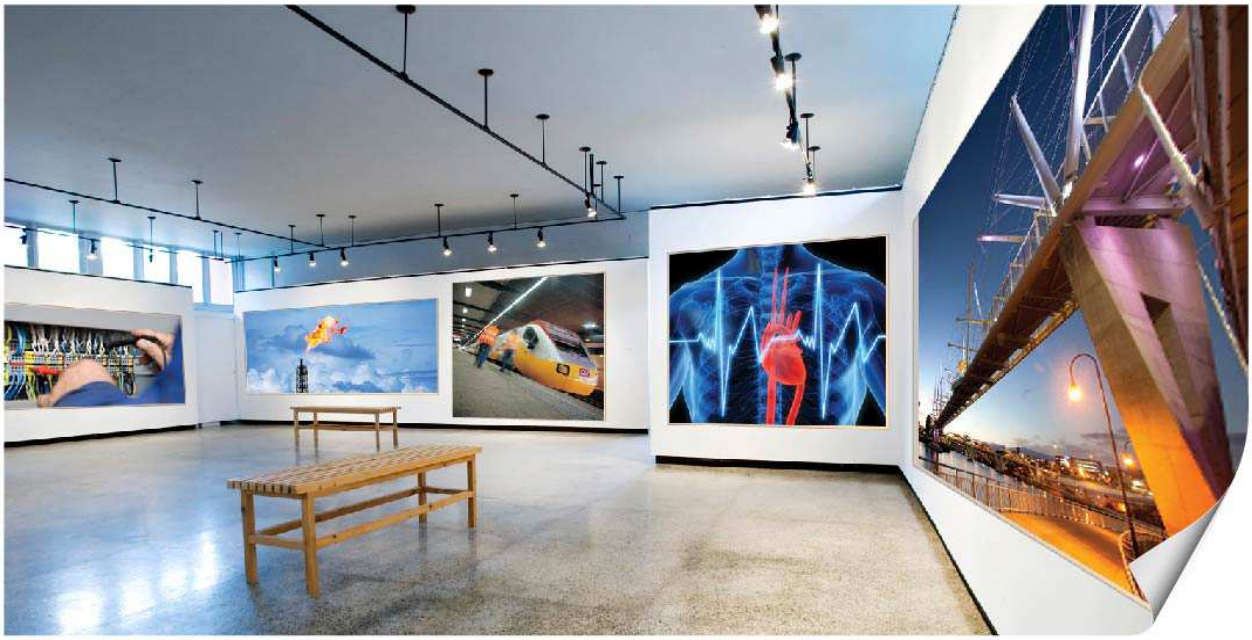
THE ENGINEERING PROFESSION
A STATISTICAL OVERVIEW

Ninth Edition, July 2012

Contact: Andre Kaspura
akaspura@engineersaustralia.org.au
02 6270 6581



ENGINEERS
AUSTRALIA

THE ENGINEERING PROFESSION: A STATISTICAL OVERVIEW,
NINTH EDITION, JULY 2012

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Author: Andre Kaspura
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National and International Policy
Engineers Australia
11 National Circuit, Barton ACT 2600
Tel: 02 6270 6555
Email: policy@engineersaustralia.org.au

www.engineersaustralia.org.au

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EXECUTIVE SUMMARY

The Engineering Profession; A Statistical Overview is a statistical resource for engineers and others interested in engineering in Australia. This in the Ninth Edition and provides updates for statistics made available in earlier editions and includes some new material. The new material includes development of the time series statistics for the engineering labour force, benchmark statistics for the skilled immigration of engineers based on the Skilled Occupation List and new statistics on year 12 subject completions and detailed commencements in university entry level courses in engineering.

Most statistics have been sourced from the Australian Bureau of Statistics. Other statistical sources used include the salaries survey conducted by APESMA and Engineers Australia's skill shortage survey. This survey is part of Engineers Australia's annual survey of engineering salaries conducted by Engineers Media and comprises a section in the wider survey about the difficulties recruiting engineers during the previous year. Finally, statistics on education were obtained from the Department of Education, Employment and Workplace Relations, the National Centre for Vocational Education Research and from the Group of 8 Universities Secretariat.

As a statistical resource, this publication is not amenable to executive summary in the normal way. Each Chapter begins with a summary of key messages, the narrative that the statistics in the Chapter give rise to. These summaries are not further condensed here.

Australian occupational statistics are very well developed for macroeconomic policy purposes. However, this statement does not apply to specific occupational groups, in this case engineers and engineering. Statistics at this level are fragmented and frequently do not conform to the parameters governing the occupational group in question. Engineers are expected to have formal qualifications in engineering; professional engineers, at least a four year bachelor degree, engineering technologists, at least a three year bachelor degree and associate engineers, at least a two year associate degree or a two year advanced diploma. This is not always reflected in commonly used statistics and can lead to a misleading perspective. As far as possible the basis of the statistics in the Overview applies the qualifications cited and where there are problems, these are clearly spelt out.

The objective of the Overview is an incremental undertaking and has benefited from helpful comments from users and from contributions of statistics from official and non-official sources. The main direction planned for immediate future development is the incorporation of statistics from the 2011 census and highlighting changes that have taken place since the 2006 census.

1. ABOUT THE STATISTICAL OVERVIEW

Key Messages

This Chapter describes the educational qualifications required to be regarded as part of the engineering team. The fragmented nature of labour market statistics in Australia, particularly for engineers, is emphasized. This edition updates statistics included in past editions but also introduces statistics for year 12 subject completions, time series statistics for engineers and SOL based migration statistics not previously available.

1.1 The Objective

Engineers and engineering have been indispensable contributors to Australian prosperity and lifestyles. Engineering services are embodied in the most humble and the most impressive goods and services used and consumed, now and in the future. The skills and expertise of engineers are unique. In many situations, when a particular skill is not available, “make do” is employed to resolve a problem. When the absent skill is that of an engineer “make do” comes with serious risks to safety, productivity and progress. While engineers are trained and equipped to do many different jobs, the reverse is not true and people trained in other skills are simply unable to function as engineers.

Engineers Australia was established to advance the science and practice of engineering for the benefit of the community. Engineers Australia sets and maintains professional standards for its members, 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.

Information about engineers is vital to Engineers Australia and to society as a whole. Guess-work is no substitute for hard information in national policy and decision making. Although this proposition is generally accepted, it is not always applied, especially in labour market policy where too often decisions are based on overarching information that does not distinguish between one profession and another. In this context the objective of the Statistical Overview is to assemble available information and statistics on engineers and engineering in Australia, so that informed decisions can be made about engineering issues.

1.2 What is Being Measured?

Engineers Australia is concerned about the engineering team. This notion is characterised by requirements for formal educational qualifications in engineering. These qualifications must comply with internationally recognised and audited competencies in engineering. The engineering team recognises that engineering can be practiced in different ways and that competencies required reflect these differences.

In the jargon of Engineers Australia, there are the following three occupational groups in the engineering team:

- Professional Engineers apply lifelong learning, critical perception and engineering judgment to the performance of engineering services. 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 bachelors 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 bachelors 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.

Engineers Australia believes that formal qualifications in engineering are just the first step towards becoming a competent practicing engineer. Engineers Australia believes that competent practicing engineers should undergo a period of work experience and professional formation leading to demonstrate that an engineer is ready to undertake independent practice; that is, to make design decisions and to sign off engineering decisions without direct supervision. This approach is consistent with arrangements in other professions including medicine, accounting, law, architecture and surveying.

Unlike some professions, engineering in Australia is not generally regulated. The exception is in Queensland where there has been comprehensive regulation of professional engineers for many decades. Engineers Australia offers its members facilities to demonstrate professional competence identical to those one would expect in a regulated system. However, membership of Engineers Australia is voluntary and therefore a wider base of information is needed to study engineers and engineering than contained in Engineers Australia membership statistics.

The Statistical Overview provides the necessary wider statistical base. It applies conventional labour market concepts, in conjunction with the educational requirements for the engineering team, to available statistics. Both official and non-official statistical sources are used. The advantage of official sources is that common classification systems are typically used, facilitating ready comparison. Furthermore, official sources have the resources to refine statistical methodologies and so ensure high quality and consistent information.

While the range of information available from official sources has expanded over time, there remain important gaps and non-official statistical sources can often help to fill in some of these. Two such sources are employed; one draws on the sample characteristics of the twice annual survey of professional engineering salaries undertaken by the Association of Professional Engineers, Scientists and Managers, Australia (APESMA). The second is the Engineers Australia survey of recruiting difficulties experienced by employers of engineers.

This survey is an integral component of another salaries survey conducted annually by Engineers Media, a subsidiary of Engineers Australia. In both cases, there are now sufficient time series of statistics to provide valuable insights.

Most of the statistics compiled in the Statistical Overview are freely available from the Australian Bureau of Statistics (ABS) and government departments. In both cases some statistics require non-standard tables and information files to be extracted from surveys and/or data bases. In some cases, fee-for-service arrangements are used to access these services, including use of the ABS census Tablebuilder facility. Engineers Australia has benefited from exceptional cooperation in most cases and the Statistical Overview would be much leaner without this.

1.3 The Changes Made in this Edition

The Statistical Overview is an evolving product and incremental improvements and changes are made in each edition. Past editions can be accessed on the Engineers Australia web-site.

In this Edition, as well as updating statistics, some important changes have been made. The first is a clearer focus on diploma qualifications in engineering. In previous years, associate degrees, advanced diplomas and other diplomas in engineering were grouped together. In this edition, these qualifications are separated.

Time series statistics from the ABS Survey of Education and Work have been updated, improved and augmented. The changes include new gender statistics, the distinction between degree and diploma qualified engineers and some statistics on changes in States.

Drawing on work undertaken by the Group of 8 Universities Secretariat, a fresh perspective on the potential flow of year 12 students to engineering courses has been introduced. This looks at year 12 completions rather than commencements and includes important gender statistics.

New statistics on commencements in engineering courses by engineering specialisation have been obtained. In the past only global commencement statistics were available. The added detail provides a better insight into developments in engineering education. An added advantage has been that statistics acquired this year from DEEWR were in a form that enabled auditing of historical statistics. Several changes advised by DEEWR were made and some errors have been corrected.

In recent years there have been significant changes to Australia's skilled migration policies. As well, the classification system used by the Department of Immigration and Citizenship (DIAC) for migration statistics has changed. With the assistance of DIAC officials, a new approach to skilled migration statistics has been developed. The change in statistical classification system is accommodated; the Skilled Occupation List (SOL) that is now the centre-piece of skilled migration has been adopted as the framework for statistics, statistics for permanent and temporary visas granted have been improved and statistics are now broken down by the occupational categories of the engineering team. The outcome is a more comprehensive view of an important and growing component of the engineering profession.

Finally, the results of the 2011 census are expected to become available later in 2012. The ABS TableBuilder facility enables very detailed analysis and for the first time this detail can be compared over two census years. The preparatory work for this analysis has led to some changes in 2006 census tables. While these statistics are now more than five years old, they are never-the-less useful benchmarks for the structure and characteristics of the engineering profession.

2. THE ENGINEERING LABOUR FORCE: CENSUS STATISTICS

Key Messages

This Chapter provides an overview of the structure of the engineering labour in 2006. Applying the strict definition of the engineering team in Chapter 1 there were 245,631 people in Australia with engineering qualifications and 200,615 of them were actively engaged with the labour market. The labour force was primarily men with only 10.6% women. A high proportion of engineers in the labour market were born overseas (48.4%).

Overall, unemployment of engineers was low and the unemployment rate was 3.0%. Unemployment was higher for women (5.1%) than men (2.8%) and higher for engineers born overseas than born in Australia. Among overseas born engineers, unemployment was highest for recent arrivals and fell the longer since arrival but many years of residency in Australia were necessary for unemployment rates to be close to those for Australian born engineers.

Although engineering education and training is closely aligned to prospective engineering careers, only 58.9% of qualified engineers actually worked in engineering. This proportion was higher for men (62.6%) than women (47.1%) and was increased with the level of engineering qualification held; the highest proportion was for doctorates (73.8%) and the lowest for associate degrees and advanced diplomas (43.2%). Another factor was country of origin; 68.6% of Australian born people with engineering qualifications worked in engineering compared to 52.8% of overseas born.

The two most important industries for engineering employment were manufacturing and professional services (or consulting) industries which accounted for over 40% of employment. Public Administration (the three levels of government and defence) employed another 9%, the construction industry 7% and transport and associated activities with 6%. Utilities employed 3.6%. The mining industry at the time was a comparatively small employer of engineers with 3.5%.

The average age of engineers was 41.7 years with men older (42.3 years) than women (36.5 years). The most populous age cohort for men was 40 to 44 years and for women 25 to 29 years. The average age of engineers employed in engineering work was younger (41.1 years) than those employed outside of engineering (43.5 years). Engineers with degree qualifications are generally younger than those with diploma qualifications. In contrast to the youth bias in skilled migration, overseas born engineers are older than Australian born engineers.

2.1 The Statistics Used

This chapter uses statistics from the 2006 population census. The census is a full enumeration of the population and its characteristics and is well suited to examining the details of a small group like Australia's engineers. Remember that engineers are only about 2½% of the labour force so that when dealing with other sources of statistics like sample surveys, the number of engineers included is very small limiting the scope for detailed analysis[1].

[1] The ABS Labour Force Survey is the main source of statistics used in labour market policy. In 2009 the ABS reported that the sample for the survey included 56,000 individuals or 0.32% of the population over 15 years.

Another advantage of census statistics is that because they cover the entire population, there is a good match between them and the Engineers Australia membership base. In contrast, the Labour Force Survey looks at individuals in the civilian labour force aged 15 to 65 years, extended to 75 years since 2009. Both the age and civilian characterisation present issues.

There are, however, disadvantages in using census statistics, some are shared with survey sources because they relate to collection protocols, and others relate to the frequency of census years and the availability of census statistics.

A limitation common to all ABS statistics is that information on educational attainment relates to the field of an individual's highest qualification. In most cases this is not an issue. But it is relatively common for engineers to complement their engineering qualifications with a postgraduate course in a business discipline, for example, a masters degree in business administration. This is where the problem arises because the individual in this example would be allocated to the business field, irrespective of whether their main occupation was in business or engineering. Hypothetically, one could correct for this defect but there are no consistent and reliable statistics to do this. As a result, the ABS statistics, whether census or survey sample based, underestimate the number of degree qualified engineers.

The ABS conducts the population census every five years and although it yields a wealth of information, accessing it has been difficult in the past. The statistics required to analyse the engineering team must comply with the educational qualifications necessary. This restriction has not been part of the format used by the ABS to publish census statistics, even in electronic form. The required statistics could be obtained from the ABS through its consultancy services on a fee-for-service basis. This entailed a priori research to design the required cross tabulations, a difficult and awkward process in the absence of actual data and was the norm until recently, including the initial releases of 2006 statistics.

In 2010, the ABS made available its TableBuilder facility. This facility enabled users to directly access census data bases to design and compile tables to their own requirements and was made available on licence. Experience with TableBuilder has shown that the facility has exceeded expectations, enabling previously impractical work to be undertaken relatively quickly. This is the facility used to compile the statistics reported in this chapter.

Unfortunately, TableBuilder is not available for earlier census years but the ABS has announced that an improved version will be available for the 2011 census data. When this data is released, Engineers Australia will examine how the structure and characteristics of the engineering team have changed between 2006 and 2011. In the meantime, statistics from the 2006 census provide structural insights that are unattainable from other statistical sources.

2.2 The Engineering Labour Force

The engineering population is that part of the Australian population with educational qualifications in engineering consistent with the engineering team. Individuals in the engineering population are divided according to whether they are in the engineering labour force or not in the labour force. Individuals who are employed or unemployed but actively looking for work are in the engineering labour force. Individuals not in the labour force may include older individuals who have retired from the labour market, full time students who choose to devote all their energy to studies, women who have left the labour market as a result of family responsibilities and other individual who are not active in the labour market through choice or circumstance.

