased unevenly from 2002 to a peak of 1,471 in 2012. After plateauing for a year, completions have since fallen sharply to 568 in 2017. There were strong numbers in the traditional areas of engineering, manufacturing, mechanical, civil, electrical and electronic engineering, which all figured in the growth 2012. All were also involved in the subsequent falls in completions, but the largest falls occurred in electrical and electronic engineering where completions fell from a peak of 629 in 2012 to 192 in 2012.

Table 6.5: Completions of Associate Degrees and Advanced Diplomas in Engineering from Australian TAFE Colleges

ASCED	Specialisation	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0300	Engineering & Related Technologies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0301	Manufacturing Engineering & Technology	186	169	290	165	181	330	227	177	258	221	321	324	190	112	110	102
0303	Process & Resource Engineering	1	3	12	5	18	4	8	8	25	18	36	25	19	26	13	8
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	191	165	157	148	160	165	151	156	186	136	96	26	132	139	112	114
0309	Civil Engineering	24	38	53	63	101	135	155	103	104	148	151	231	218	113	55	15
0311	Geomatic Engineering	22	25	22	19	17	22	35	38	27	20	35	25	49	57	65	60
0313	Electrical & Electronic Engineering & Technology	481	580	526	588	486	474	657	485	535	589	593	581	421	260	173	193
0315	Aerospace Engineering & Technology	59	11	28	16	12	25	40	33	14	10	82	122	52	21	0	0
0317	Martime Engineering & Technology	45	19	14	17	25	37	39	23	33	28	44	25	20	37	38	18
0399	Other Engineering & Technology	86	58	42	62	88	68	11	6	7	17	0	0	0	0	0	0
	Total	1095	1068	1149	1091	1079	1264	1313	1030	1186	1194	1353	1346	1108	761	561	521

Women

0300	Engineering & Related Technologies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0301	Manufacturing Engineering & Technology	39	43	38	54	66	71	71	59	51	32	41	54	28	14	10	26
0303	Process & Resource Engineering	0	0	0	0	0	2	0	2	0	0	0	2	0	5	0	2
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	4	6	6	7	5	3	0	2	16	7	7	1	5	3	3	5
0309	Civil Engineering	6	8	1	5	12	7	6	24	13	15	19	35	32	9	9	9
0311	Geomatic Engineering	1	0	0	2	2	0	0	2	2	0	0	3	2	7	1	5
0313	Electrical & Electronic Engineering & Technology	19	20	18	37	20	17	23	18	25	26	34	25	17	8	5	2
0315	Aerospace Engineering & Technology	5	3	0	2	0	2	1	1	4	0	5	1	7	1	0	0
0317	Maritime Engineering & Technology	0	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0
0399	Other Engineering & Technology	7	5	0	5	4	1	0	0	3	0	0	0	0	0	0	0
	Total	81	91	73	107	117	108	102	110	107	75	115	123	99	46	35	51

All Completions

0300	Engineering & Related Technologies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0301	Manufacturing Engineering & Technology	225	214	335	221	251	404	294	233	307	251	360	377	215	123	125	132
0303	Process & Resource Engineering	1	3	12	5	14	5	8	15	24	18	33	25	19	29	19	10
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	195	175	171	156	168	174	151	161	200	144	103	28	147	142	110	123
0309	Civil Engineering	30	43	57	65	116	142	156	126	116	167	168	263	250	119	66	27
0311	Geomatic Engineering	23	26	22	22	19	28	31	37	27	23	35	23	51	60	64	67
0313	Electrical & Electronic Engineering & Technology	500	609	544	627	509	488	676	505	564	613	629	606	446	272	178	192
0315	Aerospace Engineering & Technology	64	14	28	16	12	22	43	32	20	10	88	126	57	24	0	0
0317	Maritime Engineering & Technology	45	22	14	16	25	37	39	23	33	28	46	22	20	39	38	18
0399	Other Engineering & Technology	93	57	42	69	91	73	11	6	2	14	0	0	0	0	0	0
	TOTAL	1176	1157	1220	1204	1193	1367	1417	1141	1293	1268	1471	1468	1203	805	593	568

Source: NCVER, VOCSTATS On-Line Databases

6.4 Changes in the supply of engineers through course completions

The supply of qualified engineers is increased when students complete engineering courses and when skilled migrant engineers are granted either permanent or temporary visas. The supply of engineers is reduced when qualified engineers in the labour force leave it, either through age retirement or to pursue other interest such as full-time study or family responsibilities and when migrant engineers working in Australia on temporary visas return to their home country. This section summarises how completions of engineering courses change the supply of engineers. Table 6.6 represents the totals from earlier Tables into summary form and adds an additional year, 2018. The figures in this column are estimates of the likely completions in 2018 based upon trends in both completions and commencements. For ease of comparison the main trends are illustrated in additive form in Figure 6.6.

Completions of university and TAFE courses eligible for the engineering team peaked at 9,202 in 2012. Completions have since fallen to 8,494 in 2017 and are estimated to continue to fall, to 8,455 in 2018, and likely faster in subsequent years. The main contributor to the fall is the reduction in associate engineer completions which has been quite strong. Completions of engineering technologist degrees, the smallest component of the engineering team, have been relatively constant and do not appear to be associated with the down turn. Completions of professional engineers' degrees peaked at 7,100 in 2015 and have fallen back slightly and plateaued since. Given the trend in commencements, completions of these degrees are likely to increase in coming years.

Table 6.6: Changes in the Supply of Engineers as a Result of Domestic Course Completions

Source	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Men																
Associate Engineers																
Universities	90	92	87	83	121	155	254	285	300	475	437	445	515	488	457	450
TAFE Colleges	1068	1149	1091	1079	1264	1313	1030	1186	1194	1353	1346	1108	761	561	521	500
Sub-total	1158	1241	1178	1162	1385	1468	1284	1471	1494	1828	1783	1553	1276	1049	978	950
Engineering Technologists	524	488	561	691	490	502	439	346	377	419	400	488	415	465	455	450
Professional Engineers																
Four year degree	3272	3302	3310	3179	3417	3648	3653	3626	3945	4061	4186	4279	4437	4598	4436	4450
Four year double degree	1051	1215	1195	1192	1165	1082	1069	1348	1324	1355	1519	1562	1629	1292	1432	1400
Sub-total	4323	4517	4505	4371	4582	4730	4722	4974	5269	5416	5705	5841	6066	5890	5868	5850
Total completions	6005	6246	6244	6224	6457	6700	6445	6791	7140	7663	7888	7882	7757	7404	7301	7250
Women																
Associate Engineers																
Universities	14	<10	<10	<10	12	20	24	35	27	40	35	58	50	55	36	40
TAFE Colleges	91	73	107	117	108	102	110	107	75	115	123	99	46	35	51	50
Sub-total	105	73	107	117	120	122	134	142	102	155	158	157	96	90	87	90
Engineering Technologists	88	88	139	156	109	130	116	117	117	99	112	155	82	85	90	85
Professional Engineers																
Four year degree	663	636	604	528	506	523	552	542	595	624	627	659	641	705	696	700
Four year double degree	233	251	275	280	274	247	234	258	297	311	311	349	393	269	320	330
Sub-total	896	887	879	808	780	770	786	800	892	935	938	1008	1034	974	1016	1030
Engineering Team	1089	1048	1125	1081	1009	1022	1036	1059	1111	1189	1208	1320	1212	1149	1193	1205
Total																
Associate Engineers																
Universities	104	92	87	83	133	175	278	320	327	515	471	503	565	543	493	490
TAFE Colleges	1157	1220	1204	1193	1367	1417	1141	1293	1268	1471	1468	1203	805	593	568	550
Sub-total	1263	1314	1285	1279	1505	1590	1418	1613	1596	1983	1941	1710	1372	1139	1065	1040
Engineering Technologists	612	576	700	847	599	632	555	463	494	518	512	643	497	550	545	535
Professional Engineers																
Four year degree	3935	3938	3914	3707	3923	4171	4205	4168	4540	4685	4813	4938	5078	5303	5132	5150
Four year double degree	1284	1466	1470	1472	1439	1329	1303	1606	1621	1666	1830	1911	2022	1561	1752	1730
Sub-total	5219	5404	5384	5179	5362	5500	5508	5774	6161	6351	6643	6849	7100	6864	6884	6880
Engineering Team	7094	7294	7369	7305	7466	7722	7481	7850	8251	8852	9096	9202	8969	8553	8494	8455

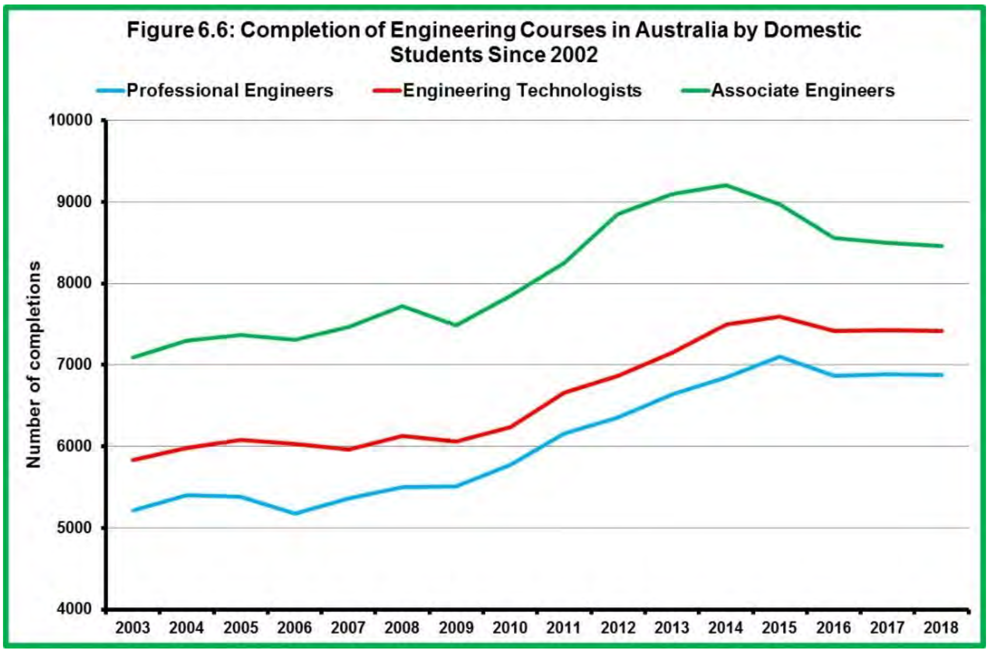


Figure 6.6: Completion of Engineering Courses in Australia by Domestic Students Since 2002

On average, few women undertake associate engineer courses. The average share of women completing these courses since 2003 has been 8.0% with 8.2% in 2017. The proportion of women completing engineering technologist courses has fluctuated widely over time and has produced the highest average of 19.1%. In recent years, results have been below this average with 16.5% in 2017. Most women studying engineering undertake four-year degree courses. An average of 14.9% of completions of these courses are by women. Overall, an average of 14.0% of completions of engineering courses since 2003 have been by women with 2017 right on average. The figures in Table 6.6 suggest that progress in addressing gender equity in engineering course completions has been slow.

7. The supply of engineers from skilled migration

7.1 Skilled migration policy

Australia has a long history of skilled migration, particularly in engineering and this is reflected in features such as the age structure of the profession. Present government skilled migration policies have been in force since 2010 following an extensive review in 2008 and 2009. But during 2017 and 2018 several important changes were made to refocus the program. In early 2019, the government had flagged further changes to require skilled migrants to work in regional areas for a period.