Table 2.1: The Engineering Labour Market in 2006

Labour force status	Doctoral degree	Masters degree	Other postgraduate	Bachelor degree	Associate degree & Advanced dip	Engineering team	Other diplomas	Extended engineering team
MEN								
Employed FT	4974	15296	3307	92583	31806	147966	38246	186212
Employed PT	598	2057	370	10473	5407	18905	4405	23310
Employed away	173	618	163	4272	2394	7620	2113	9733
TOTAL EMPLOYED	5745	17971	3840	107328	39607	174491	44764	219255
Unemployed (FT)	132	455	66	2164	913	3730	858	4588
Unemployed (PT)	21	120	16	765	305	1227	288	1515
TOTAL UNEMPLOYED	153	575	82	2929	1218	4957	1146	6103
LABOUR FORCE	5898	18546	3922	110257	40825	179448	45910	225358
Not in labour force	946	2854	735	18280	15077	37892	9867	47759
ENGINEERING POPULATION	6844	21400	4657	128537	55902	217340	55777	273117
Participation Rate (%)	86.2	86.7	84.2	85.8	73.0	82.6	82.3	82.5
Unemployment Rate (%)	2.6	3.1	2.1	2.7	3.0	2.8	2.5	2.7
Employed in Engineering	4422	12820	2615	73996	18433	112286	19850	132136
% in Engineering	75.0	69.1	66.7	67.1	45.2	62.6	43.2	58.6
WOMEN								
Employed FT	540	1728	248	9856	1787	14159	1847	16006
Employed PT	111	492	87	3067	1027	4784	1055	5839
Employed away	31	134	28	767	176	1136	185	1321
TOTAL EMPLOYED	682	2354	363	13690	2990	20079	3087	23166
Unemployed (FT)	19	88	11	410	79	607	88	695
Unemployed (PT)	9	51	8	314	99	481	87	568
TOTAL UNEMPLOYED	28	139	19	724	178	1088	175	1263
LABOUR FORCE	710	2493	382	14414	3168	21167	3262	24429
Not in labour force	83	593	83	3954	2411	7124	1261	8385
ENGINEERING POPULATION	793	3086	465	18368	5579	28291	4523	32814
Participation Rate (%)	89.5	80.8	82.2	78.5	56.8	74.8	72.1	74.4
Unemployment Rate (%)	3.9	5.6	5.0	5.0	5.6	5.1	5.4	5.2
Employed in Engineering	457	1399	198	7325	593	9972	714	10686
% in Engineering	64.4	56.1	51.8	50.8	18.7	47.1	21.9	43.7
TOTAL								
Employed FT	5514	17024	3555	102439	33593	162125	40093	202218
Employed PT	709	2549	457	13540	6434	23689	5460	29149
Employed away	204	752	191	5039	2570	8756	2298	11054
TOTAL EMPLOYED	6427	20325	4203	121018	42597	194570	47851	242421
Unemployed (FT)	151	543	77	2574	992	4337	946	5283
Unemployed (PT)	30	171	24	1079	404	1708	375	2083
TOTAL UNEMPLOYED	181	714	101	3653	1396	6045	1321	7366
LABOUR FORCE	6608	21039	4304	124671	43993	200615	49172	249787
Not in labour force	1029	3447	818	22234	17488	45016	11128	56144
ENGINEERING POPULATION	7637	24486	5122	146905	61481	245631	60300	305931
Participation Rate (%)	86.5	85.9	84.0	84.9	71.6	81.7	81.5	81.6
Unemployment Rate (%)	2.7	3.4	2.3	2.9	3.2	3.0	2.7	2.9
Employed in Engineering	4879	14219	2813	81321	19026	118258	20564	142822
% in Engineering	73.8	67.6	65.4	65.2	43.2	58.9	41.8	57.2

Source: Compiled using the ABS 2006 Population Census TableBuilder

Table 2.1 shows the engineering population in Australia in 2006 by the qualifications they held and by labour force status. Table 2.1 develops the statistics in the corresponding Table in the Eighth Edition by focusing more sharply on qualifications. The Table divides postgraduate qualifications into doctoral degrees, masters degrees and other postgraduate qualifications. The Table also distinguishes between associate degrees and advanced diplomas and other diplomas in engineering. The educational requirement for associate engineers is either an associate degree or an advanced diploma in engineering. In previous editions this distinction was not possible. But some residual problems remain. Besides associate degrees and advanced diplomas and diplomas in engineering, the statistics include a category “advanced diplomas and diplomas not further defined” with 910 individuals and a decision was needed on where to count this group. It was decided to take the conservative approach of only counting clear-cut associate degrees and advanced diplomas in the engineering team. The cost of this choice is to under-estimate this group to the extent of the inclusion of advanced diplomas in the “not further defined” group. The worst outcome is an under-estimate of 1.48% in the event that the entire group comprised advanced diplomas.

To distinguish between these improved estimates and earlier ones the term “engineering team” is used to describe the more recent and more accurate measure and the term “extended engineering team” is used to describe the inclusion of other diplomas in engineering. This distinction is also needed to compare census statistics with time series

statistics reported in a later chapter. In the case of these data, diploma qualifications in engineering could not be separated out as is done here.

In 2006, the engineering population comprised 245,631 individuals (217,340 men and 28,291 women) compared to 305,931 (273,117 men and 32,814 women) in the extended engineering population. These statistics show that 55,777 men (20.4% of the male engineering population) and 4,523 women (13.8% of the female engineering population) held diploma qualifications in engineering that do not qualify for inclusion in the engineering team.

There were 200,615 individuals in the engineering team labour force, significantly lower than the 249,787 in the extended engineering labour force, but this difference was not reflected in the participation rates and unemployment rates for the two groups. Engineering labour force participation was generally high with 81.7% of the engineering population active in the labour market. With the exception of women with doctoral degrees, the labour force participation of women was lower than for men but comparatively high at 75.0%.

It was a different story for unemployment. Although the overall unemployment rates for the engineering labour force and the extended engineering labour force were both low and consistent with frictional levels[2] of unemployment, the unemployment rates for women were generally significantly higher for women than men irrespective of qualifications. While the absolute numbers of women involved was small, this is still a surprising result at a time of acute engineering shortage.

About 3.3% of the engineering team labour force held doctoral degrees in engineering with little gender difference. About 10.5% held masters degrees in engineering, with proportionally more women (11.8%) than men (10.3%). About 62.1% held bachelors degrees in engineering with proportionally more women (68.1%) than men (61.4%). Finally, about 21.9% held associate degrees or advanced diplomas in engineering with a skew in favour of men (22.8% compared to 15.0% for women).

Women were 11.5% of the engineering team population and 10.6% of the engineering team labour force. A later chapter will show that these shares are lower than the women shares of completions of engineering entry level courses suggesting an increasing trend. Although the number of men working part time outnumbered women by four to one, the proportion of women working part time was over twice that for men (25.3% compared to 11.3%)[3]. This reflects family responsibilities and is also evident in the lower participation rate for women.

2.3 Employment in Engineering

There is a widespread presumption that there is a close relationship between education and training as an engineer and subsequent employment in engineering. Research[4] reported elsewhere shows that this is not necessarily the case and that large numbers of individual who have engineering qualifications choose to work in occupations that have low or negligible engineering content. This research applied several criteria (formal qualifications, level of work undertaken and a scale of attachment to engineering) to show that 51 of 358 4-digit ANZSCO occupations can be identified as engineering occupations. Although several other occupations had some connections to engineering, these were insufficient to require recruitment exclusively from among engineers.

[2] Economists regard frictional unemployment as the short periods of unemployment that occurs when individuals transition between jobs.
[3] This assumes that employed persons away from work have the same proportions of part time and full time employment.
[4] Engineers Australia, The Engineering Profession in Australia; A Profile from the 2006 Population Census, 2010, pp27-31, www.engineersaustralia.org.au

Table 2.1 shows summary statistics from this research and shows that 118,258 individuals in the engineering team labour force were employed in the 51 engineering occupations identified and the remaining 76,312 were employed in non-engineering occupations and 6,045 were unemployed. In other words, 58.9% of the engineering team labour force was actually employed in engineering. Later in this chapter it will be seen that this proportion varies considerably with qualifications held, gender and industry of employment.

2.4 The Influence of Immigration

Skilled migration has been the Federal Government's first line response to persistent skill shortages. Although skilled migration has been prominent in recent years, Australia's reliance on this source of supply of engineers is decades old. Census statistics cannot directly measure the scale of cumulative migration but provides a surrogate measure, the relative size of the engineering population born in Australia and born overseas. Further detail can be added by examining the circumstances of overseas born individuals by time of arrival in Australia. This is important because "born overseas" and skilled migrants are not synonymous; born overseas includes the children of earlier generations of migrants who grew to adulthood and were educated in Australia, as well as recently arrived adults who were educated and may have acquired work experience overseas.

Table 2.2 divides the statistics in Table 2.1 into Australian and overseas born components. Tables 2.3 and 2.4 give additional detail by the level of qualifications; including "other diplomas" in engineering that distinguish the engineering team and the extended engineering team.

Australian born individuals were 50.6% of the engineering population and 51.6% of the engineering labour force in 2006. The women's shares of these groups were lower than aggregate figures at 8.5% and 8.2%, respectively. Individuals born overseas were 49.4% of the engineering population and 48.4% of the engineering labour force. The women's shares of these groups were much higher than for individuals born in Australian at 14.6% and 13.0%, respectively.

Labour force participation rates were generally high but were lower for the overseas born group. Overseas born unemployment rates were over twice as high as the Australian born rates and in both cases were higher for women than men, making the rates for overseas born women particularly high for a time of skill shortage.

Table 2.2: The Engineering Labour Market in 2006, by Country of Origin

Labour force status	Australian Born			Overseas Born			Engineering Team		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Employed FT	79915	5794	85709	68051	8365	76416	147966	14159	162125
Employed PT	9041	1954	10995	9864	2830	12694	18905	4784	23689
Employed away	4323	558	4881	3297	578	3875	7620	1136	8756
TOTAL EMPLOYED	93279	8306	101585	81212	11773	92985	174491	20079	194570
Unemployed (FT)	1309	108	1417	2421	499	2920	3730	607	4337
Unemployed (PT)	330	87	417	897	394	1291	1227	481	1708
TOTAL UNEMPLOYED	1639	195	1834	3318	893	4211	4957	1088	6045
LABOUR FORCE	94918	8501	103419	84530	12666	97196	179448	21167	200615
Not in labour force	18871	2107	20978	19021	5017	24038	37892	7124	45016
ENGINEERING POPULATION	113789	10608	124397	103551	17683	121234	217340	28291	245631
Participation Rate (%)	83.4	80.1	83.1	81.6	71.6	80.2	82.6	74.8	81.7
Unemployment Rate (%)	1.7	2.3	1.8	3.9	7.1	4.3	2.8	5.1	3.0
Employed in Engineering	65973	4970	70943	46313	5002	51315	112286	9972	118258
% in Engineering	69.5	58.5	68.6	54.8	39.5	52.8	62.6	47.1	58.9

Source: Compiled using the ABS 2006 Population Census TableBuilder

Table 2.3: The Australian Born Component of the Engineering Labour Market in 2006

Labour force status	Doctoral degree	Masters degree	Other postgraduate	Bachelor degree	Associate degree & Advanced dip	Engineering team	Other diplomas	Extended engineering team
MEN								
Employed FT	1925	5319	2099	52454	18118	79915	27324	107239
Employed PT	269	603	207	4892	3070	9041	2847	11888
Employed away	82	238	106	2379	1518	4323	1496	5819
TOTAL EMPLOYED	2276	6160	2412	59725	22706	93279	31667	124946
Unemployed (FT)	25	80	24	761	419	1309	461	1770
Unemployed (PT)	9	17	0	170	134	330	130	460
TOTAL UNEMPLOYED	34	97	24	931	553	1639	591	2230
LABOUR FORCE	2310	6257	2436	60656	23259	94918	32258	127176
Not in labour force	453	994	452	8618	8354	18871	6366	25237
ENGINEERING POPULATION	2763	7251	2888	69274	31613	113789	38624	152413
Participation Rate (%)	83.6	86.3	84.3	87.6	73.6	83.4	83.5	83.4
Unemployment Rate (%)	1.5	1.6	1.0	1.5	2.4	1.7	1.8	1.8
Employed in Engineering	1823	4924	1726	45756	11744	65973	14859	80832
% in Engineering	78.9	78.7	70.9	75.4	50.5	69.5	46.1	63.6
WOMEN								
Employed FT	157	374	123	4344	796	5794	1156	6950
Employed PT	46	125	49	1237	497	1954	676	2630
Employed away	12	37	17	411	81	558	122	680
TOTAL EMPLOYED	215	536	189	5992	1374	8306	1954	10260
Unemployed (FT)	4	5	2	75	22	108	42	150
Unemployed (PT)	3	3	3	55	23	87	30	117
TOTAL UNEMPLOYED	7	8	5	130	45	195	72	267
LABOUR FORCE	222	544	194	6122	1419	8501	2026	10527
Not in labour force	22	86	21	1001	977	2107	572	2679
ENGINEERING POPULATION	244	630	215	7123	2396	10608	2598	13206
Participation Rate (%)	91.0	86.3	90.2	85.9	59.2	80.1	78.0	79.7
Unemployment Rate (%)	3.2	1.5	2.6	2.1	3.2	2.3	3.6	2.5
Employed in Engineering	148	372	113	4012	325	4970	505	5475
% in Engineering	66.7	68.4	58.2	65.5	22.9	58.5	24.9	52.0
TOTAL								
Employed FT	2082	5693	2222	56798	18914	85709	28480	114189
Employed PT	315	728	256	6129	3567	10995	3523	14518
Employed away	94	275	123	2790	1599	4881	1618	6499
TOTAL EMPLOYED	2491	6696	2601	65717	24080	101585	33621	135206
Unemployed (FT)	29	85	26	836	441	1417	503	1920
Unemployed (PT)	12	20	3	225	157	417	160	577
TOTAL UNEMPLOYED	41	105	29	1061	598	1834	663	2497
LABOUR FORCE	2532	6801	2630	66778	24678	103419	34284	137703
Not in labour force	475	1080	473	9619	9331	20978	6938	27916
ENGINEERING POPULATION	3007	7881	3103	76397	34009	124397	41222	165619
Participation Rate (%)	84.2	86.3	84.8	87.4	72.6	83.1	83.2	83.1
Unemployment Rate (%)	1.6	1.5	1.1	1.6	2.4	1.8	1.9	1.8
Employed in Engineering	1971	5296	1839	49768	12069	70943	15364	86307
% in Engineering	77.8	77.9	69.9	74.5	48.9	68.6	44.8	62.7

Source: Compiled using the ABS 2006 Population Census TableBuilder

The proportion of the engineering team labour force employed in engineering work was much higher for Australian born individuals than overseas born and was higher for men than women. About 69.5% of Australian born men were employed in engineering work compared to 58.5% of women. Overseas born men had a comparable figure (54.8%) but just 39.5% of overseas born women were employed in engineering.

Table 2.3 shows that Australian born unemployment rates were not greatly affected by the level of qualifications held. For men, unemployment was particularly low reflecting the skills shortages of the time. Unemployment rates were higher for women, but again level of qualification was not a differentiating factor. Labour force participation rates were generally high, particularly for degree qualified engineers.

An important result is the high proportions of Australian born engineers working in engineering occupations. For degree qualified men, the proportion was over 75% and over 78% for men with doctoral or masters degrees. In contrast, only 50.5% of Australian born men with associate degrees or advanced diplomas in engineering worked in engineering. The proportion was even lower (46.1%) for Australian born men with other diplomas in engineering. There was a similar pattern for Australian born women but with lower shares

employed in engineering. For degree qualified women about two-thirds were employed in engineering. In contrast only one-quarter of diploma qualified women worked in engineering.

Table 2.4: The Overseas Born Component of the Engineering Labour Market in 2006

Labour force status	Doctoral degree	Masters degree	Other postgraduate	Bachelor degree	Associate degree & Advanced dip	Engineering team	Other diplomas	Extended engineering team
MEN								
Employed FT	3049	9977	1208	40129	13688	68051	10922	78973
Employed PT	329	1454	163	5581	2337	9864	1558	11422
Employed away	91	380	57	1893	876	3297	617	3914
TOTAL EMPLOYED	3469	11811	1428	47603	16901	81212	13097	94309
Unemployed (FT)	107	375	42	1403	494	2421	397	2818
Unemployed (PT)	12	103	16	595	171	897	158	1055
TOTAL UNEMPLOYED	119	478	58	1998	665	3318	555	3873
LABOUR FORCE	3588	12289	1486	49601	17566	84530	13652	98182
Not in labour force	493	1860	283	9662	6723	19021	3501	22522
ENGINEERING POPULATION	4081	14149	1769	59263	24289	103551	17153	120704
Participation Rate (%)	87.9	86.9	84.0	83.7	72.3	81.6	79.6	81.3
Unemployment Rate (%)	3.3	3.9	3.9	4.0	3.8	3.9	4.1	3.9
Employed in Engineering	2599	7896	889	28240	6689	46313	4991	51304
% in Engineering	72.4	64.3	59.8	56.9	38.1	54.8	36.6	52.3
WOMEN								
Employed FT	383	1354	125	5512	991	8365	691	9056
Employed PT	65	367	38	1830	530	2830	379	3209
Employed away	19	97	11	356	95	578	63	641
TOTAL EMPLOYED	467	1818	174	7698	1616	11773	1133	12906
Unemployed (FT)	15	83	9	335	57	499	46	545
Unemployed (PT)	6	48	5	259	76	394	57	451
TOTAL UNEMPLOYED	21	131	14	594	133	893	103	996
LABOUR FORCE	488	1949	188	8292	1749	12666	1236	13902
Not in labour force	61	507	62	2953	1434	5017	689	5706
ENGINEERING POPULATION	549	2456	250	11245	3183	17683	1925	19608
Participation Rate (%)	88.9	79.4	75.2	73.7	54.9	71.6	64.2	70.9
Unemployment Rate (%)	4.3	6.7	7.4	7.2	7.6	7.1	8.3	7.2
Employed in Engineering	309	1027	85	3313	268	5002	209	5211
% in Engineering	63.3	52.7	45.2	40.0	15.3	39.5	16.9	37.5
TOTAL								
Employed FT	3432	11331	1333	45641	14679	76416	11613	88029
Employed PT	394	1821	201	7411	2867	12694	1937	14631
Employed away	110	477	68	2249	971	3875	680	4555
TOTAL EMPLOYED	3936	13629	1602	55301	18517	92985	14230	107215
Unemployed (FT)	122	458	51	1738	551	2920	443	3363
Unemployed (PT)	18	151	21	854	247	1291	215	1506
TOTAL UNEMPLOYED	140	609	72	2592	798	4211	658	4869
LABOUR FORCE	4076	14238	1674	57893	19315	97196	14888	112084
Not in labour force	554	2367	345	12615	8157	24038	4190	28228
ENGINEERING POPULATION	4630	16605	2019	70508	27472	121234	19078	140312
Participation Rate (%)	88.0	85.7	82.9	82.1	70.3	80.2	78.0	79.9
Unemployment Rate (%)	3.4	4.3	4.3	4.5	4.1	4.3	4.4	4.3
Employed in Engineering	2908	8923	974	31553	6957	51315	5200	56515
% in Engineering	71.3	62.7	58.2	54.5	36.0	52.8	34.9	50.4

Source: Compiled using the ABS 2006 Population Census TableBuilder

Table 2.4 shows that labour force participation rates for overseas men were comparable to Australian born men but that participation rates for Australian born women were slightly higher than for overseas born women. As was the case for Australian born engineers, overseas born engineers with diploma qualifications had lower participation rates.

Unemployment rates for overseas born men were higher than for Australian born women and the rates for overseas born women were higher still. For this group there was a clear relationship between qualification and unemployment; the higher the qualification the lower the unemployment rate. Overseas born women with bachelors degrees had an unemployment rate of 7.2% and those with associate degrees and diplomas 7.6% at a time of supposed skill shortage.

For both overseas born men and women, the proportion of the engineering team employed in engineering fell with the qualification level held. About 72.4% of overseas men with doctoral degrees were employed in engineering, falling to 64.3% for masters degrees and 56.9% for

bachelors degrees. Only 38.1% of overseas born men with associate degrees or advanced diplomas were employed in engineering. For overseas women, 63.3% with doctoral degrees were employed in engineering, 52.7% for masters degrees, 40.0% for bachelors degrees and just 15.3% for associate degrees and advanced diplomas.

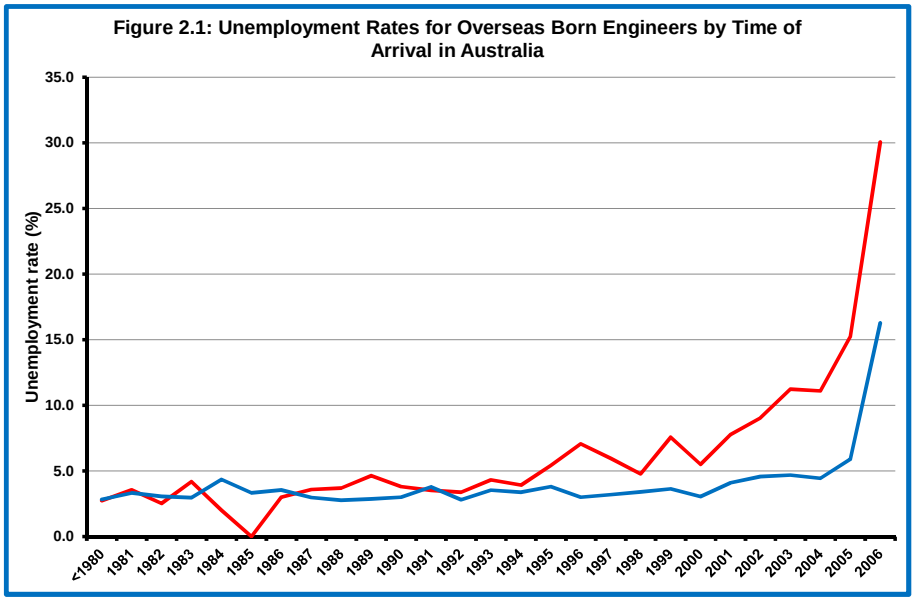


Figure 2.1 shows the unemployment rates for overseas born men and women in the engineering team labour force by time of arrival in Australia. Overseas born men who arrived in Australia since about 2002 had unemployment rates higher than earlier arrivals with the rates escalating for near term arrivals. In the case of overseas women this phenomenon extends even longer with women who arrived as far back as 1995 having unemployment rates over 5% and the near term arrivals experiencing rates that are regarded as unacceptable in Australia.

Since the 2006 census, significant changes have been made to skilled migration policies. The general intent of the changes is to strengthen the links between employers and newly arrived migrants. It remains to be seen how these changes impact the low utilisation of overseas born engineering skills.

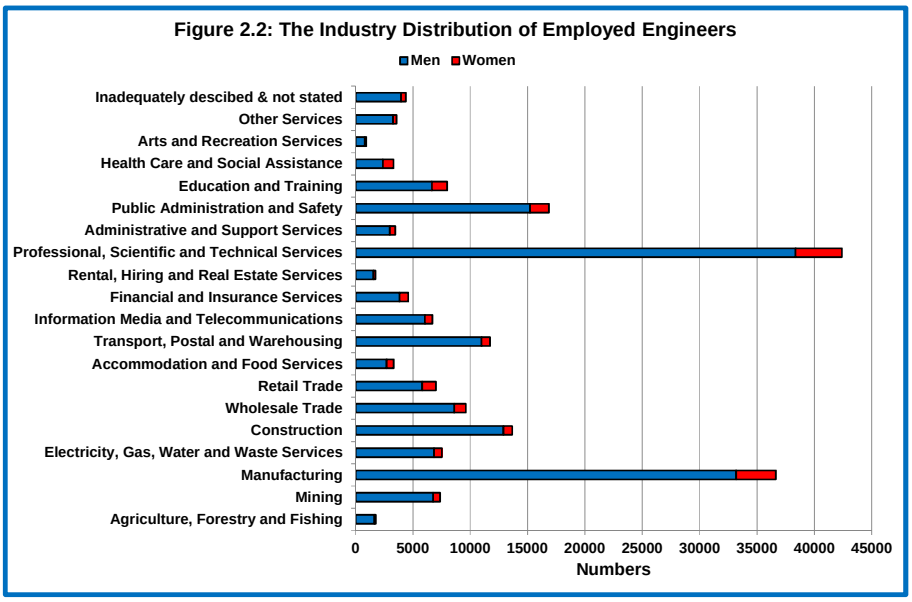
Industry Distribution

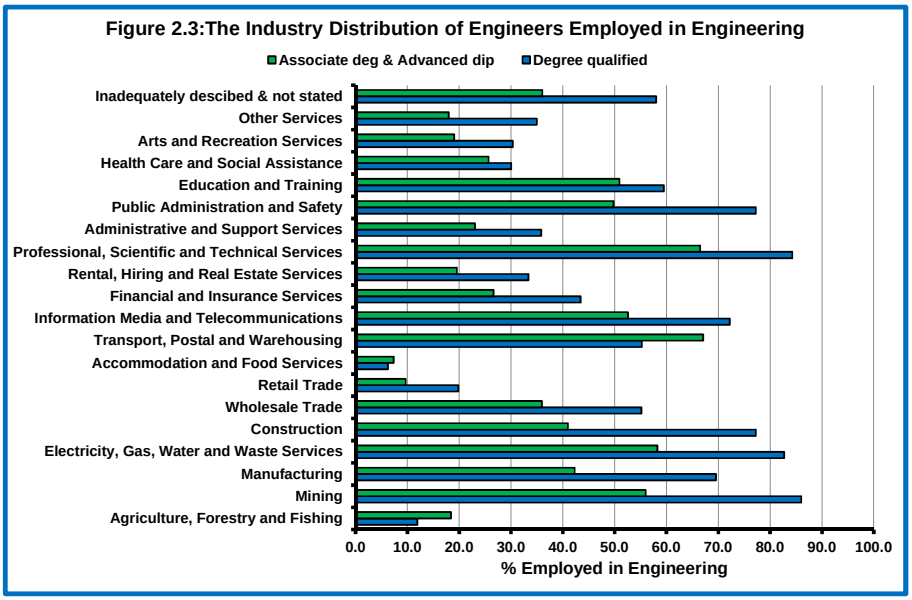
Engineers are employed in most industries but there are strong concentrations in some industries. This is shown in Tables 2.5 to 2.7 which contain statistics on the industry distribution for the employment statistics shown in Table 2.1. Figure 2.2 illustrates this distribution.

The industry employing the largest number of engineers is “Professional, Scientific and Technical Services” which employed 42,402 members of the engineering team. This industry employed 1,967 engineers with doctoral degrees, 6,543 engineers with masters degrees and other postgraduate qualifications, 29,050 engineers with bachelors degrees and 4,842 engineers with associate degrees or advanced diplomas. This industry also employed 6,051 individuals with other diploma level qualifications in engineering so that the extended engineering team employed was 48,453.

Employment in engineering work in the Professional, Scientific and Technical Services industry was particularly high. For degree qualified individuals between 82 and 84% were employed in engineering work. However, only 66.5% of individuals with associate degrees or

advanced diplomas were so employed, falling to 65.3% for individuals with other diploma qualifications. How these results compare to other industries is shown in Figure 2.3.





The second largest employer of engineers is manufacturing industry with 36,636 members of the engineering team. This includes 677 individuals with doctoral degrees, 3,869 with masters degrees or other postgraduate qualifications, 23,772 with bachelors degrees and 8,318 with associate degrees or advanced diplomas. Manufacturing had the largest concentration of individuals with associate degrees or advanced diplomas accounting for 19.5% of these qualifications. In addition 10,491 individuals with other diploma qualifications in engineering were employed in Manufacturing so that the extended engineering team employed at 47,127 was just 1,326 less than Professional etc. Services.

The proportion of engineer's employment in engineering work in manufacturing was higher the higher the qualification held by individuals. For those with doctoral degrees 80.8% were employed in engineering work, falling to 73.9% for masters degrees, 68.8% for bachelors degrees, 42.3% for associate degrees and advanced diplomas and 42.2% for other diploma qualifications.

The third largest employer of engineers is the Public Administration and Safety industry which includes the agencies of the Commonwealth, States and Territories and Local Governments and the defence forces and agencies. This industry employs 431 engineers with doctoral degrees, 2,972 with masters degrees or other postgraduate qualifications, 9,428 with bachelors degrees and 4,025 with associate degrees or advanced diplomas. In addition the industry employs 5,840 individuals with other diploma qualifications in engineering to bring the extended engineering team to 22,696.

The proportion of engineers employed in engineering work in Public Administration and Safety is high for degree qualified individuals, ranging from 79.8% for doctoral degrees to 77.3% for bachelors degrees. But there is a large drop in the proportion to 49.8% for individuals with associate degrees or advanced diplomas and 45.2% for other diploma qualifications.

The fourth largest employer of engineers is the Construction industry with 13,662 engineers; 108 with doctoral degrees, 1,187 with masters degrees or other postgraduate qualifications, 9,268 with bachelors degrees and 3,099 with associate degrees or advanced diplomas. A further 3,752 individuals have other diploma qualifications in engineering to bring employment of the extended engineering team to 17,414.

The pattern of employment in engineering work in the Construction industry is similar in pattern and scale to that in Public Administration and Safety. The proportion of degree qualified individuals ranges from 74 to 77% with a large drop to 41%b for associate degrees or advanced diplomas and 43% for other diplomas.

The fifth largest employer of engineers was the Transport, Postal and Warehousing industry with 11,714; 63 with doctoral degrees, 929 with masters degrees or other postgraduate qualifications, 5,284 with bachelors degrees and 5,438 with associate degrees or advanced diplomas. A further 3,036 individuals hold other diploma qualifications in engineering bringing the extended engineering team to 14,750.

Employment in engineering work is much lower in this industry than in the four highest ranked and ranges from 55 to 61% for degree qualified individuals. In this industry the proportion of individuals employed in engineering work with an associate degree or an advanced diploma was amongst the highest at 67.1%.

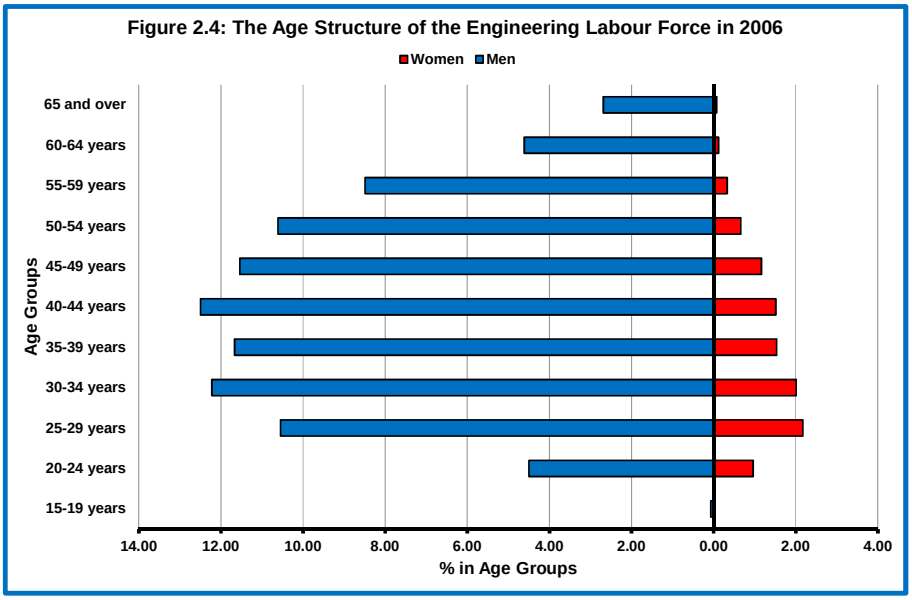
Some familiar and some unfamiliar industries complete the top ten industry employers of engineers. Ranked sixth was Wholesale Trade with 9,608 employed in the engineering team and 11,998 in the extended engineering team. Ranked seventh was Education and Training with 7,980 employed in the engineering team and 9,033 in the extended engineering team. Ranked eighth was the Mining industry with 7,366 employed in the engineering team and 8,726 in the extended engineering team. Ranked ninth was the Electricity, Gas, Water and Waste Services industry with 7,528 employed in the engineering team and 9,948 in the extended engineering team. The tenth industry was Retail Trade with 7,013 employed in the engineering team and 9,019 in the extended engineering team.

2.5 Age and Age Distribution

The age distribution for the engineering team is shown in Figure 2.4. This diagram illustrates the gender skew that exists and the comparative youth of women engineers. Using single year ages, average ages were estimated for men, women and total engineering labour forces[5]. The average age for men was 42.3 years and coincides with the most populous cohort, the 40 to 44 years age group containing 25,079 men. The average age for women

[5] The ABS census data base includes single year statistics for ages 15 to 115 years. Average ages were estimated by weighting each age year by the proportion of the engineering labour force it contains.

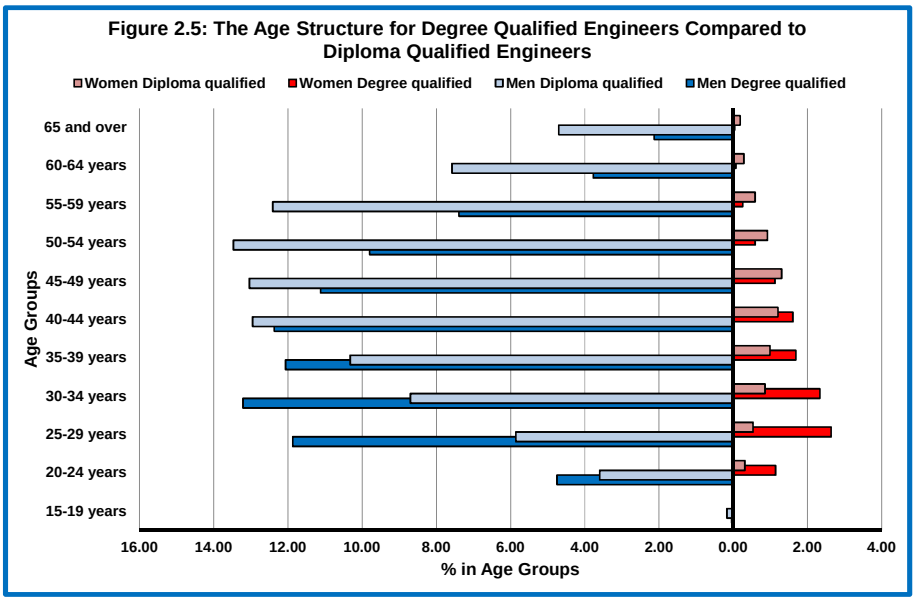
was almost six years younger at 36.5 years. For women the most populous cohort, the 25 to 29 years age group, was below the average age. For the engineering team overall, the average age was 41.7 years, only slightly less than the average age for men, reflecting the low proportion of women in the labour force.