Skilled migration policy is about improving the productive capacity of the economy. Permanent migration aims to supplement Australia's medium to longer term skills capability in areas where the output of our education system is insufficient for future needs. Temporary migration aims to establish a demand driven mechanism that enables employers to quickly overcome short term skills shortages. At times there is some confusion between the two because of careless reference to the term "skill shortage". The key point to make is there is a substantial difference between medium to long term skill shortages and more immediate short-term skill shortages. The annual Commonwealth budget has set the permanent migration target for the following financial year. However, for the 2018-19 financial year, the announced level, 128,550, is seen as a "planning" rather than a "target" figure. Temporary migration being demand driven has no in-principle limit.

From 18 March 2018, several changes were introduced into permanent visa arrangements. Minimum salary arrangements have been tightened, three years of work experience instead of two will now be required, all applicants will need to be under the maximum age of 45 years at time of application and employers are required to pay a "nomination training contribution charge (NTCC)" of $1,200 per year (turnovers less than $10 million) or $1,800 per year (higher turnover). Integrity arrangements for employer nomination visas have also been enhanced.

Temporary migration to deal with immediate skill shortages is driven by employers but from 1 March 2018 substantial changes were introduced. There are no skills assessments for temporary migrants, but at least two years' work experience in the nominated occupation are required. In the past Engineers Australia was critical of the fact that no labour market test was required. This has now changed, and labour market testing is mandatory unless an international trade obligation applies. Similarly, employers must pay Australian market salaries and meet the temporary skilled migration income threshold requirements. Finally, employers are required to pay the NTCC at the rates indicated above. Eligible occupations must be listed for temporary visas on the combined Medium and long-term Strategic Skills List (MLTSSL). The changes introduced make it more difficult and expensive for employers to hire temporary skilled migrants and the labour market test should ensure that local qualified engineers are not squeezed out of the market.

Short term skilled migration is designed to operate as an automatic stabiliser; increasing when labour markets are tight so causing skill shortages, and decreasing when labour markets ease and shortages disappear. Employers can elect to sponsor temporary migrants for permanent visas. In these cases, the normal arrangements for permanent migration apply including the annual cap on visa numbers and formal skills assessment.

The Skilled Occupation List (SOL) which has been the framework for the skilled migration program since 2010 has morphed into the Medium to Long Term Strategic Skills List (MLTSSL). The occupations on the list are still determined by the Department of Jobs and Small Business supposedly against criteria similar to the origin SOL. These criteria were:

- Long training lead time in specialised skills.
- High degree of relationship between area of training and subsequent employment.
- High risk of labour market and economic disruption if the skill is in short supply.
- Sufficient high-quality information to assess future skills requirements.

Although the List is reviewed annually, the basis of decisions has become blurred and the need for a more fundamental review is building.

In practice the Department of Home Affairs has compiled a "combined list of eligible occupations" that comprises the MLTSSL, the short-term skilled occupation list (STSOL) and the Regional occupation list22. Besides listing all the occupations eligible for skilled migration, the combined list provides a key to which visas eligibility is attached to and the relevant assessing authority for permanent visas. Over time only two engineering occupations (petroleum engineer and mining engineer) have been from the MLTSSL and all engineering occupations included on the List have been flagged for future review. We use the MLTSSL as a convenient framework to compile consistent statistics on skilled migration of engineers and we include the deleted occupations to ensure consistency.

7.2 Migration skills assessment

Aspiring permanent skilled migrants must have their educational qualifications and labour market experience assessed by an assessment authority appointed by the Department of Home Affairs prior to submitting their visa application. Engineers Australia is the authorised assessing authority for nearly all engineering occupations. Assessments are undertaken consistent with Engineers Australia's stage 1 competencies. These competencies are used in Engineers Australia's accreditation process for university entry level engineering courses and for all new members.

Recognition of engineering qualifications can occur through several pathways[23]: Qualifications may be treated as accredited qualifications if they are:

- Australian qualifications;
- Accredited under the Washington Accord which is an agreement between international engineering accreditation bodies[24] to recognise the equivalence of each other's undergraduate qualifications for Professional Engineers (the equivalent of an Australian four-year full time Bachelors Degree in engineering);
- Accredited under the Sydney Accord which is an agreement between international engineering accreditation bodies[25] to recognise the equivalence of each other's undergraduate educational qualifications for Engineering Technologists (the equivalent of an Australian three-year full time Bachelor Degree in engineering).
- Accredited under the Dublin Accord which is an agreement between international engineering accreditation bodies[26] to recognise each other's qualifications for Engineering Technicians (the equivalent of an Australian two-year full time Associate Degree or Advanced Diploma).

Qualifications that cannot be assessed in one of these ways can be accredited through a stage 1 competency assessment in which applicants are required to demonstrate that their engineering knowledge and skills meet the competency standards for the engineering occupation they intend to apply for. The competency standards applied are available on Engineers Australia's website. Engineers that come to Australia on short term employer-sponsored visa (like the former subclass 457 visa) do not have their qualifications assessed. Providing their visa application is accompanied by an employer's offer of employment and complies with minimum work experience and employment conditions, skills assessments are deemed as unnecessary.

Australia's permanent migration policy is heavily weighted towards entry level recruits, although there is now a requirement for at least three years' work experience. The assessment process described deals mainly with entry level qualifications. Assessment of work experience feeds into the points test used to rank prospective migrants. The points test always rewards younger engineers at the expense of older, more experienced ones.

[22] See www.homeaffairs.gov.au
[23] www.engineersaustralia.org.au
[24] The signatories to the Washington Accord are Canada, Hong Kong SAR, Ireland, New Zealand, South Africa, the United Kingdom, the United States of America and Australia.
[25] The signatories to the Sydney Accord are Canada, Hong Kong SAR, Ireland, New Zealand, South Africa, the United Kingdom and Australia.
[26] The signatories of the Dublin Accord are Canada, Ireland, Korea, New Zealand, UK, USA and Australia

7.3 Permanent migration

In the past three Commonwealth budgets, Australia's migration objective has been indicated as 190,000 overall with a skilled component of 128,550. While these figures did not change until the 2019 budget, the way they are treated by government has changed substantially. Until 2015-16, the budget figures were treated as annual targets. Thus in 2015-16, the overall outcome for Australia's permanent migration program was 189,770 against a target of 190,000 with a skilled outcome exactly equal to the 128,550 target.

However, in the past two years the Budget figures have been treated as ceilings. Thus, the overall outcome in 2016-17 was 183,600, 96.6% of the ceiling, and the skills component outcome was 123,500, 96.1% of the ceiling. The overall outcome in 2017-18 was 162,417, 85.5% of the ceiling, and the skills component outcome was 111,099, 86.4% of the ceiling. Despite frequent references to the importance of permanent migration driving Australia's economic growth, these figures suggest that for the past two years Australia has been moving towards a lower permanent migration intake.

The purpose of this section is to examine how engineers have shared in Australia's permanent migration program. However, the best we can do is to reproduce statistics from the Thirteenth Edition of the Statistical Overview, because more recent data has not been published by the Department of Home Affairs.

In 2015-16, 13,265 permanent visas were granted to migrant engineers, an increase of 14.0% over 2014-15. The number of professional engineers increased from 10,237 to 11,885, an increase of 16.1%. The number of engineering technologists increased from 592 to 824, an increase of 39.2% and the number of associate engineers fell from 809 to 556, a fall of 31.3%. Permanent visas granted to engineers were 10.3% of the skilled component of the 2015-16 permanent migration program. Without a change of heart from the Department of Home Affairs nothing can be said about 2016-17 or 2017-18 other than the number of permanent visas granted to engineers most likely has fallen.

Table 7.1: New Permanent Migration Visas for Engineering Occupations

Specialisation	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Professionals																
Chemical Engineer	88	89	148	131	229	299	358	289	435	524	357	380	231	298	337	369
Materials Engineer	18	22	15	29	42	32	44	43	30	14	76	92	55	43	70	94
Civil Engineer	240	265	333	355	448	695	809	921	1144	1637	1066	1091	1025	1174	1169	1211
Geotechnical Engineer	0	0	0	0	0	0	0	0	0	0	16	29	37	63	70	51
Quantity Surveyor	71	67	98	105	116	111	90	119	176	253	158	232	237	215	223	221
Structural Engineer	0	0	0	0	0	0	0	0	0	0	27	61	69	86	129	146
Transport Engineer	0	0	0	0	0	0	0	0	0	0	1	17	22	22	28	32
Electrical Engineer	134	129	174	224	277	311	533	621	741	854	497	526	435	519	591	666
Electronics Engineer	104	107	110	188	345	449	505	598	744	1408	861	849	582	457	644	795
Engineering Manager	0	0	0	0	0	0	0	0	0	0	0	0	154	139	122	120
Industrial Engineer	29	19	36	60	87	88	79	95	77	26	154	263	165	190	267	286
Mechanical Engineer	209	182	315	389	523	653	859	1007	1192	1659	1018	1127	973	1051	1103	1239
Production Engineer	17	11	16	34	59	56	63	52	62	94	85	193	155	186	228	257
Mining Engineer	16	21	16	18	26	43	40	70	98	151	110	100	122	146	192	178
Petroleum Engineer	11	9	10	12	18	43	36	37	46	25	68	73	51	61	108	116
Aeronautical Engineer	14	18	15	25	50	46	61	34	58	11	76	74	55	39	79	71
Agricultural Engineer	9	9	6	11	7	8	12	6	9	3	10	24	10	6	17	3
Biomedical Engineer	2	1	6	2	6	17	17	16	18	10	68	54	52	46	61	96
Environmental Engineer	0	0	0	0	0	0	0	0	0	0	33	60	79	74	89	102
Naval Architect	2	4	4	7	11	8	13	7	6	9	7	8	5	2	16	14
Other Engineering Professionals	240	333	468	566	908	743	373	281	253	112	173	190	212	187	165	96
Telecommunications Engineer	0	0	0	0	0	0	0	0	0	0	59	219	269	242	390	388
Telecommunications Network Engineer	0	0	0	0	0	0	0	0	0	0	37	125	134	162	247	241
Software Engineer	103	120	126	352	262	339	334	271	156	75	328	1428	2167	2358	2717	3410
Computer N/W & Systems Engineer	0	0	0	0	0	0	0	0	0	0	37	133	488	882	1175	1683
TOTAL	1307	1406	1896	2508	3414	3941	4226	4467	5245	6865	5322	7348	7784	8648	10237	11885
Engineering Technologists	121	193	222	320	519	508	357	335	291	177	414	538	407	358	592	824
Associates																
Civil	15	14	17	33	33	58	51	62	92	107	132	152	118	127	170	161
Electrical	17	13	15	18	20	28	24	33	56	69	122	92	78	87	153	126
Electronics	31	22	17	15	33	48	29	31	45	43	65	66	55	65	65	56
Mechanical	28	13	13	16	30	35	45	72	106	115	156	151	161	171	237	146
Other Engineering	8	9	17	24	13	41	40	36	17	6	5	60	69	27	110	22
Telecommunications	0	0	0	0	0	0	0	0	0	0	4	24	25	25	74	45
TOTAL	99	71	79	106	129	210	189	234	316	340	484	545	506	502	809	556
OVERALL TOTAL	1527	1670	2197	2934	4062	4659	4772	5036	5852	7382	6220	8431	8697	9508	11638	13265

Source: Statistics supplied by the former DIBP

7.4 Temporary migration

This section looks at temporary migration in greater detail using the same table format as for permanent migration. Despite its reticence in releasing updated statistics for the number of permanent visas granted to engineers, the Department of Home Affairs has released the corresponding information on temporary visas through on-line pivot tables. Statistics for two measures are available: Table 7.2 provides statistics for temporary visa holders working in Australia for the period 2008-09 to 2017-18 and Table 7.3 provides statistics for new temporary visa applications granted for the same period.