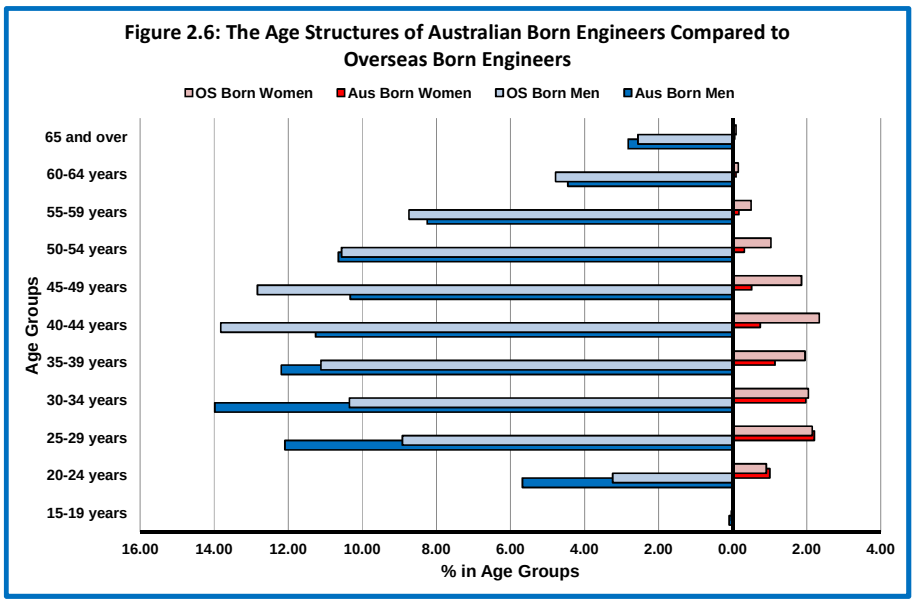


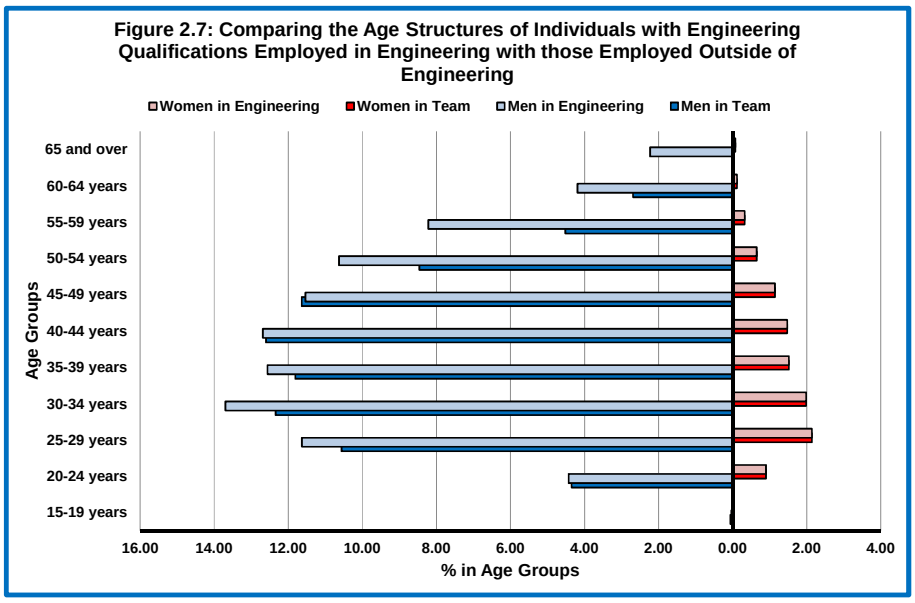
Estimates of the average ages for the employed and unemployed components of the labour force were prepared. For the employed group, average ages were almost identical to the labour force. For the unemployed group, the average age for men was slightly higher at 42.5 years and the average age of women slightly younger at 35.7 years. The latter was sufficient to lower the average age for the unemployed overall to 41.3 years.

Figure 2.5 is a variant of Figure 2.4 that compares the age structures of degree qualified engineers to diploma qualified engineers. This illustration clearly shows that diploma qualified engineers are older than degree qualified engineers. This result holds for both genders.

Figure 2.6 compares the age structures for the engineering team born in Australia and born overseas. The bias in skilled migration policies in favour of younger migrants intuitively suggests that the age structure for overseas born engineers would be younger than for Australian born engineers. But Figure 2.6 shows the opposite result.







There are more Australian born engineers in younger age groups and fewer in older age groups than is the case for overseas born engineers. This result applies to both men and women. The average ages for Australian born men, women and engineering team were 41.5 years, 33.9 years and 40.9 years respectively. The average ages for overseas born engineers in these groups were 43.3 years, 38.3 years and 42.6 years respectively.

The above results show that the impact of migration on average ages generally is temporary because migrant cohorts age as well. Since the 2006 census, skilled migration of engineers has increased well above the intakes in the years leading up to the census while the new supply of engineers who are citizens or permanent residents has been static. There is a distinct possibility that the average ages of migrant engineers will fall in 2011 census statistics.

Section 2.3 showed that 41.1% of the engineering labour force was either unemployed or not employed in an engineering occupation. It is important to understand whether the age structure for this component of the engineering labour force group differs in any way from the age structure for the component that is employed in engineering. Figure 2.7 illustrates this comparison.

The average age of the component of the engineering labour force employed in engineering is younger than the average age of the component employed outside of engineering. For those employed in engineering, the average age of men was 41.7 years, for women 34.0 years and for the component overall 41.1 years. For the component employed outside of engineering, the average age of men was 43.5 years, for women 39.1 years and for the component overall 42.9 years.

These results are reflected in the age structures illustrated in Figure 2.7. The age structure for the component of the engineering labour force employed in engineering has proportionally more individuals in younger age groups and fewer in older age groups. The conversely was true for those employed outside of engineering. This conclusion applies to both genders. It appears to suggest that the move to employment outside of engineering is related to career progression in some way.

3. THE ENGINEERING LABOUR FORCE: TIME SERIES STATISTICS

Key Messages

This Chapter applies statistics from the ABS Survey of Education and Work to compile a time series perspective on the engineering labour market.

Between 2001 and 2010, the engineering labour market has experienced significant growth with the engineering population increasing by 48.7% and the engineering labour force increasing by 51.9%. Over this decade average annual growth in the engineering population was 4.1%, average annual growth in the demand for engineers was 4.4% and average annual growth in the supply of engineers was 4.3%. Other than an increase in the unemployment rate in the aftermath of the GFC, unemployment has been very low.

In 2011, a difference between degree qualified and diploma qualified engineers appeared. Until 2010, growth rates for these components more-or-less moved together, but in 2011 they appeared to move in opposite directions. Supply of degree qualified engineers increased a little above its decade average. In contrast, supply of diploma qualified engineers contracted by a relatively large 10.6%. Demand for degree qualified engineers also grew consistent with its decade average, but the demand for diploma qualified engineers fell by 8.0%. The outcome was an exceptionally low 1.5% unemployment rate for diploma qualified engineers in what seemed to be a contracting market and an increased unemployment rate of 4.0% for degree qualified engineers. The main factor in the latter is that supply moved ahead of demand.

The proportion of engineers employed in engineering work was consistent with estimates using census statistics and varied in a narrow band from a low of 55.6% in 2007 to a high of 60.4% in 2010. In 2011, this proportion was 59.3% and was accompanied by a numerical fall in the number of engineers employed in engineering work.

The growth parameters in engineering are similar to those for other skills (with corresponding qualifications) and quite distinct and much stronger than for the labour market with skills below diploma level or no skills. However, the labour market for other skills was generally stronger than for engineering.

The proportion of degree qualified women engineers has increased unevenly over time but remains very low at 12.7% in 2011. The proportion of diploma qualified women engineers is almost half this level. The experiences of women engineers in the labour market are also characterised by greater variability in demand and supply and by higher unemployment. In 2011, demand for women engineers fell by 4.0% compared to an increase of 0.6% for men and the supply of women engineers fell by 2.0% compared to a small 0.3% increase for men. The 2011 unemployment rate for women was 9.0% and 2.5% for men.

Census statistics showed that overseas born engineers were a high proportion of the engineering labour market. This result is confirmed by time series statistics which also show that this share has increased over time and in 2011 was 51.3%. The proportion of overseas born has also increased for other skills and in the labour market as a whole but the 2011 were lower than in engineering at 32.6% and 24.9% respectively.

A small range of statistics on jurisdictional labour markets confirm popular impressions that average demand growth for engineers has been higher in Queensland and in Western Australia. However, despite losing some share, NSW and Victoria still account for over 60% of the demand for engineers in 2011 while the two resource States mentioned accounted for

29.4%. Demand in the combined total of South Australia, Tasmania and the Territories were on par with Victoria and much slower than the rest of the country. An issue for further investigation is the much greater year on year variability in demand for engineers at jurisdictional level and the role of this variability in the proportion of engineers working in engineering.

3.1. The Statistics Used

This Chapter uses statistics from the ABS Education and Work Survey (EWS) to analyse changes in the engineering labour market over time. Statistics from the ABS Population Census have many advantages including enabling analysis of the engineering labour market in some detail as Chapter 2 demonstrates. However, the Census occurs every five years, and as time passes, statistics lose currency. This is an issue not unique to engineering and the ABS has developed a range of surveys to cover the gap between Census years.

Most Australian labour market policy decisions depend on the ABS monthly Labour Force Survey (LFS). The objective of the LFS is to provide statistics on employment, unemployment, the labour force and the participation rate[6]. In this framework employment measures the demand for labour, the labour force measures the supply of labour, the participation rate measures the availability of labour given the population and the unemployment rate measures the utilisation of available labour. The LFS is now over forty years old and is highly regarded as a source of reliable statistics.

Chapter 1 pointed out that educational qualifications in engineering are essential for inclusion in the engineering team. Unfortunately, the LFS does not include educational attainment in its questionnaire[7]. This means that LFS statistics on engineers need to be compiled on some other basis that is covered by its questionnaire. Often this is occupation, an unsatisfactory approach; self-nomination as an engineer is an inadequate substitute for formal qualification in engineering and because engineers are employed in a more extensive range of occupations than typically selected.

Thus, an alternative source of labour market time series statistics that does take into account educational attainment is required. This is the ABS Education and Work Survey. The EWS is an annual supplement to the LFS, one of a range of supplements designed to augment statistics collected in the LFS. The objective of the EWS is the relationship between education and work, particularly the transition from study to work. The EWS has changed since its inception to reflect the recognition of continuous lifetime learning and this has led to inclusion in it of the connection between educational attainment and labour market status.

The EWS uses the same statistical classification systems as the LFS and as employed in the Census. However, because the EWS and LFS are sample surveys benchmarked by the Census, fully reconciled statistics should not be expected. But the surveys are regarded as reliable indicators of trend changes and this is how they are used in this Chapter.

[6] ABS, Questionnaires Used in the Labour Force Survey, Information Paper, 2004, Cat No 6232.0, www.abs.gov.au

[7] Information collected on the employed includes, full time or part time employment, industry, occupation, hours worked and status in employment; for the unemployed, whether looking for full time or part time work, duration of unemployment and the characteristics of last job; general information collected also includes age, sex, marital status, household relationships, birthplace and year of arrival in Australia and participation in school and tertiary education.

Since the LFS and EWS are different surveys, some differences between the two need to be anticipated as well. Just how different was examined to help understand the statistics. On average over the period examined the EWS under-estimated employment in the LFS by 0.9%, and under-estimated unemployment and labour force in the LFS by 0.5%. Trends were consistent as were all turning points. The largest difference between the two surveys was

Population; the EWS under-estimated LFS population by 2.9%. The consequence was that EWS participation rates are on average about 2% higher than in the LFS. Now that 2011 Census statistics are becoming available and are providing revised benchmarks, EWS statistics may be revised but this is unlikely before 2012 results are made available late this year. In the meantime, comparisons of groups within the EWS are reliable and comparisons and judgments about the EWS and other statistics can be informed by the differences just mentioned.

The amount of detail available from ABS sample surveys is limited due to survey standard errors. The engineering team is just 2.5% of the Australian labour force and this is indicative of the degree to which engineering is represented in ABS samples. The consequence is that several broad indicators of trends in engineering are available, but the level of detail of the Census cannot be replicated. This limitation applies in various forms; statistics can be obtained for larger but not smaller jurisdictions; some statistics on gender are possible but even at national level some gender variables are not available.

There are other limitations as well, including how the ABS compiles the survey data. Associate engineers require an advanced diploma or an associate degree in engineering, but in the EWS, the ABS groups together advanced and other diplomas and separation of these statistics is not feasible. This means that the statistics in this Chapter refer to the “extended engineering team”, through the inclusion of other diplomas in engineering. In part the implications of this issue are examined by drawing a distinction between degree and diploma qualified engineers.

3.2. The Engineering Labour Market

The engineering labour market from 2001 to 2011 is described in Table 3.1. The Table divides the engineering population into those employed, unemployed, in the labour force and not in the labour force. The engineering population is everyone with at least a diploma in engineering. The labour force is the segment of the population actively engaged with the labour market and is related to the population by the participation rate. An alternative name for the labour force is the supply of engineers. Employment is a measure of the demand for engineers and the unemployment rate, the proportion of the labour force not employed, measures the utilisation of available labour.

Because EWS statistics for advanced diplomas and associate degrees cannot be separated from other diplomas in engineering, Tables 3.2 and 3.3 show the degree qualified engineering labour market and the diploma qualified engineering labour markets respectively. Over 95% of Engineers Australia members are degree qualified.
To facilitate discussion, Table 3.4 shows decade average annual growth rates for employment, labour force and population for the three primary Tables as well as unemployment rates in 2001, 2011 and the lowest unemployment rate.

Population

In 2001, the engineering population was 273,900, 178,000 or 65.0% were degree qualified and 95,000 or 35.0% were diploma qualified. Over the decade to 2011, average annual population growth was 4.1% and by 2011 had increased the population to 407,300. Average annual growth was faster for degree qualified engineers (4.7% pa) than for diploma qualified

engineers (3.6% pa), increasing the proportion of degree qualified engineers to 68.3% and reducing the proportion of diploma qualified engineers to 31.7% by 2011.

Table 3.1: The Engineering Labour Market in Australia

Year	Employed	Unemployed	Labour Force	Not in LF	Population
2001	232,700	9,500	242,200	31,700	273,900
2002	262,600	11,800	274,400	29,100	303,500
2003	273,500	11,800	285,300	29,900	315,200
2004	270,300	9,500	279,800	35,100	314,900
2005	283,300	9,100	292,400	34,100	326,500
2006	293,300	9,300	302,600	29,800	332,400
2007	315,500	8,900	324,400	34,500	358,900
2008	336,800	8,200	345,000	31,900	376,900
2009	341,800	14,700	356,500	34,400	390,900
2010	355,400	13,900	369,300	40,700	410,000
2011	355,900	11,900	367,800	39,500	407,300

Source: ABS, Education and Work, 6227.0

Table 3.2: The Degree Qualified Engineering Labour Market

Year	Employed	Unemployed	Labour Force	Not in LF	Population
2001	154,000	5,700	159,700	18,300	178,000
2002	163,800	6,500	170,300	17,800	188,100
2003	176,600	8,000	184,600	16,500	201,100
2004	172,300	5,700	178,000	20,700	198,700
2005	186,600	5,200	191,800	19,300	211,100
2006	192,800	6,000	198,800	16,800	215,600
2007	199,600	5,200	204,800	22,300	227,100
2008	236,000	4,900	240,900	20,100	261,000
2009	221,700	8,100	229,800	19,400	249,200
2010	229,300	8,200	237,500	23,400	260,900
2011	239,900	10,100	250,000	28,100	278,100

Source: ABS, Education and Work, 6227.0

Table 3.3: The Diploma Qualified Engineering Labour Market

Year	Employed	Unemployed	Labour Force	Not in LF	Population
2001	78,700	3,800	82,500	13,400	95,900
2002	98,800	5,300	104,100	11,300	115,400
2003	96,900	3,800	100,700	13,400	114,100
2004	98,000	3,800	101,800	14,400	116,200
2005	96,700	3,900	100,600	14,800	115,400
2006	100,500	3,300	103,800	13,000	116,800
2007	115,900	3,700	119,600	12,200	131,800
2008	100,800	3,300	104,100	11,800	115,900
2009	120,100	6,600	126,700	15,000	141,700
2010	126,100	5,700	131,800	17,300	149,100
2011	116,000	1,800	117,800	11,400	129,200

Source: ABS, Education and Work, 6227.0

Table 3.4: Changes in the Engineering Labour Market

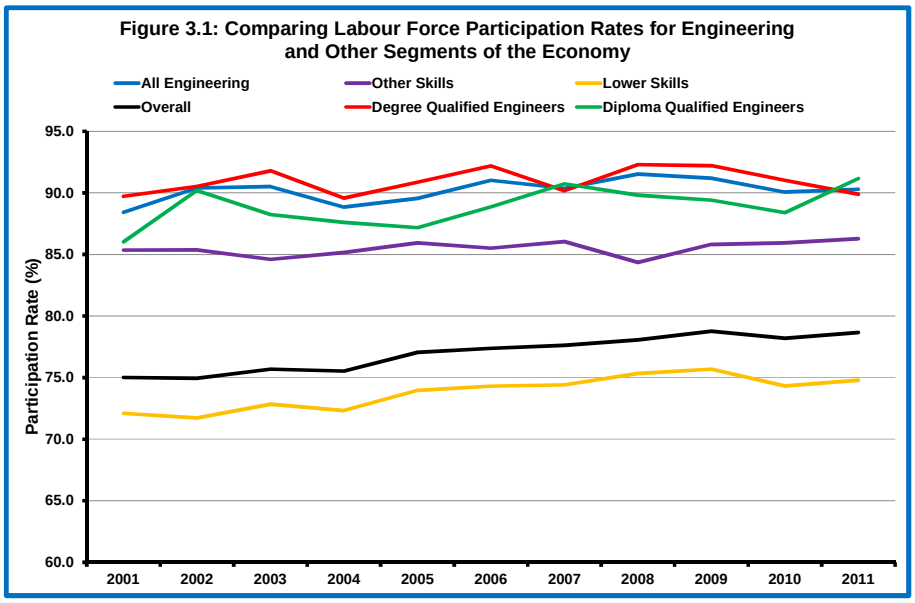
Factor	Degree	Diploma	Overall
Average population growth (% pa)	4.7	3.6	4.1
Population growth 2011 (%)	6.6	-13.3	-0.7
Average supply growth (% pa)	5.3	4.3	4.3
Supply growth 2011 (%)	4.8	-10.6	-0.4
Average demand growth (% pa)	4.7	4.6	4.4
Demand growth 2011 (%)	4.6	-8.0	0.1
Unemployment in 2001 (%)	3.6	4.6	3.9
Unemployment in 2011 (%)	4.0	1.5	3.2
Lowest unemployment (%)	2.0 (2008)	1.5 (2011)	2.4 (2008)

Source: Estimated from ABS, Survey of Education & Work, Cat No 6227.0

In 2011, the most recent year for which statistics were available, the aggregate engineering population contracted from 410,000 in 2010 to 407,300, a fall of 0.7%. This outcome was the product of opposing changes in the degree and diploma qualified markets. The population of degree qualified engineers grew by 6.6%, about 40% faster than the decade average. In contrast, the population of diploma qualified engineers fell by 13.3%.