The design of the temporary visa program allows for their number to increase when employers experience skill shortages in Australia. Thus, we observe that between 2008-09 and 2012-13 the number of migrant engineers working in Australia on temporary visas increased from 9,763 to 13,412. From about late 2012, the demand for engineers in Australia contracted over thirty consecutive months. The number of migrant engineers working in Australia then fell from its 2012-13 peak to a low of 6,903 in 2016-17. In 2017-18, this number increased once more to 7,110. At this stage it is too early to tell whether this rise is a change in trend or simply an annual fluctuation.

The single largest occupational change in Table 7.1 is for software engineers. This occupation has seen the number of migrant engineers employed on temporary visas continuously increase from 755 in 2008-09 to 2,092 in 2017-18. When this occupation is removed from the list, the structural conclusion set out above does not change even though the absolute numbers are smaller. The number of migrant engineers working on temporary visas increases from 9,008 in 2008-09 to 12,300 in 2012-13 then falls to 4,961 in 2016-17 before increasing in 2017-18 to 5,018.

Table 7.2: Temporary Skilled Visas held by engineers, Australia

Specialisations	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Professionals										
Chemical Engineer	273	218	203	187	176	129	93	65	39	32
Materials Engineer	67	62	66	47	56	45	29	18	12	12
Civil Engineer	1586	1313	1349	1730	1514	965	548	319	346	424
Geotechnical Engineer	0	0	82	234	223	142	78	30	34	35
Quantity Surveyor	256	303	407	579	576	414	248	143	130	153
Structural Engineer	0	0	83	176	173	119	69	54	69	73
Transport Engineer	0	0	44	80	68	44	36	35	53	75
Electrical Engineer	541	410	439	545	548	420	320	234	228	258
Electronics Engineer	248	193	179	238	216	200	130	85	85	79
Engineering Manager	763	753	854	1006	939	914	700	518	507	503
Industrial Engineer	81	71	123	161	174	157	109	80	55	56
Mechanical Engineer	971	749	718	928	957	755	587	427	439	451
Prod or Plant Engineer	202	153	190	239	250	197	152	113	101	82
Mining Engineer	370	247	250	490	485	345	167	66	47	53
Petroleum Engineer	253	241	258	306	357	384	309	189	127	93
Aeronautical Engineer	53	41	36	38	28	22	13	14	17	21
Agricultural Engineer	10	10	8	9	8	6	<5	<5	<5	<5
Biomedical Engineer	16	25	24	23	26	22	18	22	23	30
Environmental Engineer	0	0	51	123	136	84	60	28	22	22
Naval Architect	20	20	18	20	14	16	14	12	14	12
Other engineering professionals	509	460	561	876	932	700	517	329	287	338
Telecommunications Engineer	0	0	14	44	71	49	51	42	17	24
Telecommunications Network Engineer	0	0	31	154	108	71	80	69	88	93
Software Engineer	755	953	1074	1041	1112	1260	1581	1737	1942	2092
Computer Network & Systems Engineer	0	0	125	270	307	283	281	321	323	361
TOTAL	6974	6222	7196	9550	9454	7743	6194	4952	5005	5375
Engineering Technologists	463	365	292	274	221	150	106	62	52	88
Associates										
Civil	452	377	397	529	487	371	234	144	146	179
Electrical	519	425	431	570	667	610	598	507	518	484
Electronics	295	264	251	267	285	242	200	153	129	66
Mechanical	677	633	708	1082	1317	1376	1178	813	677	560
Other Engineering	383	350	441	623	757	725	587	405	253	166
Telecommunications	0	0	43	270	224	210	159	113	123	192
TOTAL	2326	2049	2271	3341	3737	3534	2956	2135	1846	1647
OVERALL TOTAL	9763	8636	9759	13165	13412	11427	9256	7149	6903	7110

Source: Statistics extracted from D of Home Affairs pivot tables, data.gov.au/dataset/visa-temporary-work-skilled

Vacancies statistics show that the demand for engineers fell sharply from late 2012 to levels well below growth in vacancies for professionals and vacancies in general. In the past two years there has been modest recovery, but well below the levels experience at the beginning of the time series shown in the Tables. One would normally expect that new temporary visas granted to move ahead of the number of migrant engineers working in Australia on these visas and this is what Table 7.3 shows.

The number of new temporary visas granted increased from 7,434 in 2008-09 to a peak of 10,731 in 2011-12, the year before the peak in numbers working on temporary visas. As demand for engineers waned the number of new temporary visas granted fell to a low of 4,210 in 2015-16. In 2016-17, the number of new temporary visas granted increased to 4,838 but fell again to 3,013 in 2017-18. This last year included three months under the new temporary visa arrangements and it will be interesting to see whether numbers continue to wane in future influenced by the tighter conditions imposed on 18 March 2018.

As was the case in Table 7.2, software engineers dominate Table 7.3. New temporary visas granted to software engineers have been more variable with many annual fluctuations. However, as was the case for the number of engineers working in Australia on temporary visas, the structure of new visas granted does not change when software engineers are excluded from the Table. The number of new visas granted increases from 6,621 in 2008-09 to 9,794 in 2011-12 then falls to 2,883 in 2015-16 increasing to 3,448 in 2016-17 then falling to 1,857 in 2017-18.

Table 7.3: New Temporary Skilled Visas Granted to Engineers, Australia

Specialisation	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Professionals										
Chemical Engineer	188	135	143	121	88	46	60	20	18	28
Materials Engineer	52	31	46	35	22	18	12	7	6	11
Civil Engineer	1039	560	824	1161	642	231	192	154	252	220
Geotechnical Engineer	0	0	110	206	82	27	24	16	30	26
Quantity Surveyor	184	165	249	379	218	101	82	51	79	82
Structural Engineer	0	0	101	148	78	28	37	34	46	31
Transport Engineer	0	0	54	43	33	10	17	18	45	48
Electrical Engineer	375	207	319	449	324	168	160	125	185	137
Electronics Engineer	181	118	112	188	124	79	51	42	74	34
Engineering Manager	533	464	559	669	533	439	310	240	388	269
Industrial Engineer	61	45	130	152	103	72	57	47	41	26
Mechanical Engineer	673	399	508	688	612	296	301	213	355	236
Prod or Plant Engineer	129	89	152	177	142	99	69	50	57	34
Mining Engineer	203	71	166	383	188	39	24	18	33	31
Petroleum Engineer	159	157	199	228	222	212	121	63	67	52
Aeronautical Engineer	44	38	31	35	23	9	9	8	10	37
Agricultural Engineer	<5	<5	<5	5	<5	<5	<5	<5	<5	<5
Biomedical Engineer	17	14	20	15	17	13	8	9	21	12
Environmental Engineer	0	0	56	99	59	19	17	5	14	15
Naval Architect	15	8	15	23	16	9	9	7	11	<5
Engineering Prof nec	372	223	449	663	507	233	229	182	231	176
Telecommunications Eng	0	0	23	57	55	31	16	15	14	18
Tele Network Engineer	0	0	52	183	142	22	111	84	67	30
Software Engineer	813	761	879	937	1020	1061	1451	1327	1390	1156
Computer Network & Systems Engineer	0	0	149	263	202	183	190	212	205	212
TOTAL	5042	3488	5350	7307	5455	3448	3561	2949	3642	2131
Engineering Technologists	334	145	146	190	80	64	44	26	40	58
Associates										
Civil	357	130	238	379	262	129	84	55	86	98
Electrical	375	218	379	535	524	365	351	353	305	177
Electronic	260	164	174	233	197	147	110	91	71	0
Mechanical	757	554	751	1260	1377	1169	960	495	473	396
Other Engineering	309	183	256	512	404	244	245	198	142	54
Telecommunications	0	0	57	315	118	61	52	43	79	99
TOTAL	2058	1249	1855	3234	2882	2115	1802	1235	1156	824
OVERALL TOTAL	7434	4882	7351	10731	8417	5627	5407	4210	4838	3013

Source: Statistics extracted from D of Home Affairs pivot tables, data.gov.au/dataset/visa-temporary-work-skilled

Table 7.4: The Stock of Skilled Migrants Added to the Australian Supply of Engineers

Year	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
New Permanent Visas Granted										
Professional Engineers	5245	6865	5322	7348	7784	9648	10237	11885	?	?
Engineering Technologists	291	177	414	538	407	358	592	824	?	?
Engineering Associates	316	340	484	545	506	502	809	556	?	?
Total	5852	7382	6220	8431	8697	10508	11638	13265	?	?
Holders of Temporary Visas										
Professional Engineers	6974	6222	7187	9544	9454	7743	6194	4952	5005	5375
Engineering Technologists	463	365	292	274	221	150	106	62	52	88
Engineering Associates	2326	2049	2271	3341	3737	3534	2956	2135	1846	1647
Total	9763	8636	9750	13159	13412	11427	9256	7149	6903	7110
Additional Supply of Engineers										
Professional Engineers	12219	13087	12509	16892	17238	17391	16431	16837	?	?
Engineering Technologists	754	542	706	812	628	508	698	886	?	?
Engineering Associates	2642	2389	2755	3886	4243	4036	3765	2691	?	?
Total	15615	16018	15970	21590	22109	21935	20894	20414	?	?

Source: Statistics supplied by D of Home Affairs

7.5 Skilled migration trends and the supply of engineers

Between 2006 and 2011, 71.4% of the growth in the engineering labour force was from skilled migration. Between 2011 and 2016, this share increased to 76.5%. Figure 7.1 shows that similar shares apply to inter-census growth in employment in engineering even though the proportions of migrants employed in engineering occupations are substantially lower than for Australian born qualified engineers. This high dependence on skilled migration is the reason why dependable statistics on migration trends are important to the engineering profession.

The situation discussed in section 7.4 means that the only recourse is judgment based on experience with migration skills assessment numbers. A best guess is that permanent visas were granted to 8,000 to 10,000 engineers in the occupations listed in Table 7.1. The indications are that the numbers of software engineers continue to increase and that the falls in the balance of the list are much greater. From a policy point of view, it is not entirely clear that a cut in skilled migration, and a cut in the number of engineers granted permanent visas, has actually been announced. Transparency is a major problem.