Supply of Engineers

Engineers have a high propensity to actively engage with the labour market. This is illustrated in Figure 3.1 which compares participation rates for engineers to other groups in the labour market. In this illustration “other skills” refers to people with at least a diploma qualification in a field other than engineering and lower skills refers to all people with qualifications below diploma level or no qualifications. Although there are more fluctuations in the engineering participation rates, they remained high throughout the period covered.



Over the decade, average annual growth in the supply of engineers was 4.3% and was higher for degree qualified engineers (5.3% pa) than diploma qualified engineers (4.3% pa), increasing the former group by 56.5% and the latter group by 42.8%.

The situation in 2011 reflected the changes that occurred in the respective engineering populations. The supply of degree qualified engineers increased by 4.8%, a little below the decade average but comparatively strong growth. However, the supply of diploma qualified

engineers fell by 10.6%. Overall, the supply of engineers fell by about half the fall in the engineering population (-0.4%).

Further research is needed before an explanation for these changes is possible. Two points could be tested; first, Census statistics suggest that the average age of diploma qualified engineers is higher than for degree qualified engineers; second, diploma qualifications are less popular with students now than in the past. Both points suggest the possibility of a structural change in the overall engineering labour market. How this impacts would depend on industry distribution and the prospects for different industries.

Demand for Engineers

Over the decade since 2001, average annual growth in the demand for engineers was 4.4% pa and fairly similar for degree and diploma qualified engineers. In 2011, demand for degree qualified engineers continued to grow consistent with this pattern but the demand for diploma qualified engineers fell by 8.0%. These opposing changes produced an overall situation of virtually no demand growth.

Unemployment

Both degree and diploma qualified unemployment rates fell over the early part of the decade; the degree qualified rate fell to 2.0% in 2008 and the diploma qualified rate fell to 3.2% in the same year. The impact of the GFC was felt in the engineering labour market in 2009 with the overall rate of unemployment rising to 4.1%; 3.5% for degree qualified and 5.2% for diploma qualified engineers.

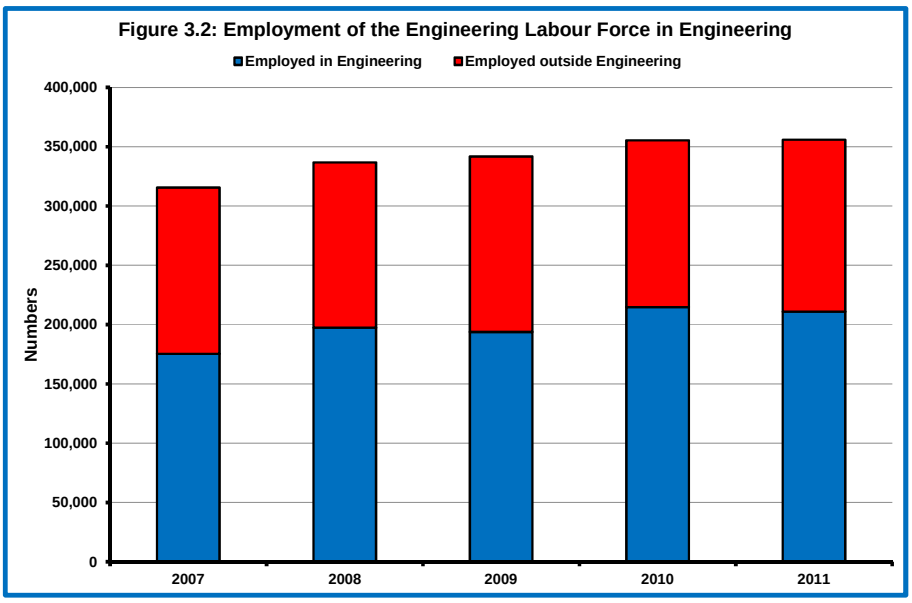
Since then the diploma qualified unemployment rate has fallen sharply to just 1.5% in 2011. However, rather than being a reflection of strong demand for these engineers, this low rate was the outcome of supply falling less than demand in an overall contracting market segment. For degree qualified engineers, in 2011 supply grew a fraction faster (4.8%) than demand (4.6%) and this was reflected in an increase in the unemployment rate for this group. In 2010, the rate had remained unchanged from the previous year at 3.5%, but in 2011, the unemployment rate was 4.0%.

3.3. Employment in Engineering

Section 2.3 noted that 2006 Census statistics show that 57.2% of the engineering labour force was employed in engineering work while the balance were employed in work other than engineering and a small number were unemployed. The ABS has been able to provide a time series perspective on this issue by providing EWS statistics that divide employment in this way. Figure 3.2 illustrates these statistics.

The proportion of the engineering labour force employed in engineering work has varied from a low of 55.6% in 2007 to a high of 60.4% in 2010. In 2011, 59.3% were employed in engineering. Numerically numbers have increased by 22.5% from 175,300 in 2007 to 214,800 in 2010, but in 2011 this fell to 211,000.

Engineering qualifications equip individuals for a wide range of analytical and problem solving work, but rarely is it feasible for individuals from other fields to do engineering work. Some engineers move out of engineering as a result of progression in their careers; either they are promoted into non-engineering jobs or they believe their prospects are improved by shifting into non-engineering career paths. Other engineers react to circumstances; w when faced with a downturn in engineering employment, some engineers move out of engineering in preference to moving to where engineering jobs are located.



3.4. How Does Engineering Compare to Other Sectors?

Figure 3.1 illustrated the difference in participation rates between engineering and other segments of the Australian labour market. Table 3.5 extends this comparison to changes in demand and supply for the "extended" engineering labour force, Table 3.6 compares supply and demand for degree qualified skills and Figure 3.3 compares trends in unemployment rates.

Table 3.5: Comparing Engineering to Other Segments of the Economy

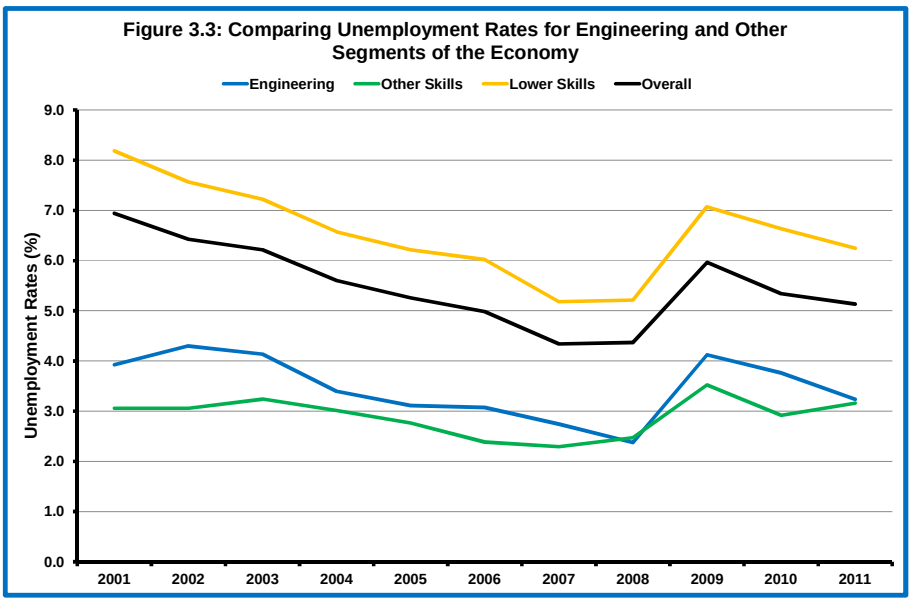
Factor	Engineering	Other Skills	Lower Skills	Overall
Average demand growth (%)	4.4	6.2	0.5	2.2
Demand in 2011	0.1	4.6	2.6	3.2
Average supply growth (%)	4.3	6.2	0.3	2.0
Supply in 2011	-0.4	4.9	2.2	3.0
Unemployment in 2001 (%)	3.9	3.1	8.2	6.9
Unemployment in 2011 (%)	3.2	3.2	6.2	5.1
Lowest unemployment (%)	2.4 (2008)	2.5 (2008)	7.1 (2009)	4.3 (2007)

Source: Estimated from ABS, Survey of Education & Work, Cat No 6227.0

Table 3.6: Comparing Degree Qualified Engineers and Other Skills

Factor	Engineering	Other Skills
Average demand growth (% pa)	4.7	5.0
Demand growth 2011	4.6	6.0
Average supply growth (% pa)	5.3	5.0
Supply growth 2011	4.8	6.0
Unemployment in 2001 (%)	3.6	2.7
Unemployment in 2011 (%)	4.0	2.8
Lowest unemployment (%)	2.0 (2008)	2.1 (2007/08)

Source: Estimated from ABS, Survey of Education & Work, Cat No 6227.0



Several points emerge from these comparisons:

- Average demand growth for the decade since 2001 was highest for “other skills” at 6.2% per annum, substantially higher than for engineering.
- Average demand growth was lowest for the component of the labour market with qualifications below diploma level or no qualifications with just 0.5% per annum.
- Comparing the two degree qualified skilled groups, the difference in average demand growth is reduced substantially, but on average the growth in demand for “other skills” (5.0% per annum) remained higher than for engineers (4.7% per annum).
- The comparison of decade average growth in supply showed similar relationships and average growth rates to those for demand with the highest average growth for “other skills”. However, Table 3.6 shows that average supply growth for degree qualified engineers (5.3% per annum) was slightly higher than average supply growth for degree qualified “other skills” (5.0% per annum).
- The two skilled groups have experienced much lower unemployment than the “lower skills” component of the economy. However, Figure 3.3 shows that the unemployment rate for engineers has been higher than for “other skills” with the exception of 2008 when anecdotal information suggested skill shortage pressures were at their highest.
- In 2011, the overall unemployment rate for the two skilled groups were the same, 3.2%, but for different reasons.
- In engineering, the unemployment rate was the result of combining a very tight but contracting market for diploma qualified engineers with a market for degree qualified engineers that was not as tight. Demand growth for degree qualified engineers was 4.6% in 2011, in line with the decade average, but although supply growth moderated to 4.8% (from its decade average of 5.3%), stronger supply increased the unemployment rate.
- For “other skills” demand and supply in 2011 grew slower than decade averages resulting in a small increase in unemployment to 3.2%. Degree qualified “other skills” experienced an increase in both demand (6.0%) and supply growth (6.0%) above decade averages and much higher than in engineering. The 2011 unemployment rate (2.8%) for degree qualified other skills was well below the rate for degree qualified engineers (4.0%).

This comparison supports the view that skilled labour markets in Australia have been, and remain, tight. Gauged by their unemployment rates the labour market for engineers and "other skills" are both consistent with employers' views that skilled people are hard to find. However, there are substantial differences between the two groups not evident in aggregate statistics. The contraction of the diploma qualified market for engineers has been discussed; there appears not to have been any general contraction in this labour market for "other skills". Similarly, combining the degree and diploma engineering markets disguises the emergence of some supply growth ahead of demand. At 4.0% unemployment, the degree qualified market for engineers is not over-supplied; instead it shows that excess demand is higher for "other skills".

3.5. Gender and Engineers

The proportion of women engineers has been low historically. Progress has been slow and uneven over time as shown in Figure 3.4. In 2011 the proportion of degree qualified women engineers in the labour force was just 12.7%, 7.0% for diploma qualified engineers and 10.9% in the overall engineering labour force.

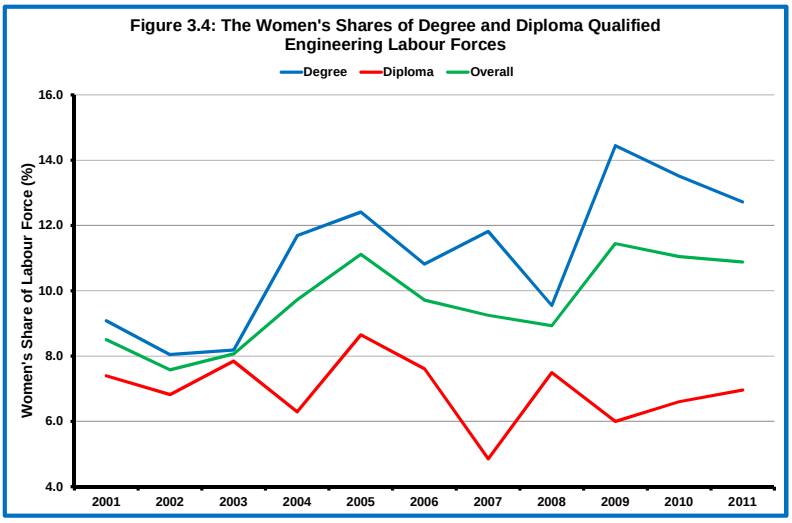


Table 3.7: The Labour Market Experiences of Men and Women Engineers

Factor	Men	Women	Overall
Average demand growth (%)	4.2	5.0	4.4
Demand growth in 2011 (%)	0.6	-4.0	0.1
Average supply growth (%)	4.1	7.5	4.3
Supply growth in 2011 (%)	-0.3	-2.0	-0.4
Unemployment in 2001	3.8	4.9	3.9
Unemployment in 2011	2.5	9.0	3.2

Source: Estimated from ABS, Survey of Education & Work, Cat No 6227.0

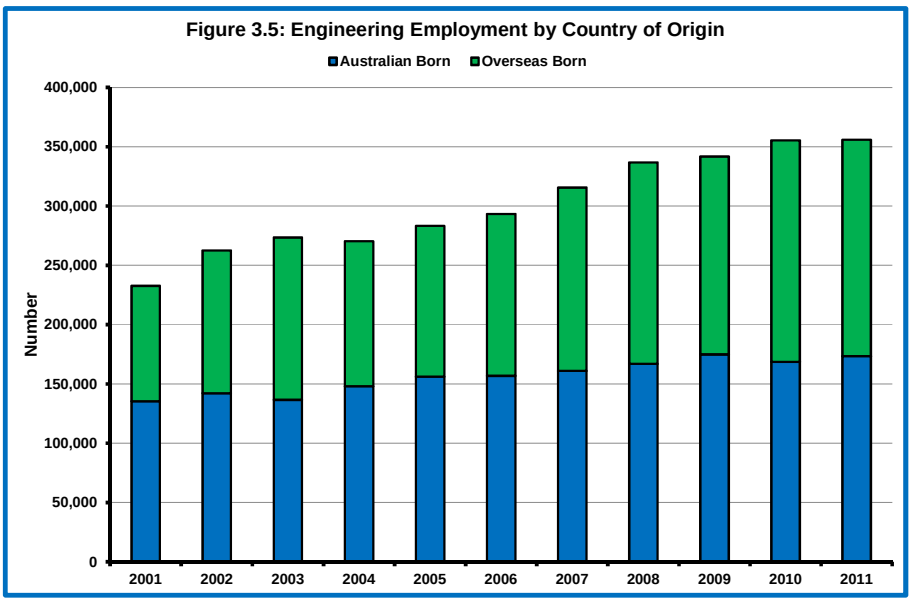
The labour market experiences of women engineers also differs to that of men in other respects. Table 3.7 provides a gender dimension for the growth in demand and supply and for unemployment. The statistics in several years were not available due to standard error issues and the averages in the Table were for available years and may not line up with those in other Tables.