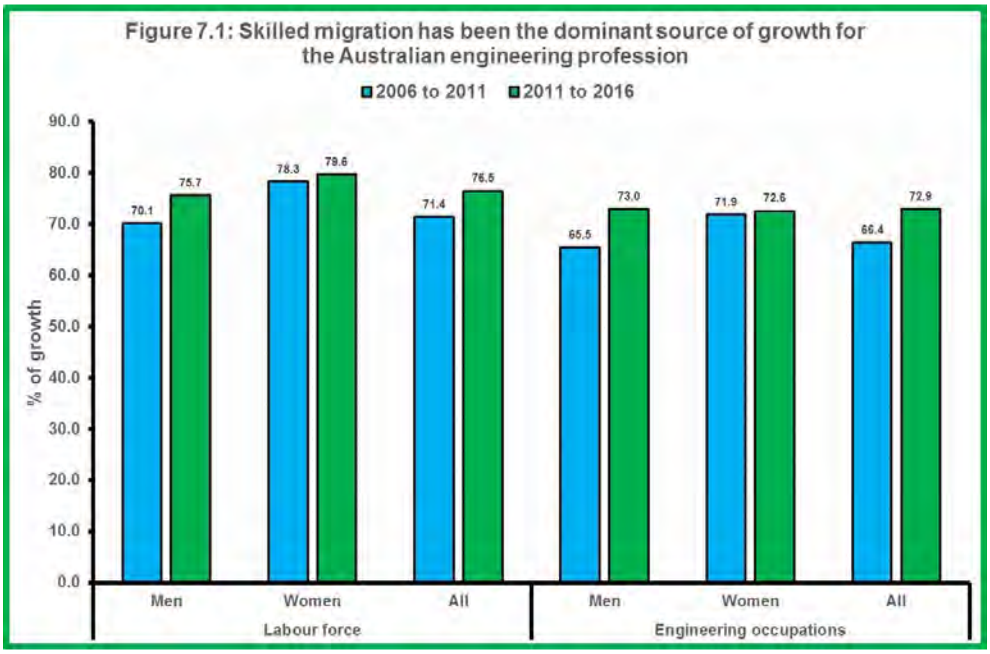
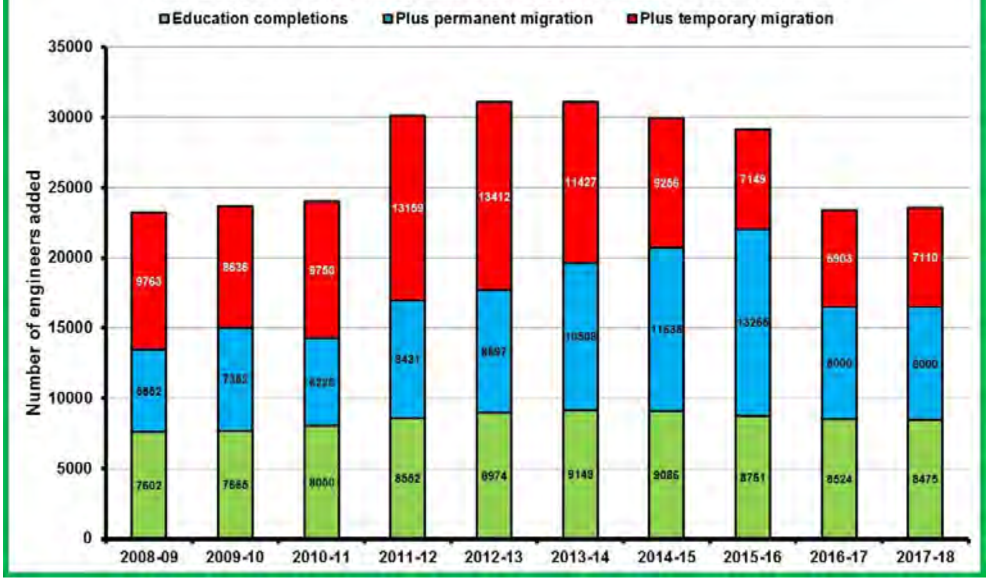


Figure 7.1: Skilled migration has been the dominant source of growth for the Australian engineering profession

Figure 7.2: The Relative Contributions of Education Completions and Skilled Migration to Changes in the Supply of Professional Engineers



However, what is clear is that the skilled migration contribution to the supply of engineers has fallen to around the 15,000 mark in the past two years which is around about the migrant intake in 2008-09. The implication this change becomes evident in Figure 7.2 which combines skilled migration figures with financial year forms of the education completions set out in Table 6.6.

Education completions are trending downwards. So is permanent migration with the exact size of the fall dependent on the guess we made for the last two years. Temporary migration increased last year after three years of falls. It is fair to conclude that the supply of qualified engineers from domestic sources and skilled migration is now trending downwards.

8. Engineers in industry

8.1 Preliminary remarks

Engineers feature much more prominently in a select number of industries. These industries are 'core engineering industries' in which the proportion of qualified engineers working in engineering occupations is above the economy wide average. Core engineering industries include mining, manufacturing, the utilities, construction, information media and telecommunications and public administration.

The past decade has a structural shift in Australian employment from manufacturing to services-based industries. This has been accompanied by a shift in the predominant business model of industry from vertical integration to a focus on core business and the contracting out of non-core business to other business entities that provide these services. The result has been a profound change in the industries where most qualified engineers are employed.

Employment growth for qualified engineers in Australia has been strong for the decade 2006 to 2016, but has slowed in recent years, but employment in engineering occupations has been more muted. From 2006 to 2011 growth was driven by the resources boom, and the demand for engineers in engineering occupations, particularly in core industries, was strong.

From 2011 to 2016 employment growth for qualified engineers slowed but was still strong. What changed was that employment in engineering occupations slowed substantially with the result that the distribution of qualified engineers across industry changed. Most of the employment growth for qualified engineers occurred in non-core engineering industries, and more engineers moved into employment options away from tradition engineering roles.

These quantitative changes, as important as they are, have not yet affected the rank order of the industries that employ the most qualified engineers. Industries such as professional services, manufacturing and construction are still the largest employers of qualified engineers. However, employment of qualified engineers in manufacturing has started to fall while the rapid growth that occurred in professional services has begun to stall.

8.2 Changes in broad industry structure

The ABS use the Australian and New Zealand Standard Industry Classification (ANZSIC) for industry statistics. This classification system was used in each of the past three censuses. It is a hierarchical system with the broadest characterisation of industries at the 1-digit level and the most specific characterisation at the 4-digit level. This arrangement allows analyses to be conducted at an overview level and enables analysts to drill down into the classification to examine the detail of what is happening. Thus, manufacturing is treated as Division C or a 1-digit industry; within manufacturing, basic chemical and chemical product manufacturing is sub-division 18, or a 2-digit industry; and within this 2-digit industry, group 180 basic chemical manufacturing is a three-digit industry; and finally, within group 180, class 1811 industrial gas manufacturing is a 4-digit industry. This structure is consistently applied across 19 1-digit industries. This section reviews how the distribution of employed qualified engineers has changed over 2006, 2011 and 2016 censuses.

8.2.1 The distribution of employed qualified engineers

When dealing with industry distribution it is important to observe that the ABS classifies people to industries on the basis of employment. Unemployed persons are not assigned an industry. In census statistics, some people do not provide responses to every question, including the ones used to assign them to an industry, or provide inadequate information for this purpose. When the numbers involved are high, this inadequate response needs to be taken into account when assessing industry distribution.

With these points in mind, the employment of qualified engineers in broad industries in 2006, 2011 and 2016 is shown in Table 3.1 while Table 3.2 shows the corresponding employment of qualified engineers in engineering occupations.

Table 3.1: Employment of qualified engineers in industry, 2006 to 2016

Broad industry	2006			2011			2016		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Agriculture, Forestry and Fishing	1626	137	1763	1641	155	1796	2333	277	2610
Mining	6764	601	7365	12238	1315	13553	14051	1618	15669
Manufacturing	33172	3462	36634	37185	3961	41146	34568	4143	38711
Electricity, Gas, Water and Waste Services	6848	684	7532	9951	1134	11085	10976	1517	12493
Construction	12909	756	13665	19492	1411	20903	26608	2169	28777
Wholesale Trade	8610	1003	9613	10491	1229	11720	10735	1471	12206
Retail Trade	5807	1213	7020	6936	1542	8478	10804	2432	13236
Accommodation and Food Services	2700	626	3326	3587	866	4453	6652	1673	8325
Transport, Postal and Warehousing	10976	740	11716	15148	1203	16351	18985	1697	20682
Information Media and Telecommunications	6045	658	6703	7398	840	8238	9866	1419	11285
Financial and Insurance Services	3833	766	4599	4848	1052	5900	6410	1623	8033
Rental, Hiring and Real Estate Services	1565	170	1735	1766	239	2005	2757	502	3259
Professional, Scientific and Technical Services	38361	4042	42403	53717	6940	60657	54532	8262	62794
Administrative and Support Services	2984	471	3455	3765	729	4494	5273	1155	6428
Public Administration and Safety	15211	1651	16862	16696	2248	18944	19782	3070	22852
Education and Training	6654	1324	7978	8010	1814	9824	10294	2951	13245
Health Care and Social Assistance	2383	932	3315	3115	1431	4546	4657	2355	7012
Arts and Recreation Services	808	125	933	1081	201	1282	1686	343	2029
Other Services	3273	309	3582	4228	422	4650	5536	662	6198
Inadequately described	3972	424	4396	4033	478	4511	12866	1548	14414
Total	174501	20094	194595	225326	29210	254536	269371	40887	310258

Table 3.2: Employment of qualified engineers in engineering occupations by industry, 2006 to 2016

Broad industry	2006			2011			2016		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Agriculture, Forestry and Fishing	254	5	259	240	15	255	411	29	440
Mining	5532	508	6040	10061	1110	11171	11171	1365	12536
Manufacturing	21472	1730	23202	24037	2134	26171	21284	2268	23552
Electricity, Gas, Water and Waste Services	5341	558	5899	7802	908	8710	8152	1146	9298
Construction	8922	508	9430	13985	1052	15037	18314	1577	19891
Wholesale Trade	4506	368	4874	5442	480	5922	5793	661	6454
Retail Trade	1060	120	1180	1175	155	1330	1898	297	2195
Accommodation and Food Services	199	20	219	192	24	216	332	24	356
Transport, Postal and Warehousing	6742	372	7114	9290	710	10000	10089	946	11035
Information Media and Telecommunications	4116	424	4540	5283	554	5837	7111	992	8103
Financial and Insurance Services	1648	251	1899	2298	444	2742	3427	752	4179
Rental, Hiring and Real Estate Services	483	32	515	535	40	575	773	107	880
Professional, Scientific and Technical Services	31877	2992	34869	45212	5381	50593	45634	6290	51924
Administrative and Support Services	1032	82	1114	1336	161	1497	1277	174	1451
Public Administration and Safety	10803	1111	11914	11516	1499	13015	13359	2041	15400
Education and Training	4092	561	4653	4896	765	5661	6008	1098	7106
Health Care and Social Assistance	865	82	947	937	171	1108	1395	258	1653
Arts and Recreation Services	228	29	257	323	39	362	461	72	533
Other Services	954	58	1012	1299	92	1391	1462	149	1611
Inadequately described	2160	152	2312	2135	187	2322	6735	601	7336
Total	112286	9963	122249	147994	15921	163915	165086	20847	185933

Table 3.1 shows that in 2006, there were 194,595 qualified engineers employed in Australia. By 2011, this number had grown to 254,536 at an average compound rate of 5.5% per year. Growth slowed to an average 4.0% per year between 2011 and 2016 increasing the number of qualified engineers to 310,258. Table 3.2 shows that the number of qualified engineers employed in engineering occupations grew from 122,249 in 2006 to 163,015 in 2011, an average compound rate of 6.0% per year. Once again growth slowed between 2011 and 2016, to average 2.6% per year, increasing the number of qualified engineers employed in engineering occupations to 185,933. To put these figures into context, they should be compared to changes in other segments of the labour market.

8.2.2 How different segments of the labour market have changed

For this purpose, we define "other skilled workers" as those who have the same level of qualification as qualified engineers, that is, at least an associate degree or advanced diploma, in any field except engineering. "Less skilled workers" are those with qualifications below an associate degree or advanced diploma in any field, including engineering and qualified engineers have been defined earlier. Table 3.3 shows how the totals in Tables 3.1 and 3.2 compare to other labour market segments.

Table 3.3: Employment growth in different segments of the Australian labour market

Group	2006 to 2011		2011 to 2016	
	Increase	% pa	Increase	% pa
Overall employment	954,133	2.0	625,485	1.2
Less skilled workers	309,428	0.9	-27,099	-0.1
Other skilled workers	584,764	4.8	596,862	4.0
Qualified engineers	59,941	5.5	55,722	4.0
Qualified engineers in engineering occupations	41,666	6.0	20,018	2.6

During the first period in Table 3.3, employment growth for qualified engineers and other skilled workers were both high relative to less skilled workers. Average growth in employment for qualified engineers was higher, 5.5% per year compared to 4.8% per year, but growth in employment of qualified engineers in engineering occupations was higher still at average 6.0% per year. This relationship demonstrates why employers believed that before 2011 there was an engineering shortage. In contrast, employment growth for less skilled workers was just average 0.9% per year.

Employment growth generally slowed in the second period. For skilled workers, qualified engineers and other fields alike, employment growth remained fairly high averaging 4.0% per year. However, the slowdown in growth was more abrupt for employment of qualified engineers in engineering occupations which grew by average 2.6% per year. Even so this was much strong than the situation for less skilled workers where employment actually contracted.

The key issue that emerges from Table 3.3 is if employment growth for qualified engineers remained high while it more than halved for qualified engineers employed in engineering occupations, where did the large increase in qualified engineers work?

8.2.3 Core engineering and non-core industries

In Chapter 2 we discussed the notion that qualified engineers may not necessarily be employed in engineering related work and employment of qualified engineers in engineering occupations was introduced as a means of differentiating the two situations. We now introduce the concept of core-engineering industries to help answer the question posed above.

Core-engineering industries are industries in which the proportion of qualified engineers employed in engineering occupations is above the economy wide average. Table 8.4 shows the proportions of qualified engineers in engineering occupations for the core-engineering industries and Table 8.4 shows these proportions for non-core engineering industries. Bear in mind the caveat put forward above; the ABS assigns people to industry on the basis of employment, in other words, the figures in Tables 8.4 and 8.5 have employment as denominator instead of the labour force as in Chapter 2 and consequently are a little higher.

Table 8.4: Core engineering industries, % of qualified engineers in engineering occupations

Core Engineering Industries	2006	2011	2016
Professional, Scientific and Technical Services	82.2	83.4	82.7
Mining	82.0	82.4	80.0
Electricity, Gas, Water and Waste Services	78.3	78.6	74.4
Information Media and Telecommunications	67.7	70.9	71.8
Construction	69.0	71.9	69.1
Public Administration and Safety	70.7	68.7	67.4
Manufacturing	63.3	63.6	60.8
Economy-wide average	62.8	64.4	59.9

Table 8.5: Non-core engineering industries, % of qualified engineers in engineering occupations

Non-Core Engineering Industries	2006	2011	2016
Education and Training	58.3	57.6	53.6
Transport, Postal and Warehousing	60.7	61.2	53.4
Wholesale Trade	50.7	50.5	52.9
Financial and Insurance Services	41.3	46.5	52.0
Rental, Hiring and Real Estate Services	29.7	28.7	27.0
Arts and Recreation Services	27.5	28.2	26.3
Other Services	28.3	29.9	26.0
Health Care and Social Assistance	28.6	24.5	23.6
Administrative and Support Services	32.2	33.3	22.6
Agriculture, Forestry and Fishing	14.7	14.2	16.9
Retail Trade	16.8	15.7	16.5
Accommodation and Food Services	6.6	4.9	4.3
Inadequately described or not stated	52.6	51.5	50.9
Economy wide average	62.8	64.4	59.9

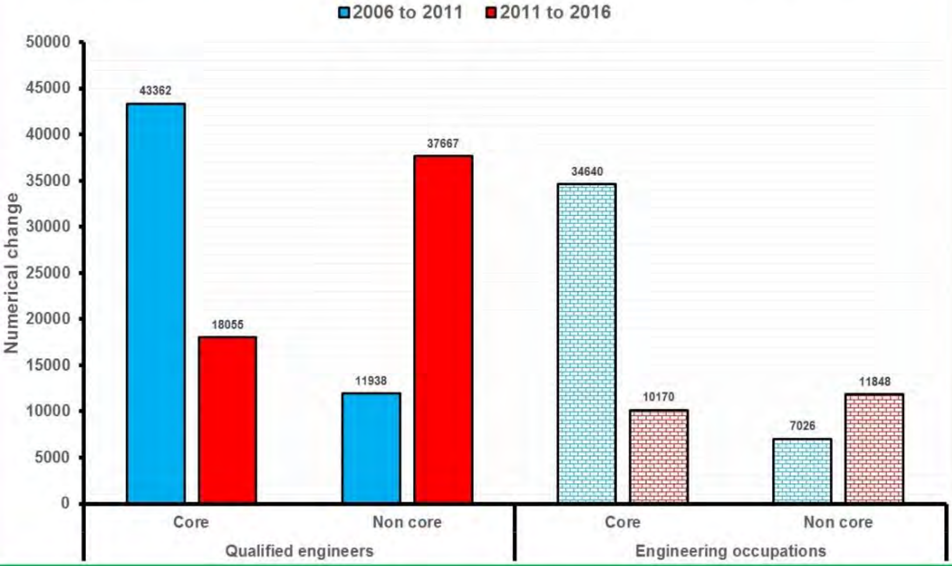
In the three census years, 2006, 2011 and 2016, 67.0%, 68.6% and 62.1%, respectively of qualified engineers were employed in core industries. At the same time, these industries employed 78.4%, 79.6% and 75.7%, respectively of all qualified engineers employed in engineering occupations. This is why the core-engineering industries are so important to the engineering profession.

8.2.4 Employment growth has shifted away from core-engineering industries

In Table 3.3, we showed that employment of qualified engineers increased by 59,941 between 2006 and 2011. This change was heavily weighted towards core industries for which the increase was 43,362 leaving an increase of 16,579 spread across non-core industries. An even higher share of the increase in qualified engineers employed in engineering occupations occurred in the core industries. The overall increase as noted in Table 3.3 was 41,666. Of this 34,640 occurred in the core industries and 7,026 occurred in the non-core industries. These changes are illustrated by the blue bars in Figure 8.1.

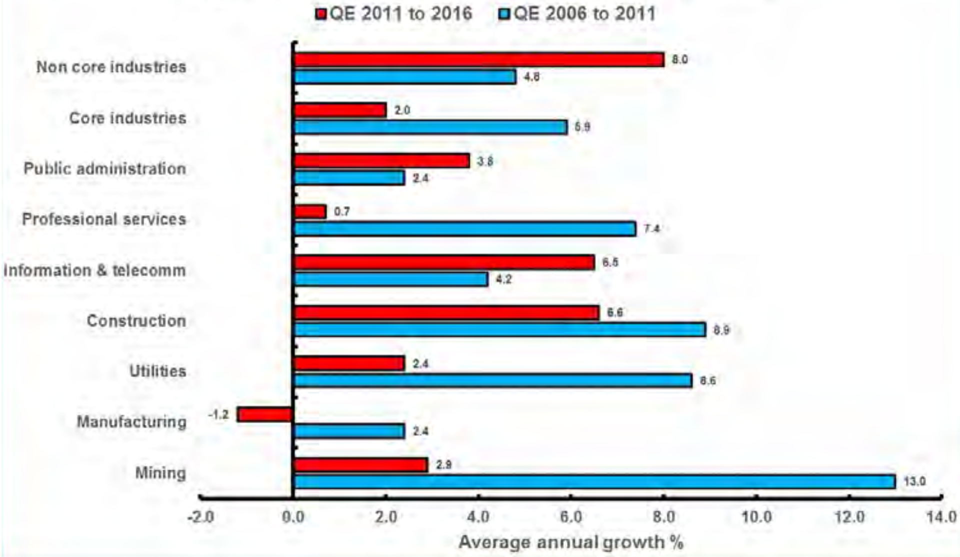
Between 2011 and 2016 the situation changed radically. Instead of the lion's share of growth occurring in core-engineering industries, it occurred in the non-core industries. The overall increase in employment of qualified engineers was 55,722; the increase in core industries was 18,055 while the increase in non-core industries was 37,667. The increase in employment of qualified engineers in engineering occupations was 22,018, almost half the increase between 2006 and 2011. Between 2006 and 2011, 83.1% of the increase in employment in engineering occupations was in the core industries, but between 2011, the increase in employment in engineering industries was 10,170 and 11,848 of the increase occurred in non-core industries.

Figure 8.1: Growth in engineering employment in core industries has fallen substantially



Two points are worth highlighting: first, the number of new employment opportunities in engineering occupations was radically smaller; 22,018 compared to 41,666 between 2006 and 2011. Second, even though overall 75.7% of all qualified engineers employed in engineering occupations were employed in core-engineering industries in 2016, over the preceding five years only a minor share of the increase in employment in engineering occupations occurred in these industries, 53.8% occurred in non-core industries.

Figure 8.2: Average annual growth in employment of qualified engineers in augmented core industries, 2006 to 2011 and 2011 to 2016

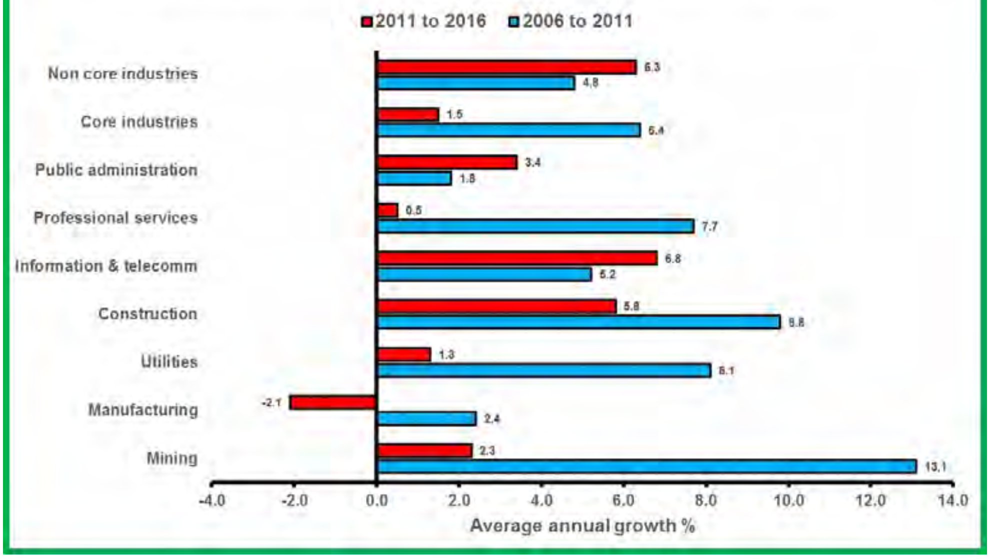


In Figures 8.2 and 8.3 we look at the changes illustrated in Figure 8.1 in more detail. Figure 8.2 looks at average annual growth in the number of qualified engineers in the core-engineering industries and Figure 8.3 looks at the corresponding changes in the number of qualified engineers employed in engineering occupations.

Considered as a group the number of qualified engineers employed in the core engineering industries grew by an average 5.9% per year between 2006 and 2011 compared to average 4.8% per year in the non-core industries. Mining, the utilities, construction and professional services experienced above average growth rates. Manufacturing, information media and telecommunications experienced below average growth.

Moving to 2011 to 2016, the first point to note is that average annual growth in employment of qualified engineers in the core industry group fell to almost one-third the rate in the earlier period, to average 2.0% per year. Average growth was above average in mining, the utilities, construction, information media and public administration. Average growth was below average in the two largest employing industries, manufacturing and professional services. Indeed, employment of qualified engineers contracted by average 1.2% per year. This is a worrying trend because the change in business model in manufacturing feeds contractionary forces into the professional services industry.