- Average demand growth was higher for women (5.0% per annum) than for men (4.2% per annum) but was much more variable.
- In 2011, demand for men engineers grew by 0.6% but the demand for women engineers fell by 4.0%.
- Average supply growth for women (7.5% per annum) was also higher than for men (4.1% per annum) and also showed greater variability than for men.
- In 2011, the supply of men engineers fell by 0.3%, but the supply of women engineers fell by 2.0%.
- For men, the difference between average annual demand and average annual supply growth (4.2% per annum demand compared to 4.1% per annum supply) suggests falling unemployment. For women, this comparison (5.0% per annum demand compared to 7.5% supply) suggests increasing unemployment.
- In 2011, the unemployment rate for men engineers was 2.5% and for women engineers it was 9.0%.

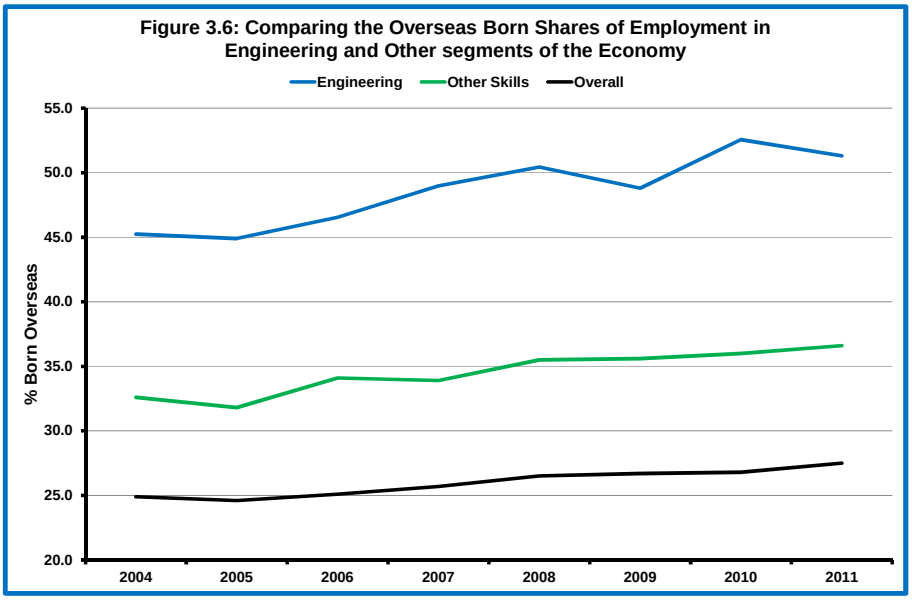
Australia has some extraordinary women engineers but this should not be confused with improvement in the status of women in engineering. Engineering remains male dominated and greater variability in demand and supply growth and current much higher unemployment rate suggest that the labour market experience of women is inferior to that of men engineers.

3.6. The Influence of Immigration

For several years now, the Commonwealth Government's first line response to a shortage of engineers has been skilled migration. Policies to improve the output of engineering education have also been implemented and increasing enrolments and completions in engineering courses suggest these policies have met with some success. However, the education of engineers has a long gestation period and the actual increase in completions has made only a small contribution to the additional numbers required. Although the number of engineers is small compared to the overall skilled migration program, the proportion of engineers employed in Australia that were born overseas has steadily increased as shown in Figure 3.5.



At the beginning of the decade, the proportion of engineers employed, born overseas, was already 41.8%. By the end of the decade it had grown to 52.6%. In comparison overseas born shares for "other skills" and overall employment were much lower, being 32.6% and 24.9% respectively. The respective trends are illustrated in Figure 3.6.



Underlying the changes evident in these illustrations was a substantial difference in employment growth between Australian and overseas born engineers:

- Average annual employment growth for Australian born engineers between 2001 and 2011 was 2.6% per annum.
- In 2011, employment grew by 2.8% for Australian born engineers.
- Average annual employment growth for overseas born engineers between 2001 and 2011 was 6.9% per annum.
- In 2011, employment of overseas born engineers fell by 2.2%.

These statistics show that the Australian engineering labour force has become highly dependent on overseas born engineers through skilled migration. The degree of this dependence comes with risks that are yet to be evaluated.

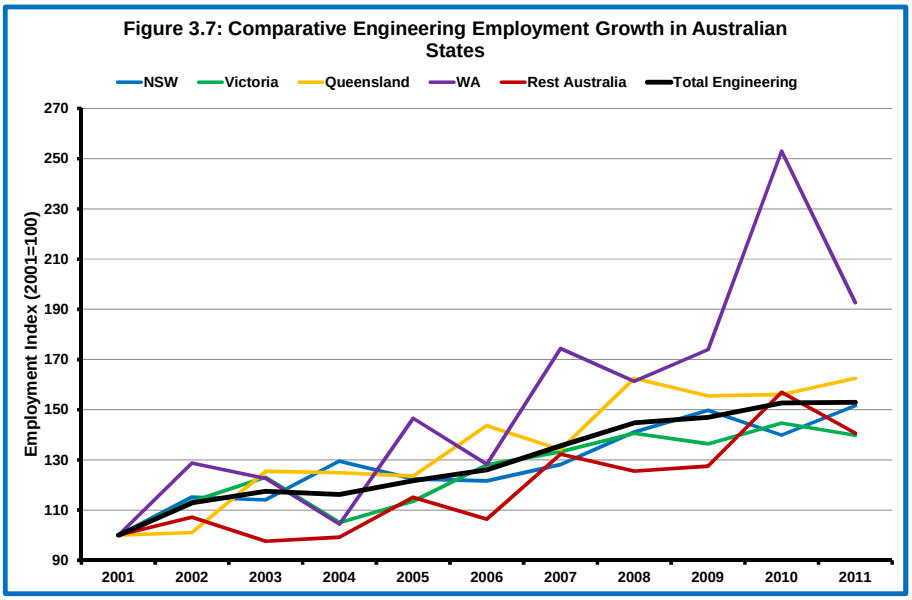
3.7. Jurisdictional Differences

Although general statistics have confirmed that Australia's resources boom has been focused on Queensland and Western Australia, there are no statistics on how the boom has affected the demand for, and supply of, engineers. Table 3.8 overcomes this gap in information by comparing the growth rates in demand and supply for NSW, Victoria, Queensland, Western Australia and the rest of Australia. Even though Western Australia is a key State in the resources boom, it is none-the-less one of the smaller jurisdictions so far as the engineering labour market is concerned and because of standard error problems reliable statistics are only available for employment. Even though statistics for South Australia, Tasmania and the two territories are aggregated into the Rest of Australia, a similar problem arises. This issue meant that the most reliable comparison is restricted to employment.

Table 3.8: Key Changes in the Jurisdictional Distribution of the Engineering Labour Market

Factor	Share of Demand		Demand Growth (% pa)		Supply Growth	
State	2001	2011	Decade Average	In 2011	Decade Average	In 2011
NSW	35.2	34.8	4.1	8.4	4.2	6.2
Victoria	28.2	25.8	3.4	-3.4	3.5	-4.0
Queensland	16.0	17.0	5.0	4.1	4.5	4.2
WA	9.9	12.4	8.6	-23.9	*	*
Rest of Australia	10.8	9.9	3.8	-10.4	4.2	*
Australia	100.0	100.0	4.4	0.1	4.3	-0.4

Source: ABS, Education and Work, 6227.0



The first two columns of Table 3.8 show the relative scale of jurisdictional engineering labour markets in 2001 and in 2011. Although resource States have become the centre of much attention, NSW and Victoria remain the largest engineering labour markets but they have lost some ground; NSW falling from 35.2% of engineering demand in 2001 to 34.8% and Victoria falling from 28.2% to 25.8%. The two resource States increased their shares; Queensland from 16.0% in 2001 to 17.0% in 2011 and Western Australia from 9.9% to 12.4%. The share of demand in the smaller jurisdictions fell from 10.8% in 2001 to 9.9% in 2011.

The decade average annual growth in demand was weakest in Victoria (3.4% pa) and the Rest of Australia 3.8% pa) and strongest in Western Australia (8.6% pa), Queensland (5.0% pa) and NSW (4.1% pa). In 2011, demand changes were somewhat erratic with positive growth in Queensland (4.1% pa) and NSW (8.4% pa) but with reduced demand in Western Australia (-23.9%), Victoria (-3.4%) and the Rest of Australia (-10.4%). The Western Australia result should be seen in the context described in the next paragraph.

One of the features of the trends in engineering demand in States was its high variability. This is illustrated in Figure 3.7 using an index number approach to deal with the scale differences. The black line is the demand trend for Australia as a whole. This exhibits variability typical of many economic variables but these changes are quite minor compared to the changes in engineering demand in individual jurisdictions. This conclusion is evident for all jurisdictions but applies particularly in the resource States. For example, in Western Australia the demand for engineers fell by 23.9% in 2011 following an increase of 45.5% in 2010.

The issue is whether these large changes in demand are within the adaptive capacity of the engineering labour market. A common view is that the growth in demand for engineers in some States means that greater labour mobility is essential. However, another view is that

excessive variability in demand for engineers mitigates against mobility. This view has been recognised in recent changes to infrastructure development policy through the implementation of the National Infrastructure Construction Schedule. The objective here was to establish a pipeline of infrastructure projects to overcome the disruptive effects on infrastructure workforces of large intervals between cessation of one project and commencement of another[8].

Engineering involves a long period of formal and professional training and are likely to have similar aspirations to other professionals in the Australian labour market. The challenges and rewards offered by employment in resource projects are no doubt attractive to some engineers, but the high variability in demand suggests that some of the engineering skill shortage experienced may be the result of excessive variability. Further research is essential to investigate possible links.

[8] National Infrastructure Construction Schedule, May 2012, www.infrastructure.gov.au

4. MOVING FROM SCHOOL INTO ENGINEERING COURSES

Key Messages

Science and mathematics are key subjects influencing the flow of year 12 students into engineering and science further education. Statistics on year 12 participation in mathematics and science show that the proportions of students studying advanced and intermediate level mathematics and science subjects have been falling. The participation statistics used to determine these trends say little about subject completions or about gender participation.

This year statistics on year 12 subject completions have become available. These statistics confirm the broad relationship between level of mathematics studied evident in participation statistics, but they also show that completions of year 12 advanced mathematics courses have been increasing, completions of intermediate mathematics courses have been falling and completions of fundamental mathematics courses have been increasing. In advanced mathematics completions by boys increased from 15,000 to 23,500 over past 6 years and for girls from 9,300 to 15,500. In intermediate mathematics, completions by boys fell from 45,000 to 39,000 and from 42,000 to 36,000 for girls. In fundamental mathematics, completions by boys increased from 38,000 to 43,600 and by girls from 44,000 to 48,000.

Most of the trends in completion of science subjects have been fairly stable over the past 6 years but there is considerable difference in the mix of subjects. The highest level of completions are in biology completions by girls which have averaged about 29,500 annually, but boys completions are about half this level. Physics course completions by boys have averaged about 20,000 annually but completions by girls are about one third this level. In chemistry the gender difference is quite small with about 17,000 completions by boys and 16,000 completions by girls annually.

Interest in university engineering courses is growing with applications for, offers and acceptances of offers all at record levels just prior to the change to fully demand driven courses. The profile of Australian Tertiary Admission Ranks for engineering compares well with other disciplines. There are proportionally more engineering acceptances with ranks in and above the 70 to 80 interval than in other disciplines and proportionally fewer acceptances with ranks lower than this interval. The profile of ranks for engineering acceptances has remained consistently high.

The Chapter shows that progress has been achieved in attracting more high standard students to university engineering courses. However, even though less pessimistic than participation statistics, completions of year 12 mathematics and science courses show these subjects are likely to constrain growth in engineering and other science based courses in the future.

4.1. Enrolments in Year 12 Mathematics and Science

This section updates the statistics on enrolments in year 12 mathematics and science subjects covered in previous editions of the Statistical Overview. Figure 4.1 shows the trends in the proportion of year 12 students enrolled in mathematics units. The statistics illustrated were prepared by Barrington and published by the Australian Mathematical Sciences Institute[9].

[9] AMSI, www.amsi.org.au

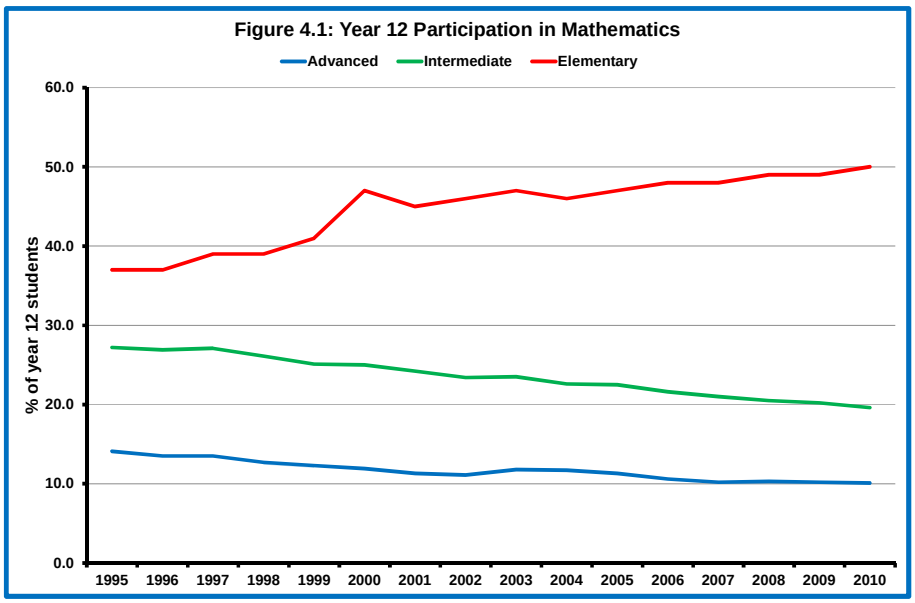
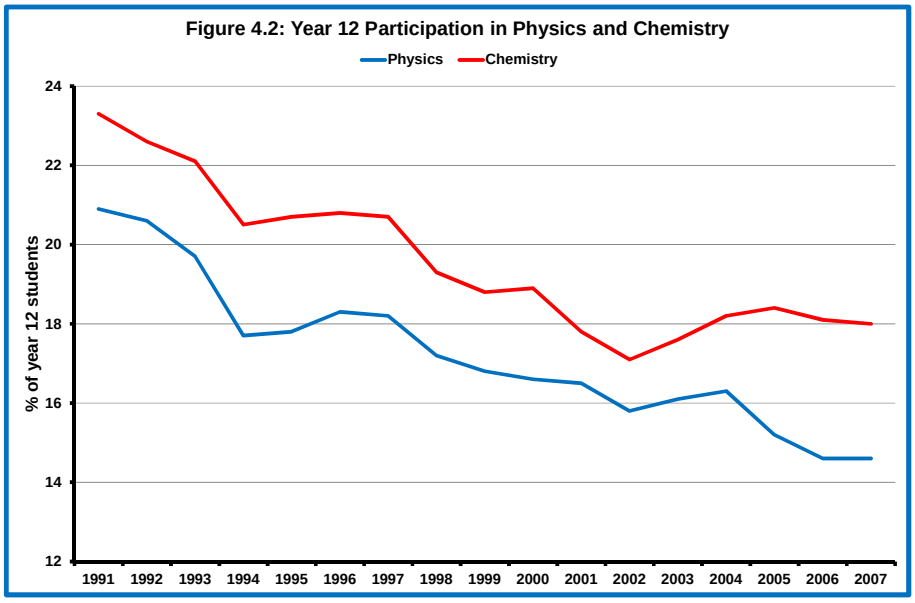


Figure 4.1 shows that the proportions of students studying advanced mathematics and intermediate mathematics has fallen steadily since the mid-1990s. During the last two years the trend for advanced mathematics has flattened out at slightly more than 10% but the proportion of students studying intermediate mathematics continues to fall. When combined with increases in year 12 retention, absolute numbers of students studying mathematics at both intermediate and advanced level have been slowly increasing. The proportion of students studying elementary mathematics has continued to rise and now accounts for half of enrolments.

Figure 4.2 shows the trends in the proportion of year 12 students enrolled in physics and chemistry, two key enabling subjects for university engineering courses. Since the early 1990s the trend has been for fewer students to enrol in these subjects. The trend for chemistry has flattened out at about 18% but in physics it continues to fall.

A recent report prepared by the Australian Academy of Science for the Chief Scientist provides another perspective on the trends shown in Figure 4.2. The report used updated statistics and notes that students can study one, two or more science subjects in year 12 and compares the number of students studying at least one science subject to total year 12 enrolments. Figure 4.3 illustrates the resulting trend.