Figure 8.3: Average annual growth of employment of qualified engineers in engineering occupations in augmented core industries, 2006 to 2011 and 2011 to 2016



For the core engineering industries as a group, average annual growth in employment of qualified engineers in engineering occupations was 6.4% per year compared to average 6.0% per year for the engineering labour market as a whole and 4.8% in the non-core industries. Above average growth was experienced by the same four industries which had above average growth in employment of qualified engineers; mining, manufacturing, construction, and professional services. Similarly, below average growth was experienced by manufacturing and public administration.

Between 2011 and 2016, average annual growth in employment of qualified engineers in engineering occupations in the core industry group fell to less than one-quarter the rate in the earlier period, to average 1.5% per year compared to average 6.3% per year. Growth rates contracted sharply in most industries except information media and public administration. Employment of qualified engineers in engineering occupations in manufacturing fell by average 2.1% per year and grew by just average 0.5% per year in the largest employing industry, professional services.

Comparing the two inter-census periods, the first was strongly influenced by the resources boom and to some extent by a construction boom, both buildings and infrastructure, in major cities. As these influences waned there was an expectation that construction would continue to grow, and grow sufficiently to take up the slack from the end of the resources boom. Construction did hold up, but commentators failed to consider the consequences of the structural shift between manufacturing and services, and the link between engineering employment in manufacturing and professional services.

8.3 Which industries employ most engineers

This section looks at which industries employ the most qualified engineers. In previous sections the focus was on Division or 1-digit industries, the broadest category, often referred to as industry sectors. The statistics described below are compiled at group or 3-digit level in order to drill down into broad industries to establish more specific information.

8.3.1 Qualified engineers

There are two important observations that flow from data on the top 20 3-digit industries of employment for qualified engineers in Australia for the three census years of 2006, 2011 and 2016. First, by far the largest employer of qualified engineers is the "architectural, engineering and technical services" industry which for our purposes can be given the short hand "engineering consulting". This industry has consistently been the highest employer of qualified engineers. The number of qualified engineers employed in this industry was 13.1% of employment in 2006, 15.3% of employment in 2011 and 11.3% of employment in 2016. It is important to note the contraction in employment between 2011 and 2016.

Engineering consulting employs substantially more qualified engineers than the second ranked industry which was computing system design and related services which consistently ranked as the second highest employer of qualified engineers. In contrast to engineering consulting, employment in computer system design etc has increased strongly reflecting the role of qualified engineers in the digital revolution.

The data puts into perspective several industries that often feature in public commentary. Infrastructure construction is represented by the industry "heavy and civil engineering construction. In 2006, this industry employed 2.0% of qualified engineers and ranked ninth. In 2011, it employed 2.7% of qualified engineers and ranked third. The industry increased its share of employment to 2.9% in 2016 but slipped to fourth in the rankings. In other words, employment of qualified engineers in this industry is comparatively small and exceptionally large increases in industry activity would be necessary to substantially influence overall numbers at the national level.

The resources boom has been seen as a major influence on engineering employment, but once again this should be seen in perspective. In 2006, the highest ranked resources industry was "metal ore mining" which employed 1.3% of qualified engineers and ranked sixteenth. No other resources industry appeared in the top 20 employing industries. In 2011, employment of qualified engineers increased in metal ore mining with the industry accounting for 1.8% of employment of qualified engineers and its ranked increased to tenth. By 2011, "oil and gas extraction" also appeared in the list accounting for 1.3% of employed qualified engineers and ranked eighteenth. In 2016, metal ore mining continued to increase employment of qualified engineers accounting for 2.1% of employment and a higher rank of sixth. Oil and gas extraction maintained its share and rank. Coal mining did not rank in the top 20 employers of qualified engineers in any of the lists.

The second observation to make is about the lack of concentration of employment. We have already noted the difference in scale of employment between the top and second ranked industries. But this difference in scale is accompanied by highly dispersed employment across the remaining industries. In 2006, the top 10 employing industries accounted for 36.5% of all employed qualified engineers and the top 20 for 50.2%. In other words, 49.8% of employed qualified engineers worked in industries outside the top 20.

The strong demand conditions in the lead up to 2011 resulted in more concentrated employment. The top 10 employing industries increased their share of employed qualified engineers to 37.9% and the top 20 to 52.1%, reducing employment outside the list to 47.9%.

As demand weakened, greater dispersion reappeared. In 2016, the top 10 employing industries accounted for 34.8% of employed qualified engineers and the top 20 for 48.1%. These figures are lower than those in 2006. In 2016, 51.9% of employed qualified engineers were employed in industries not included in the top 20 industries of employment.

8.3.2 Qualified engineers employed in engineering occupations

Greater concentration in the top 10 and 20 industries becomes apparent when attention is turned to employment of qualified engineers in engineering occupations. In Table 8.5 the top 10 employing industries have consistently accounted for 47 to 48% of qualified engineers employed in engineering occupations and the top 20 employing industries have consistently accounted for almost two-thirds of qualified engineers employed in engineering occupations.

The top two employing industries are the same as described in Section 8.3.1, but account for a higher share between them: 24.4% in 2006, 27.2% in 2011 and 24.0% in 2016. These ranks, however, mask the important change in the 2016 figures. Although employment of qualified engineers in engineering occupations continued to grow in the computer system design industry, it contracted sharply in the engineering consulting industry. This is an important result for the engineering profession and warrants careful observation in future.

Table 8.5: The top twenty 3-digit industries of qualified engineers working in engineering occupations in Australia, 2006, 2011 and 2016

	In engineering occupation 2006			In engineering occupations 2011			In engineering occupations 2016		
Rank	Industry	No	%	Industry	No	%	Industry	No	%
1	Architectural, Engineering and Technical Services	22,839	18.7	Architectural, Engineering and Technical Services	35,271	21.5	Architectural, Engineering and Technical Services	31,193	16.8
2	Computer System Design and Related Services	6,925	5.7	Computer System Design and Related Services	9,275	5.7	Computer System Design and Related Services	13,466	7.2
3	Tertiary Education	4,014	3.3	Heavy and Civil Engineering Construction	6,006	3.7	Heavy and Civil Engineering Construction	7,608	4.1
4	Defence	3,732	3.1	Tertiary Education	4,909	3.0	Inadequately described	6,872	3.7
5	Telecommunications Services	3,673	3.0	Telecommunications Services	4,741	2.9	Telecommunications Services	6,242	3.4
6	State Government Administration	3,557	2.9	Defence	4,112	2.5	Tertiary Education	6,171	3.3
7	Heavy and Civil Engineering Construction	3,212	2.6	Other Machinery and Equipment Wholesaling	3,840	2.3	Metal Ore Mining	5,266	2.8
8	Motor Vehicle and Motor Vehicle Part Manufacturing	3,195	2.6	Metal Ore Mining	3,812	2.3	Defence	4,652	2.5
9	Other Machinery and Equipment Wholesaling	3,083	2.5	Air and Space Transport	3,642	2.2	Local Government Administration	4,418	2.4
10	Air and Space Transport	2,979	2.4	Management and Related Consulting Services	3,529	2.2	Other Machinery and Equipment Wholesaling	4,160	2.2
11	Local Government Administration	2,916	2.4	Local Government Administration	3,374	2.1	Air and Space Transport	3,984	2.1
12	Management and Related Consulting Services	2,581	2.1	State Government Administration	3,351	2.0	Management and Related Consulting Services	3,681	2.0
13	Water Supply, Sewerage and Drainage Services	2,193	1.8	Non-Residential Building Construction	3,078	1.9	Non-Residential Building Construction	3,194	1.7
14	Metal Ore Mining	2,120	1.7	Motor Vehicle and Motor Vehicle Part Manufacturing	3,029	1.8	State Government Administration	3,168	1.7
15	Inadequately described	2,019	1.7	Water Supply, Sewerage and Drainage Services	2,828	1.7	Oil and Gas Extraction	2,956	1.6
16	Non-Residential Building Construction	1,955	1.6	Oil and Gas Extraction	2,692	1.6	Water Supply, Sewerage and Drainage Services	2,954	1.6
17	Scientific Research Services	1,518	1.2	Electricity Distribution	2,612	1.6	Electricity Distribution	2,670	1.4
18	Professional and Scientific Equipment Manufacturing	1,508	1.2	Coal Mining	2,109	1.3	Motor Vehicle and Motor Vehicle Part Manufacturing	2,495	1.3
19	Computer and Electronic Equipment Manufacturing	1,504	1.2	Inadequately described	2,033	1.2	Coal Mining	2,316	1.2
20	Electricity Distribution	1,503	1.2	Professional and Scientific Equipment Manufacturing	1,921	1.2	Residential Building Construction	2,275	1.2
	Top 20 industries	77,026	63.0		106,164	64.8		119,741	64.4

In Table 8.5, heavy and civil engineering construction assumes a greater order of importance. Over successive censuses its share of employment in engineering occupations increases from 2.6%, to 3.7% and to 4.1% in 2016 and its rank increases from seventh in 2006 to third in each of 2011 and 2016. Telecommunications is consistently the fifth ranked industry. Defence has increased its employment in engineering occupations over time, but its rank order has steadily fallen. In contrast, both employment in engineering occupations and rank order have fallen for state government administration.

In 2006, the highest ranked manufacturing industry was "motor vehicle and motor vehicle parts manufacturing. It employed 2.6% of qualified engineers employed in engineering occupations and ranked eighth. By 2011, its employment had fallen to 1.8% and its rank to fourteenth and by 2016 its employment share was down to 1.2% and it ranked eighteenth. There were two other manufacturing industries in the top 20 in 2006; professional and scientific equipment manufacturing and computer and electronic equipment manufacturing. By 2011, the latter had dropped out of the list and by 2016, both had dropped out of the list.

The number of qualified engineers employed in "state government administration" has steadily fallen as has its ranking; in 2006, this industry accounted for 2.9% of qualified engineers employed in engineering occupations and ranked sixth, in 2006, it accounted for 2.0% and ranked twelfth, and in 2016 it accounted for 1.7% and ranked fourteenth, each with successively lower numbers. On the other hand, "local government administration" steadily increased its employment of qualified engineers in engineering occupations and over time increased its share and ranking. At the Commonwealth level, although "defence" steadily increased its employment of qualified engineers in engineering occupations, its ranking dropped over time. "Central government administration" does not feature in the top 20 employers of qualified engineers in engineering occupations. These results do not auger well for procurement of infrastructure services by government.

As was the case in the previous section, resources industries have become more prominent but generally have comparatively small employment of qualified engineers employed in engineering occupations. In 2006, the only resources industry in the top 20 was "metal ore mining" which accounted for 1.7% of employment and ranked fourteenth. In 2011, employment had nearly doubled and accounted for 2.3% and the industry's ranking increased to eighth. That year another resources industry joined the list; "oil and gas extraction" which accounted for 1.6% of employment and ranked eighteenth. By 2011, combined employment of these industries had increased to 3.3% of qualified engineers employed in engineering occupations.

A disconcerting aspect of Table 8.5 is the prominence of "inadequately described" in 2016. Although the confusion on census night cannot be discounted, a more likely factor is that many of these engineers were involved in the restructuring of the engineering labour market at the time and saw themselves as associated with engineering occupations, but transition factors confused their view of the industry they belonged to.

9. The engineering labour market in 2019

9.1 Some indicators of economic conditions

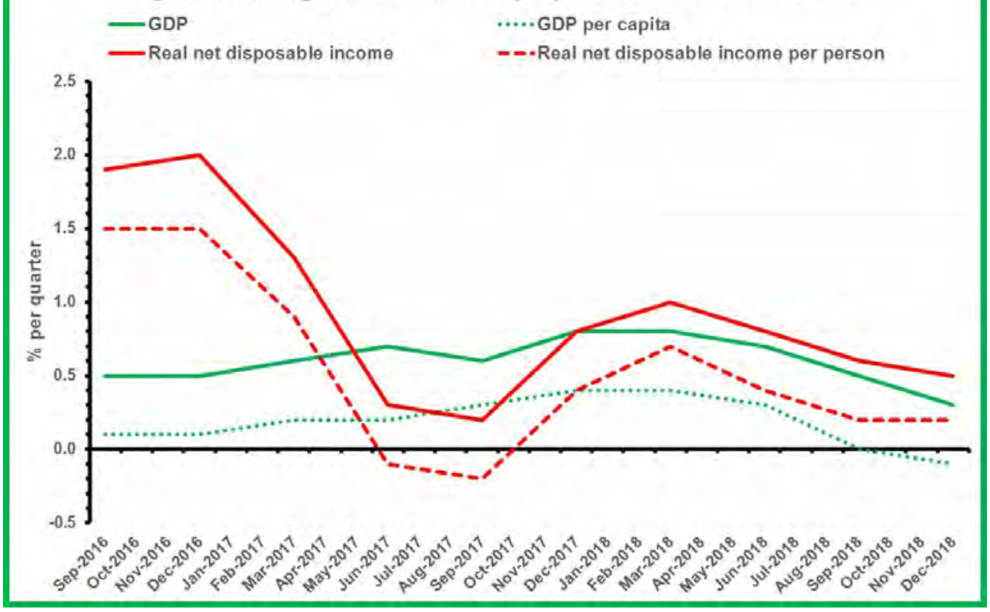
Before moving on to an assessment of conditions in the engineering labour market in 2019 we review several broad indicators of economic demand to establish the context in which the engineering labour market operates. The indicators considered are changes in gross domestic product and changes in gross domestic product per person, changes in both engineering and building construction and vacancies for engineers.

9.1.1 The macroeconomic perspective

Overall conditions in the Australian labour market reflect external pressures on the economy, private sector decision-making and the effects of government policies. A buoyant economy usually is associated with increasing demand for engineers while a weakening economy has the opposite effect. Gross domestic product (GDP) remains the most commonly used measure of change in economic activity. An alternative measure which better reflects the economic well-being of Australians is net disposable national income (NNDI) which adjusts GDP for international trade and changes in the terms of trade, adjusts GDP for incomes earned by foreign businesses and people and adjusts GDP for capital consumption or depreciation.

Both measures provide important background for this Chapter. Figure 9.1 illustrates the quarterly changes in Australia's gross domestic product and gross domestic product per person since September 2016, the month after the 2016 census. These changes are shown in green. Also shown in Figure 9.1 are changes in net national disposable income and changes in net national disposable income per person shown in red. All trends in Figure 9.1 are expressed in chain volume terms, that constant price terms[27] and ABS trend statistics are also used.

Figure 9.1: Changes in GDP and GDP per person since the 2016 census



Since the 2016 census, GDP growth trended upwards until December 2017 when it was 0.8% for the quarter. Since then, overall GDP has continued to grow, but at a decreasing rate. In December 2018, the latest quarter for which data are available, GDP grew by 0.3%. GDP per person has followed a similar path, but reduced by the impact of

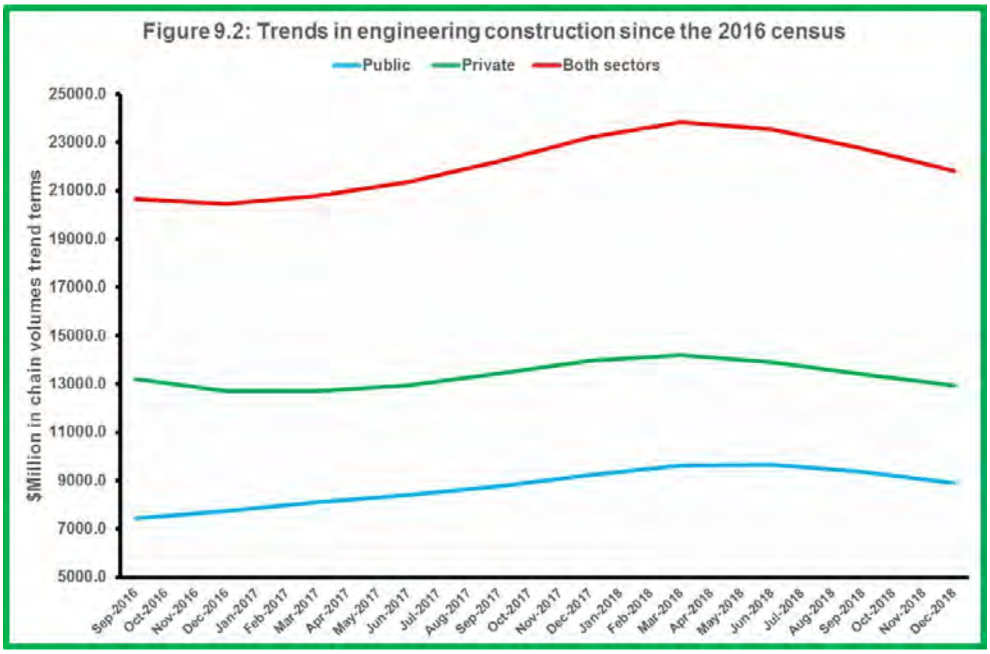
[27] See ABS, Australian National Accounts, National Income, Expenditure and Product, December 2018, Cat No 5206.0, 6 March 2019, www.abs.gov.au

population growth. When GDP growth peaked in December 2017, GDP per person increased by 0.4%. In December 2018, population growth turned an increase in GDP of 0.3% into a fall of 0.1% in GDP per person. These measures show that since the 2016 census economic conditions initially improved for just over a year but have since deteriorated with quarterly growth lower than when the census was conducted.

The changes in real net disposable income were more volatile. Just after the 2016 census NNDI grew relatively fast to a peak in December 2016. Thereafter NNDI growth fell sharply and by September 2017 was down to 0.2% for the quarter. Between September 2017 and March 2018, NNDI growth increased once more to 1.0% in the latter quarter. During the rest of 2018 NNDI growth fell and in the December quarter was 0.5%. Once again, the trend in per person changes closely followed the main trend and by December growth in NNDI per person had fallen to 0.2%. Although the mid-range of the NNDI figures are somewhat different to those for GDP, the conclusion about economic conditions in December 2018 are the same. The Australian economy has weakened since the 2016 census was conducted.

9.1.2 Construction activity

Engineers have critical roles in construction. Two broad areas of construction are considered; engineering construction and construction on building. Engineering construction which in other Engineers Australia publications[28] is split into engineering construction on infrastructure and engineering construction on resources, heavy industry and other engineering construction. Here we are not concerned about this difference because the objective is to use engineering construction as an indicator of economic activity relevant to the engineering labour market rather than as an indicator of infrastructure trends. Similarly, building construction can be split between residential and commercial building. These segments are of varying importance to engineers, but availability of statistics means we apply statistics on building without differentiating between them.



[28] See Engineers Australia, Engineering construction on infrastructure; Ten years of trends to 30 June 2018, 18 October 2018, www.engineersaustralia.org.au

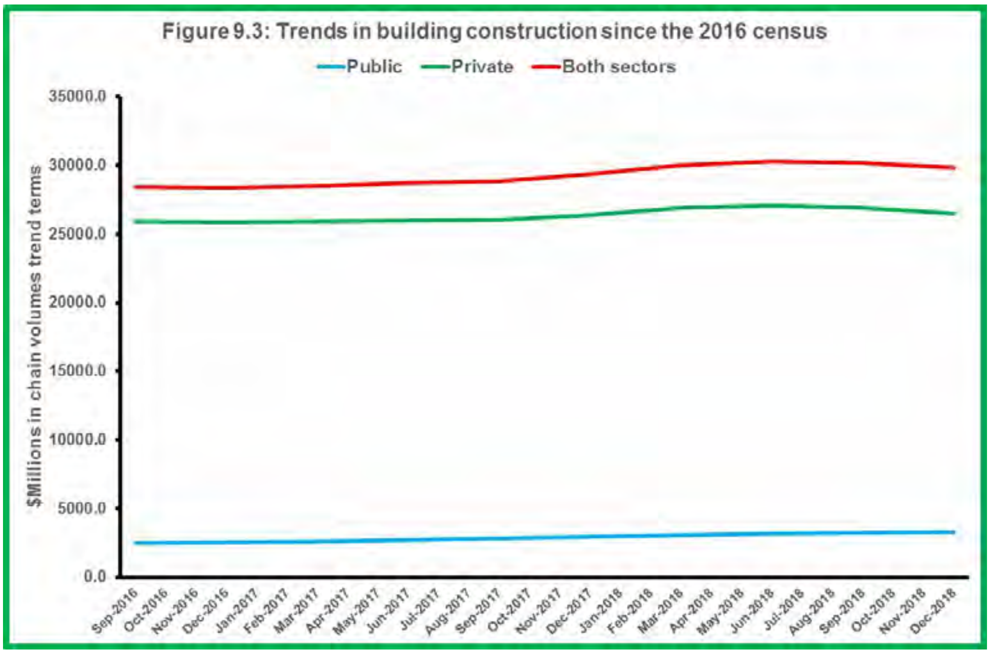


Figure 9.3: Trends in building construction since the 2016 census

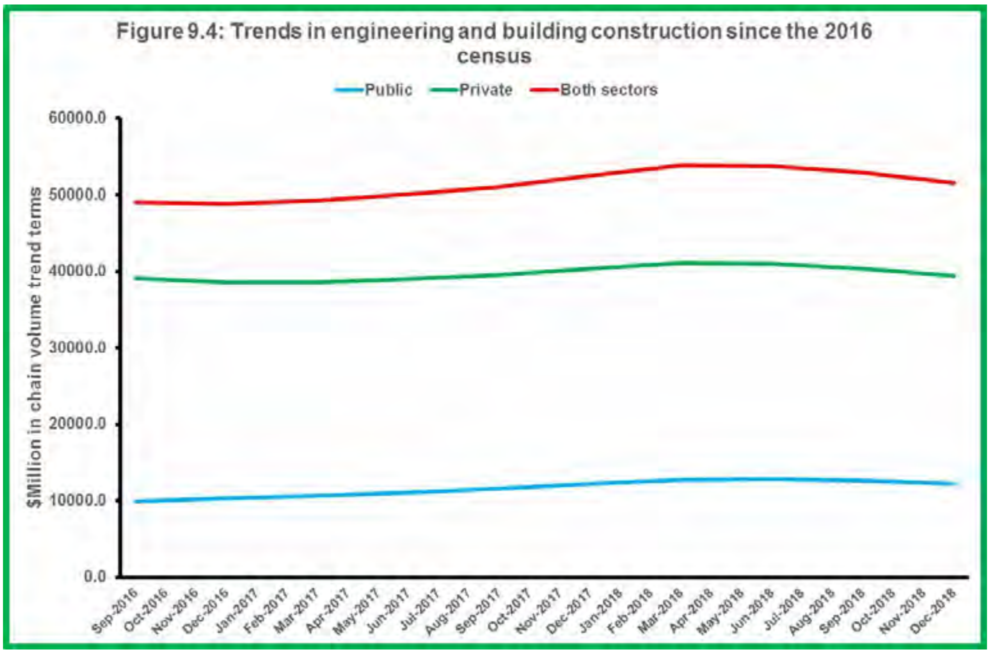


Figure 9.4: Trends in engineering and building construction since the 2016 census

Figure 9.2 illustrates the trends in public and private sector engineering construction and the trend for the two sectors combined. Figure 9.3 does the same thing for building construction and Figure 9.4 combined the trends shown separately in the two previous diagrams. All statistics used are chain volumes that were trended by the ABS.