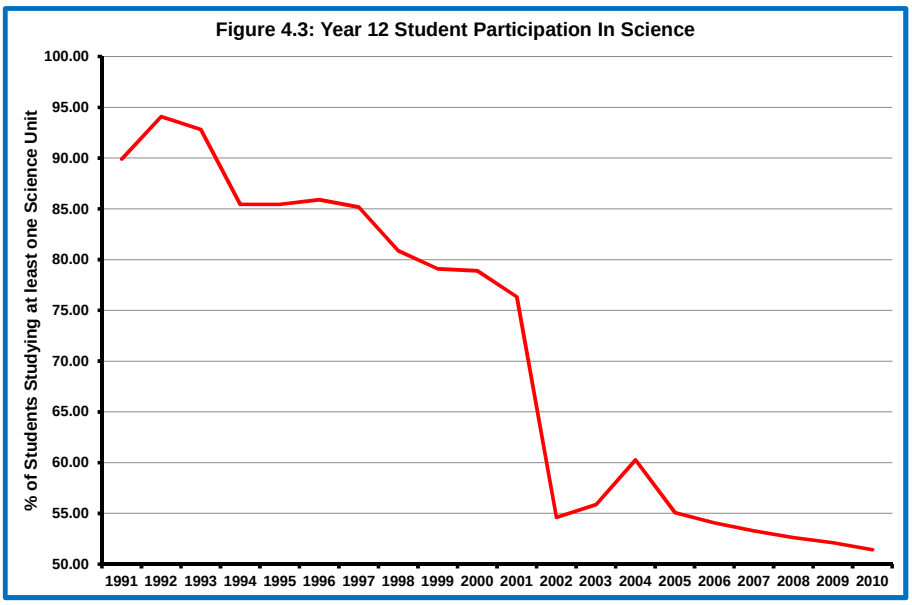


Figure 4.3 shows that the proportion of year 12 students studying at least one science subject has fallen from a high of 94.1% in 1992 to just 51.4% in 2010. The report notes that there was a dramatic fall during 2001 and 2002 that cannot be explained by any specific policy change by State and Territory education authorities.

The value of the statistics illustrated in Figures 4.1 to 4.3 is impaired by several gaps. In the case of Figures 4.1 and 4.2, gender statistics are not available. While Figure 4.3 has more up to date statistics, it is more useful to analyse statistics on individual subjects or combination of subjects. In all cases, enrolment in a subject is not an indicator that studies are completed. Ideally, trends in year 12 subject completions should be linked to trends in applications for university places.

4.2. Completions of Year 12 Mathematics and Science

Relying on year 12 commencement statistics to give an indication of tertiary study directions has some obvious shortcomings. Student commencements do not all complete initial courses; trends in proportions commencing different courses are less helpful than actual numbers; availability of statistics has been a problem and some are quite old, and information on gender has been problematic. Recently, a Policy Note released by the Group of 8 Universities secretariat described how using year 12 course completions can overcome most of these problems. Year 12 course completions statistics were sourced from State and Territory assessment, curriculum or accreditation agencies[10]. The different course nomenclature used by jurisdictions was reconciled into advanced, intermediate and fundamental (instead of elementary in Barrington's approach). The Group of 8 secretariat has kindly made these statistics available to Engineers Australia and they are used below to outline insights into the potential flow of year 12 graduates into tertiary engineering courses[11].

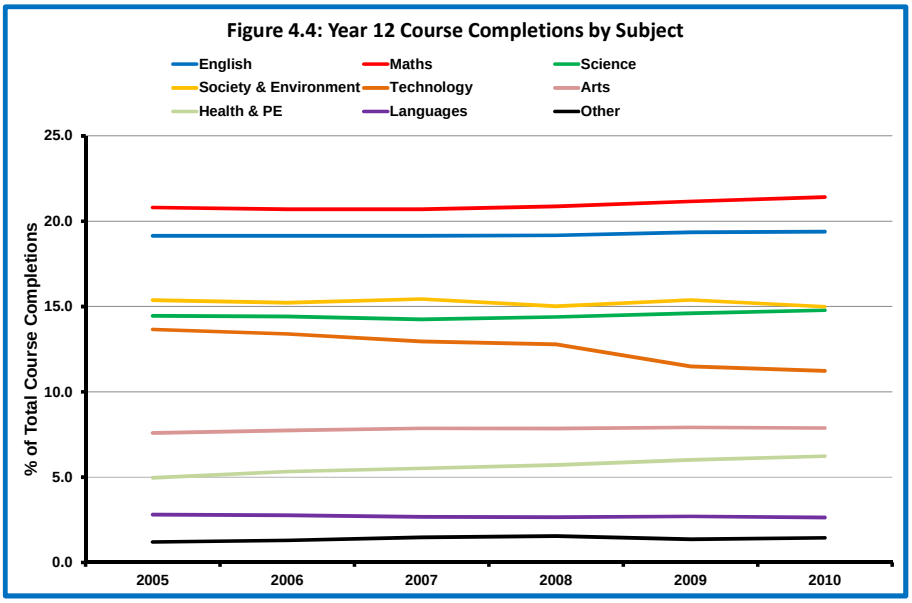
The statistics compiled are course completions, by subject and overall, rather than unit record statistics for individual students. The statistics can be used in several ways; to reflect on the status of mathematics and science studies in year 12 programs; to examine the gender balance in various subjects and to examine trends in absolute numbers of course

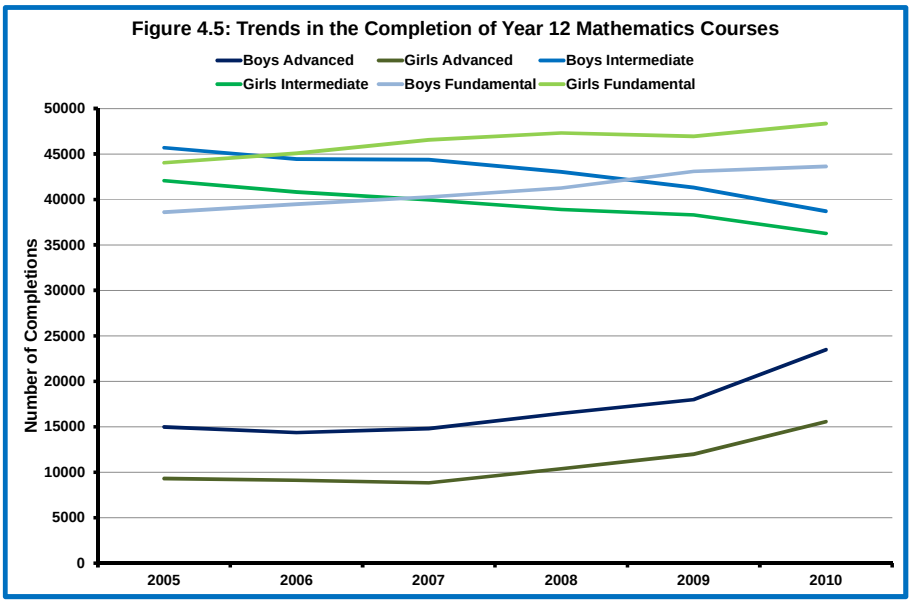
[10] Group of 8, National Trends in Year 12 Course Completions, Policy Note Number 6, April 2012, www.go8.edu.au

[11] I would like to express my thanks to Mike Gallagher and Mike Teese from the GO8 for making the statistics available to Engineers Australia.

completions and to compare these with trends in engineering course applications, offers and acceptances.

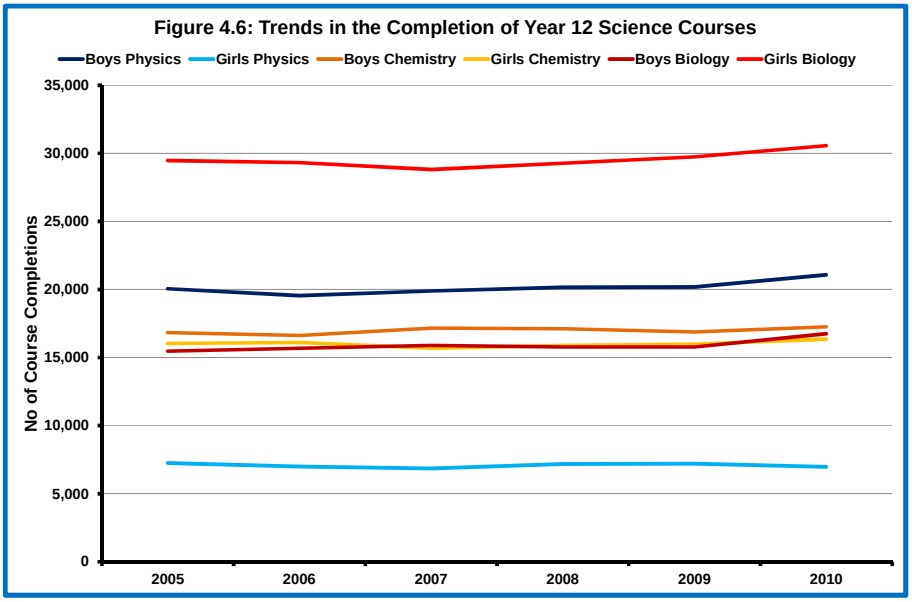
In 2005, there were 194,165 year 12 students who completed 214,542 courses, an average of 4.9 courses per student. By 2010, student numbers had increased by 10.5% to 214,542 but course completions increased by only 2.8% because the average number of course completed per student had fallen to 4.6%. The key issues for the flow of year 12 students into tertiary engineering courses is the inclusion of mathematics and science in year 12 programs and the level of mathematics and the type of science studied. Figure 4.4 deals with the first of these issues.





On average each year 12 student completed between 4.9 and 4.6 courses, in round terms about 5 courses. In other words, a subject that has in the vicinity of twenty percent of completions is studied by almost all students. Figure 4.4 shows that both mathematics and English are widely studied with most students completing courses and the trends for both subjects are steady over the six years considered. However, this is not the case in science where completions are about 14.5% of total year 12 completions.

Figure 4.5 looks at mathematics courses more closely; it shows the trends in the numbers of boys and girls completing advanced, intermediate and fundamental mathematics courses. The illustration is in numbers of completions and in this respect differs from the analysis in the Go8 Policy Note which looked at the proportion of mathematics completions at each level. The trend directions are consistent between these alternative.



Overall, completions of mathematics courses have increased for both genders; by 6.6% for boys and by 5.0% for girls. The number of advanced mathematics course completions has increased for both boys and girls; by 56.7% for boys and by 67.1% for girls. But the number of completions by girls is considerably and consistently lower than for boys. In 2010, 23,484 advanced mathematics courses were completed by boys and 15,553 were completed by girls. These statistics convey a different impression to the downwards trend in and low proportion of year 12 commencements in advanced mathematics.

The number of intermediate mathematics course completions has fallen for both boys and girls; by 15.3% for boys and by 13.8% for girls. Considerably fewer girls than boys complete intermediate mathematics courses. In 2010, 38,704 intermediate mathematics courses were completed by boys and 36,261 by girls.

The number of fundamental mathematics course completions has increased for both boys and girls; by 13.1% for boys and by 9.8% for girls. The gender composition is the opposite of completion of advanced and intermediate mathematics courses and more girls than boys' complete mathematics at this level.

Figures 4.2 and 4.3 show that year 12 science commencements have been decreasing. In contrast, completion statistics show that year 12 science completions have been steady at about 14.5% of total course completions. Science completions are considerably lower than mathematics, proportionally and numerically, but it is the composition of science completions and its gender balance that is the limiting factor on the potential flow of year 12 students to tertiary engineering courses. This is illustrated in Figure 4.6 which shows the trends in course completions for the three courses that account for three-quarters of completions; physics, chemistry and biology.

Biology accounts for about one third of year 12 science completions (the red trends in Figure 4.6). Completions by girls outnumber completions by boys by two to one; in 2010, there were 30,555 completions by girls compared to 16,747 by boys.

Chemistry accounts for about one quarter of year 12 science completions (the brown & yellow trends in Figure 4.6). Although completions by boys were higher, there was not a great deal separating genders. In 2010, there were 17,253 completions by boys and 16,363 completions by girls.

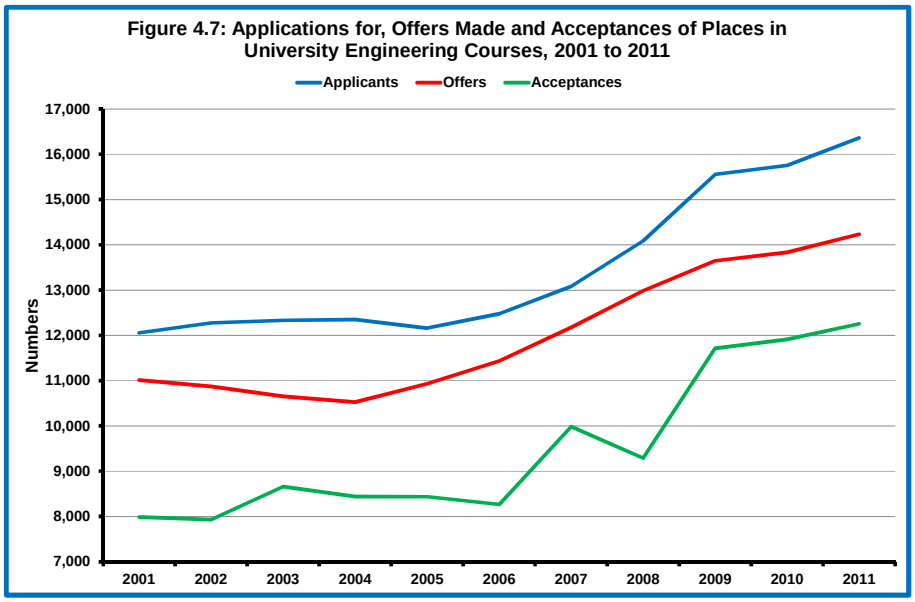
About one fifth of year 12 science completions were physics courses and here there was a reversal of the gender balance evident for biology completions. Completions by boys outnumber completions by girls by almost three to one. There was a slowly increasing trend in completions by boys but at best static or slowly falling trend for girls. In 2010, 17,253 boys completed year 12 physics courses and only 6,977 girls.

These statistics suggest that Australia is facing severe difficulties in respect to the flow of individuals with year 12 completions in advanced mathematics and science courses. Although, the numbers of course advanced mathematics completions for girls are lower than for boys, numerically the flow potentially available to move into tertiary courses requiring this level of mathematical background is reasonably high and has been increasing. However, in respect to science completions, completions by girls favour biology and chemistry and are very low and possibly falling in physics.

4.3. Transition from School to University Engineering

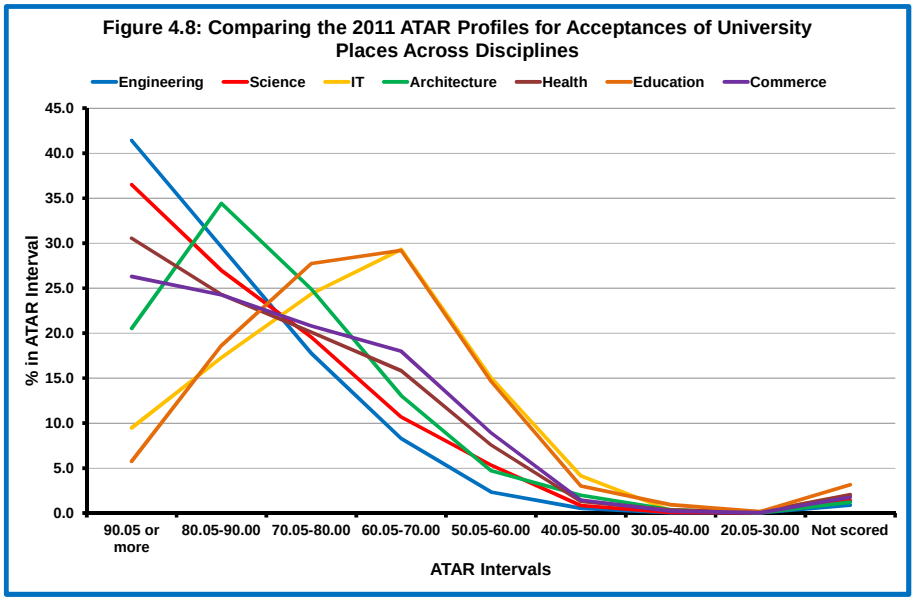
Figure 4.6 shows that interest in university engineering courses continues to grow and universities have responded with more offers of places, and acceptances continue to rise.

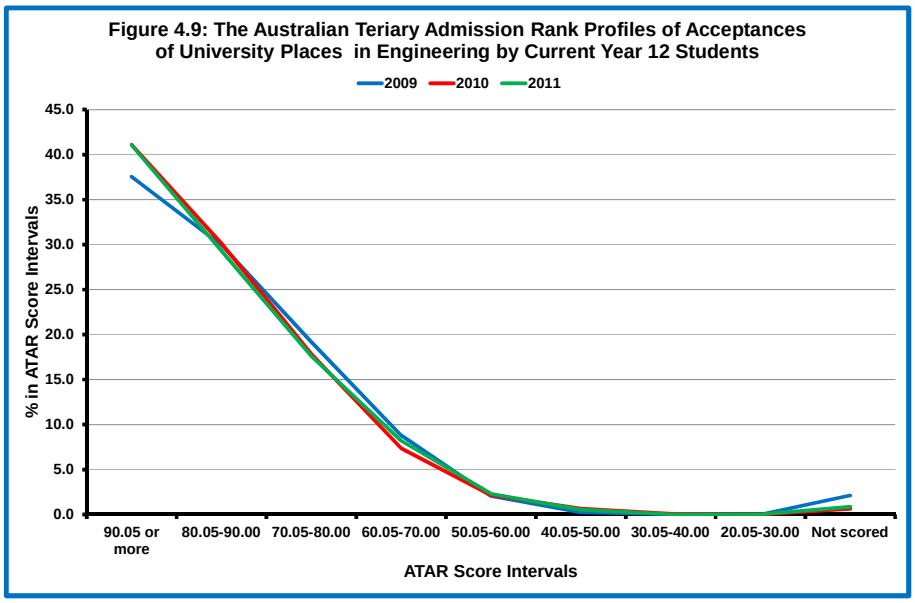
In 2011, applications for places in engineering courses increased by 607 or 3.8% and the cumulative increase since 2001 was 35.7%. Offers of places increased by 400 or 2.9% and the cumulative increase since 2001 was 29.2%. Acceptances of offers increased by 343, also 2.9%, and the cumulative increase since 2001 was 53.4%.