At around 2016 census time, private sector engineering construction was falling and continued to fall until March 2017. From the it slowly increased to a fresh peak in March 2018. For the rest of 2018, private sector engineering construction fell. Public sector engineering construction (which is almost all infrastructure) increased from the time of the census to a peak in June 2018. It fell during the last six months of 2018. Overall engineering construction fell for most of 2018, consistent with a weakening sector.

The main change in building construction trends occurred in the last six months of 2018. The public sector trend has continued a slow upwards trajectory. As Figure 9.3 shows, the early stages of the private sector trend were very similar, but from December 2017 through to June 2018 there was a noticeable lift in the trend. However, the last six months of 2018 were characterised by falling private sector building construction. With private sector construction outweighing the public sector by five to one, the changes in the private sector are reflected in the overall trend and show evidence of weakening building construction.

The overall trends in engineering and building construction shown in Figure 9.4 show an overall weakening of these sectors of the economy. In December 2018, a combined $51.6 billion in constant prices was constructed, down 4.1% on the peak of $53.8 billion in the March quarter of 2017, but still 5.2% higher than immediately after the 2016 census. While engineering and building construction conditions are weakening, they were still more buoyant than at census time.

9.1.3 Job vacancies

Another important indicator of conditions in the engineering labour market is job vacancies which are inversely related to the unemployment rate through a relationship that economists refer to as the Beveridge curve. When vacancies are high, typically unemployment is low, and conversely, when vacancies are low unemployment is high. Thus, increasing vacancies are associated with improving conditions and falling vacancies with deteriorating conditions. With this in mind, Figure 9.5 illustrates the trends for job vacancies for engineers from a year before the census through to December 2016 and compares this trend to that for professionals (less engineers) and all job vacancies in the Australian labour market[29].

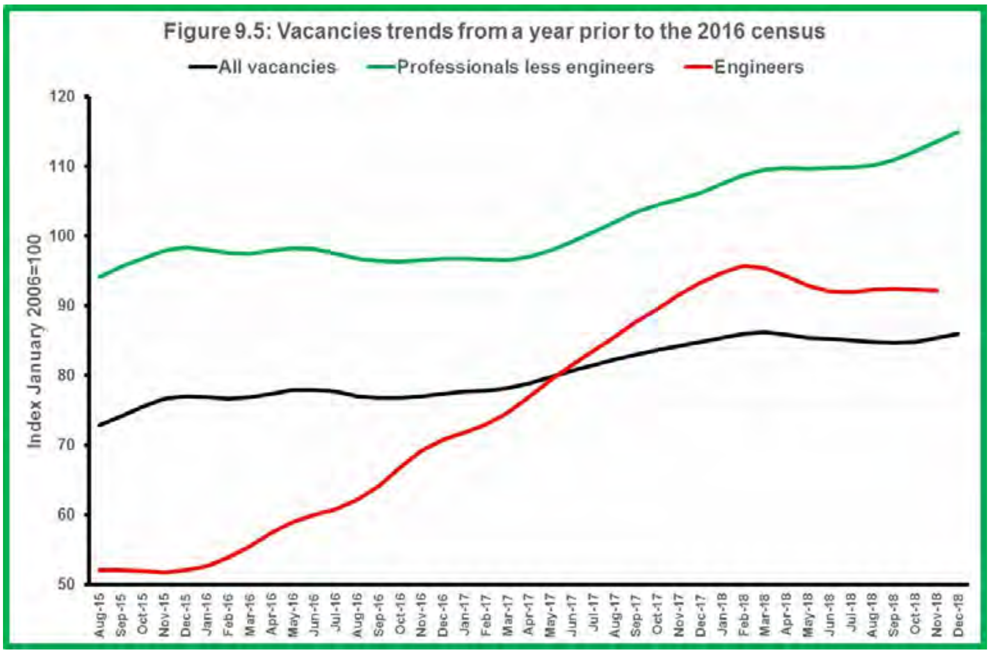


Figure 9.5: Vacancies trends from a year prior to the 2016 census

The trend in job vacancies for engineers was low and static from August 2015 through to about January 2016 when it began a steady upwards trajectory. The index was 100 in January 2006 when it began and as it began to rise it was 52.7, in other words, there were half as many vacancies for engineers around January 2016 as there were 10 years earlier. By the time of the 2016 census, vacancies for engineers had increased to 62.2, a useful improvement but still well below the 2006 starting point.

Immediately following the 2016 census, vacancies for engineers continued to improve and by February 2018 had improved to 95.8, more-or-less to the level that prevailed in January 2006. However, throughout 2018 job vacancies for engineers initially fell and then stalled in the last few months of the year. By December 2018, the index had fallen back to 92.2.

There is no doubt that vacancies for engineers have grown faster than vacancies in general. But vacancies for engineers trail a fair way behind vacancies for professionals. From August 2015 through to June 2017, vacancies for professionals, adjusted to exclude engineers, languished at a static trend below 100. But in July 2017, vacancies for professional increased to 100.6 and the trend has continued upwards so that by December 2018 it was 114.9. In other words, while vacancies for professionals continue to grow, vacancies for engineers have stalled at a substantially lower level. The vacancy situation in the engineering labour market is better than at the time of the 2016 census, but the improvement was short-lived and has stalled since early 2018.

[29] These statistics are taken from Engineers Australia, Engineering Vacancies Report, 2018 Trends, January 2019, www.engineersaustralia.org.au

9.2 Assessing the supply of engineers

This section brings together the material covered in earlier Chapters that has a bearing on recent growth in the supply of engineers. Here we are talking about the supply of people with qualifications that satisfy the requirements for the engineering team. We assess issues relevant to demand or whether they work in engineering in section 9.3.

The supply of engineers has grown strongly over the past decade, but there was a lull coinciding with a short period just before and just after the 2016 census. Census statistics in Chapter 2 showed that between 2006 and 2011, the supply of qualified engineers grew by an average 5.6% per year which slowed to an average 4.6% per year between 2011 and 2016. The strongest growth was from skilled migration where average growth in the two periods cited was 8.0% and 7.7% per year, respectively compared to 5.3% and 4.1%, respectively for Australian born qualified engineers. Analysis in another Engineers Australia publication[30] showed that there was a large reduction in labour force participation, particularly for Australian born men which influenced the slowdown.

The time series statistics in Chapter 3 provided more insights into the adjustment that occurred. These statistics confirmed the view that long term growth in supply of qualified engineers has been high, 4.43% per year since 2001, but it slowed abruptly between 2014 and 2016, just before the 2016 census. During these years, supply grew by just 1.22% per year, reflecting the view that labour force participation was an important adjustment mechanism. Indeed, SEW statistics showed that the supply of qualified engineers contracted in 2016. However, by 2017 stronger growth had resumed and strengthened in 2018.

Other evidence about supply circumstances comes from the education statistics in Chapter 6 and the skilled migration statistics in Chapter 7. In Chapter 6, we observed that Australia's production of its own engineers was slow to respond to the high demand conditions up to 2012, with of course, the short disruption caused by the global financial crisis. This was no surprise because the duration of engineering courses is longer than most other disciplines. The result was that completions of entry level engineering courses peaked at 9,202 in 2012. This number has since fallen back to 8,494 in 2017, the last firm statistic, and was estimated to be 8,455 in 2018.

What these numbers mean is that since 2003, the cumulative number of completions of entry level engineering courses by domestic students was 129,453. To put this into perspective, the Australian born segment, of the engineering labour force in the 2016 census, the corresponding group, was 137,058. In the past five years alone, 43,673 domestic students have completed entry level engineering courses.

The influence of skilled migration has been blurred by the inability of the Department of Home Affairs to provide statistics on the number of permanent visas granted to migrant engineers in 2016-17 and 2017-18. It was necessary to resort to guess-work based on the overall skilled migrant intakes in those years. For assessment purposes, we guestimated that about 8,000 permanent visas were granted in each of those years. This is well below the 2015-16 outcome which was 13,265 permanent visas granted to people eligible for occupations in the engineering team.

Even so the cumulative effect is large. Over the past five years, the cumulative number of permanent visas granted is 51,411. At the same time there was a large cohort of international engineers working in Australia on temporary visas, ranging from 11,427 in 2013-14 down to 7,110 in 2017-18. While the reduction in the number of temporary visa holders is in line with government policy design, the residual number in 2017-18 was extraordinarily high given conditions in the engineering labour market.

The factors discussed above combine to indicate that the supply of qualified engineers has continued to grow strongly. There was a disruption to this growth during 2014 to 2016, the aftermath of the end of the resources sector construction boom, but it has since resumed. Supply growth from domestic education completions is likely to slowly fall as the reduction in entry level course commencements that began in 2013 works its way through the system. Supply growth from skilled migration appears to have slowed, but the best information we have indicates that it is still higher than the level of domestic completions. In conclusion, change seems to be slowly heading in the right direction, but supply growth for qualified engineers remains buoyant.

[30] Engineers Australia, Australia's engineering capability: How the last ten years will affect the future, March 2019, www.engineersaustralia.org.au

9.3 Assessing the demand for engineers

Census statistics from Chapter two convey the impression of strong continuing demand for qualified engineers, but a pronounced slowdown in the demand for qualified engineers to be employed in engineering occupations. Between 2006 and 2011, the demand for qualified engineers grew by an average 5.5% per year, a little more slowly than supply. Between 2011 and 2016, this growth slowed to average 4.0% per year. The slowdown was more substantial for Australian born qualified engineers with the corresponding figures being 5,3% per year slowing to 3.6% per year, compared to 7.7% per year slowing to 7.0% per year for the overseas born or skilled migrant segment.

Between 2006 and 2011, the demand for qualified engineers to be employed in engineering occupations grew by average 6.0% per year, faster than growth in demand for qualified engineers more generally. This was taken as evidence of a skills shortage. In the following five years, 2011 to 2016, demand for qualified engineers to be employed in engineering occupations slowed by more than half to average 2.6% per year. This slowdown was quite strong for both segments of the labour force. For the Australian born segment, growth fell from average 3.7% per year to average 1.4% per year and for the overseas born segment it fell from an average 9.0% per year to average 3.8% per year.

When employers complain about skill shortages, they are really talking about a shortage of qualified engineers to work in engineering occupations. Between 2006 and 2011, the demand for qualified engineers in engineering occupations averaged 6.0% per year. Attempting to meet this from Australian sources was impossible because employment of qualified engineers in engineering occupations for qualified engineers for the Australian born segment averaged just 3.7% per year. The gap was filled by migrant engineers, indeed employment of overseas born qualified engineers in engineering occupations needed to grow by 9.0% per year to satisfy demand.

Even though demand in engineering occupations slower dramatically to 2.6% per year during 2011 to 2016, Australian sources were still insufficient to meet demand with employment in engineering occupations in this segment growing by just 1.4% per year. The entry of large numbers of new graduates into the market was offset by a large wave of retirements by older men and fewer young qualified engineers taking up employment in engineering occupations. Skilled migration was still necessary to make up the difference and grew by 3.8% per year.

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