Year 12 programs are the basis of tertiary entrance processes for current year 12 students moving on to universities. Various names are used by States and Territories to describe the measure of student achievement involved. In NSW and the ACT, it is called the Universities Admission Index (UAI), in SA, WA, Tasmania and the NT, it is called the Tertiary Entrance Rank (TER), in Queensland, it is called the Overall Position (OP) and in Victoria, the Equivalent National Tertiary Entrance Rank (ENTER). Since 2009 all jurisdictions except Queensland moved to Australian Tertiary Admissions Rank (ATAR).

Figure 4.7 compares the profile of ATAR scores for acceptances of places in engineering courses to the profiles of acceptances in other major disciplines in 2011. Engineering continues to have proportionally more acceptances from students with higher ATAR scores and proportionally fewer acceptances from students with lower ATAR scores. This





comparison was undertaken at a high level of aggregation and the result could alter in some cases, for example, health includes programs for medical practitioners, nursing and other areas health. Statistics are not available that distinguish between these areas and this may be a factor. This issue is less of a problem in other course areas.

Figure 4.8 compares the profiles of ATAR scores for acceptances of places in engineering for the three years 2009 to 2011. There has been little change during these years at a time when acceptances have been increasing.

5. STATISTICS ON UNIVERSITY ENGINEERING COURSE PARTICIPATION

Key Messages

University course commencements by domestic students (citizens and permanent residents) increased by 8.0% in 2010 continuing a rising trend that began in 2006. There were increase in all level of courses except research master degrees which were static. Bachelor degree commencements increased by 4.1% to 12,541 with nearly all the increase being in four year or four year double degree courses.

There was a small increase of 1% in overseas student commencements, suggesting the rapid growth in past years has flattened out. There was a 6% increase in bachelor degree commencements, offsetting contractions at other course levels.

There are now record numbers of students enrolled in engineering courses. In 2010, total enrolments were 85,348; 57,901 domestic and 27,447 overseas students, up 46.4% from 2001. There are now 61,518 students studying bachelor degree in engineering; 44,656 domestic students and 16,862 overseas students.

In 2010, domestic completions of engineering courses increased by 6.8% to 8,935. There were 6,237 completions of bachelor degrees, up 2.9% from the previous year. Course completions by women were 15.9% of all completions and 14.7% of bachelor degree completions.

Overall domestic engineering completions have been about 5.4% and overseas engineering completions about 6.9% of total university completions during the past decade. In both cases, however, completions of doctoral degrees has been almost twice this share.

5.1 Course Commencements

In this Edition, a new approach to course commencements and completions is introduced. This Section will focus on commencements in engineering courses of all levels, from doctoral degrees to undergraduate enabling courses. As in past years, these statistics are for Engineering and Related Technologies, a higher level categorisation that includes Geomatic Engineering or Surveying. The following Section takes a different approach and looks at commencements in entry level engineering courses by engineering specialisations.

Domestic students are students who are Australian citizens or Australian permanent residents. Overseas students are citizens or permanent residents of other countries and who do not have permanent Australian residency. Overseas students are required to have student visas to study in Australia. In recent years, many overseas students have remained in Australia after completing their studies. This course of action is actively encouraged by Australia's skilled migration policies but involves completing migration formalities to obtain a permanent resident visa or a temporary 457 visa.

Tables 5.1 to 5.4 show commencements in university engineering and related technologies courses arranged in several ways; Tables 5.1 and 5.2 deal with commencements by domestic and overseas students respectively; Table 5.3 looks at the total of all commencements with a focus on the relative contributions of domestic and overseas students and Table 5.4 looks at the total of all commencements with a focus on gender.

Table 5.1: Domestic Students Commencing Engineering and Related Technologies Courses

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	406	472	492	537	437	378	418	380	443	514
Research masters	272	292	246	269	232	211	179	143	247	244
Coursework masters	646	849	840	795	727	759	853	916	1211	1284
Other postgraduate	906	823	947	850	901	841	791	864	937	909
Bachelors	9148	8792	8667	8574	8663	8913	9460	9698	10300	10731
Ass degrees & advanced diplomas	212	232	233	240	331	349	459	759	849	1221
Diplomas	26	67	42	45	46	45	155	163	200	259
Other undergraduate	208	519	547	496	366	394	421	137	172	294
Total	11824	12046	12014	11806	11703	11890	12736	13060	14359	15456

Women

Doctoral	128	142	123	150	113	108	101	118	143	164
Research masters	52	74	76	78	60	46	55	44	51	59
Coursework masters	152	158	167	169	149	184	178	212	238	257
Other postgraduate	194	175	159	167	191	198	162	216	221	225
Bachelors	1638	1486	1422	1336	1257	1375	1591	1597	1752	1810
Ass degrees & advanced diplomas	14	32	17	<10	42	42	65	83	81	136
Diplomas	0	4	3	<10	0	2	15	21	33	25
Other undergraduate	29	54	52	27	64	86	97	89	116	220
Total	2207	2125	2019	1936	1876	2041	2264	2380	2635	2896

All domestic commencements

Doctoral	534	614	615	687	550	486	519	498	586	678
Research masters	324	366	322	347	292	257	234	187	298	303
Coursework masters	798	1007	1007	964	876	943	1031	1128	1449	1541
Other postgraduate	1100	998	1106	1017	1092	1039	953	1080	1158	1134
Bachelors	10786	10278	10089	9910	9920	10288	11051	11295	12052	12541
Ass degrees & advanced diplomas	226	264	250	240	373	391	524	842	930	1357
Diplomas	26	71	45	45	46	47	170	184	233	284
Other undergraduate	237	573	599	523	430	480	518	226	288	514
Total	14031	14171	14033	13742	13579	13931	15000	15440	16994	18352

Source: Data provided by DEEWR

Table 5.2: Overseas Students Commencing Engineering & Related Technologies Courses

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	190	186	207	213	222	272	336	413	579	600
Research masters	97	117	133	173	137	135	144	131	144	164
Coursework masters	1089	1442	2443	2344	2142	1940	2101	2084	2580	2217
Other postgraduate	194	219	128	134	260	269	251	255	316	257
Bachelors	2818	3206	3564	3283	3109	3184	3523	3679	4385	4628
Ass degrees & advanced diplomas	15	29	14	23	40	47	159	129	181	144
Diplomas	1	29	12	17	64	48	345	274	415	590
Other undergraduate	2	9	46	34	41	63	34	50	45	53
Total	4406	5237	6547	6221	6015	5958	6893	7015	8645	8653

Women

Doctoral	47	40	50	51	50	89	95	162	225	198
Research masters	24	23	25	30	40	43	54	49	64	54
Coursework masters	216	303	407	443	437	355	427	468	520	553
Other postgraduate	27	38	20	28	35	53	50	54	49	61
Bachelors	556	653	716	653	669	670	766	786	926	998
Ass degrees & advanced diplomas	1	1	1	2	1	2	3	4	10	13
Diplomas	0	18	0	0	44	67	86	39	60	81
Other undergraduate	3	1	17	8	10	10	19	13	15	12
Total	874	1077	1236	1215	1286	1289	1500	1575	1869	1970

All overseas commencemenrs

Doctoral	237	226	257	264	272	361	431	575	804	798
Research masters	121	140	158	203	177	178	198	180	208	218
Coursework masters	1305	1745	2850	2787	2579	2295	2528	2552	3100	2770
Other postgraduate	221	257	148	162	295	322	301	309	365	318
Bachelors	3374	3859	4280	3936	3778	3854	4289	4465	5311	5626
Ass degrees & advanced diplomas	16	30	15	25	41	49	162	133	191	157
Diplomas	1	47	12	17	108	115	431	313	475	671
Other undergraduate	5	10	63	42	51	73	53	63	60	65
Total	5280	6314	7783	7436	7301	7247	8393	8590	10514	10623

Source: Data provided by DEEWR

Table 5.3: Students Commencing Engineering & Related Technologies Courses, by Country of Domicile

Domestic students

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	534	614	615	687	550	486	519	498	586	678
Research masters	324	366	322	347	292	257	234	187	298	303
Coursework masters	798	1007	1007	964	876	943	1031	1128	1449	1541
Other postgraduate	1100	998	1106	1017	1092	1039	953	1080	1158	1134
Bachelors	10786	10278	10089	9910	9920	10288	11051	11295	12052	12541
Ass degrees & advanced diplomas	226	264	250	240	373	391	524	842	930	1357
Diplomas	26	71	45	45	46	47	170	184	233	284
Other undergraduate	237	573	599	523	430	480	518	226	288	514
Total	14031	14171	14033	13742	13579	13931	15000	15440	16994	18352

Overseas students

Doctoral	237	226	257	264	272	361	431	575	804	798
Research masters	121	140	158	203	177	178	198	180	208	218
Coursework masters	1305	1745	2850	2787	2579	2295	2528	2552	3100	2770
Other postgraduate	221	257	148	162	295	322	301	309	365	318
Bachelors	3374	3859	4280	3936	3778	3854	4289	4465	5311	5626
Ass degrees & advanced diplomas	16	30	15	25	41	49	162	133	191	157
Diplomas	1	47	12	17	108	115	431	313	475	671
Other undergraduate	5	10	63	42	51	73	53	63	60	65
Total	5280	6314	7783	7436	7301	7247	8393	8590	10514	10623

All commencing students

Doctoral	771	840	872	951	822	847	950	1073	1390	1476
Research masters	445	506	480	550	469	435	432	367	506	521
Coursework masters	2103	2752	3857	3751	3455	3238	3559	3680	4549	4311
Other postgraduate	1321	1255	1254	1179	1387	1361	1254	1389	1523	1452
Bachelors	14160	14137	14369	13846	13698	14142	15340	15760	17363	18167
Ass degrees & advanced diplomas	242	294	265	265	414	440	686	975	1121	1514
Diplomas	27	118	57	62	154	162	601	497	708	955
Other undergraduate	242	583	662	565	481	553	571	289	348	579
Total	19311	20485	21816	21169	20880	21178	23393	24030	27508	28975

Source: Data provided by DEEWR

Table 5.4: Students Commencing Engineering & Related Technologies Courses, by Gender

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	596	658	699	750	659	650	754	793	1022	1114
Research masters	369	409	379	442	369	346	323	274	391	408
Coursework masters	1735	2291	3283	3139	2869	2699	2954	3000	3791	3501
Other postgraduate	1100	1042	1075	984	1161	1110	1042	1119	1253	1166
Bachelors	11966	11998	12231	11857	11772	12097	12983	13377	14685	15359
Ass degrees & advanced diplomas	227	261	247	263	371	396	618	888	1030	1365
Diplomas	27	96	54	62	110	93	500	437	615	849
Other undergraduate	210	528	593	530	407	457	455	187	217	347
Total	16230	17283	18561	18027	17718	17848	19629	20075	23004	24109

Women

Doctoral	175	182	173	201	163	197	196	280	368	362
Research masters	76	97	101	108	100	89	109	93	115	113
Coursework masters	368	461	574	612	586	539	605	680	758	810
Other postgraduate	221	213	179	195	226	251	212	270	270	286
Bachelors	2194	2139	2138	1989	1926	2045	2357	2383	2678	2808
Ass degrees & advanced diplomas	15	33	18	2	43	44	68	87	91	149
Diplomas	0	22	3	0	44	69	101	60	93	106
Other undergraduate	32	55	69	35	74	96	116	102	131	232
Total	3081	3202	3255	3142	3162	3330	3764	3955	4504	4866

All commencing students

Doctoral	771	840	872	951	822	847	950	1073	1390	1476
Research masters	445	506	480	550	469	435	432	367	506	521
Coursework masters	2103	2752	3857	3751	3455	3238	3559	3680	4549	4311
Other postgraduate	1321	1255	1254	1179	1387	1361	1254	1389	1523	1452
Bachelors	14160	14137	14369	13846	13698	14142	15340	15760	17363	18167
Ass degrees & advanced diplomas	242	294	265	265	414	440	686	975	1121	1514
Diplomas	27	118	57	62	154	162	601	497	708	955
Other undergraduate	242	583	662	565	481	553	571	289	348	579
Total	19311	20485	21816	21169	20880	21178	23393	24030	27508	28975

Source: Data provided by DEEWR

- Course commencements by domestic students increased from 16,994 in 2009 to 18,352 in 2010, an increase of 8.0%. Over two-thirds of the increase was in entry level course, 489 additional commencements in bachelors degrees and 427 additional commencements in associate degrees and advanced diplomas. The remaining increase was widely spread; 92 additional doctoral degree commencements, the same increase in course work masters degrees, 51 additional commencements in diploma courses and 226 additional commencements in sub-diploma undergraduate courses. Research master degree commencements increased by only five and commencements in sub-masters postgraduate courses fell by 24.

After several years of strong growth, commencements by overseas students slowed, growing only 109 or 1.0% from 10,514 in 2009 to 10,623 in 2010. Commencements in bachelors degrees continued to grow strongly, increasing by 313 or 5.9%. There was also strong growth in commencements in diploma courses from 475 in 2009 to 671 in 2010, an increase of 41.3%. However, commencements in all other courses either fell or marked time; doctoral degree commencements fell by 6, research masters degree commencements increased by 10, course work masters degree commencements fell by 313 or 10.0%, sub-masters postgraduate commencements fell by 47 and associate degree and advanced diploma commencements fell by 34.

Total commencements grew from 27,508 in 2009 to 28,975 in 2010, an increase of 1,467 or 5.3%. The share of postgraduate course commencements fell from 29.0% in 2009 to 26.8% in 2010, the share of bachelors degree commencements fell from 63.1% to 62.7% while the share of sub degree commencements increased from 7.9% to 10.5% in 2010. Table 5.4 shows that the women's share of postgraduate commencements was higher than for men (32.3% compared to 25.7%), the women's share of bachelors degree commencements was lower than for men (52.7% compared to 63.7%) and there was a similar share of sub-degree commencements. Overall, there was a slight increase in the women's share of commencements from 16.4% in 2009 to 16.8% in 2010 with the women's share higher among overseas students (18.5%) than domestic students (15.8%).

5.2 Commencements in Entry Level Courses

This year for the first time statistics on commencements in entry level courses by engineering specialisation were obtained. Statistics were obtained for domestic commencements in three year degree; four year degree and four year double degree bachelors courses by engineering specialisation. Corresponding statistics for overseas students will be included next year. Statistics were also obtained for domestic commencements in associate degrees and advanced diplomas and diplomas in engineering. However, the numbers in these sub-degree courses were much smaller than for degrees and when disaggregated encountered a large number of small cells in statistical Tables.

Table 5.1 shows domestic commencements in three year bachelor degree courses, Table 5.2 shows domestic commencements in four year bachelors courses and Table 5.3 shows commencements in four year double degree bachelors courses. Before discussing these Tables a comment on DEEWR's approach to small cell statistics is necessary. DEEWR's privacy policy does not allow release of statistics smaller than five in the cells of any Table. However, the relevant number is included in totals given for Tables. This presents some difficulties when presenting three panel Tables like the ones used here. The course adopted was to use DEEWR totals in total rows to overcome the small cell problem. This means that the totals in the third panel of the Tables are the sum of the rows in these panels and not the sums of the total rows in the top two panels. In some cases there are a large number of small cells so that as a general rule the statistics in this section should be taken as only a guide to the distribution by engineering specialisation.

Table 5.5: Detailed Domestic Commencements in Three Year Bachelor Degrees in Engineering

Men

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0300	Engineering & Related Technologies nfd	206	184	191	163	138	92	17	16	12	21
0301	Manufacturing Engineering & Technology	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
0303	Process & Resource Engineering	45	52	82	61	41	63	58	50	45	44
0305	Automotive Engineering & Technology	0	0	0	0	0	33	35	25	31	36
0307	Mechanical & Industrial Engineering	97	127	<10	11	16	11	<10	<10	28	29
0309	Civil Engineering	41	27	29	48	23	19	10	<10	14	12
0311	Geomatic Engineering	115	122	130	58	36	22	33	18	38	33
0313	Electrical & Electronic Engineering	370	420	334	133	191	118	158	119	130	115
0315	Aerospace Engineering & Technology	216	275	211	197	152	195	229	267	336	406
0317	Maritime Engineering & Technology	<10	<10	14	<10	<10	<10	<10	<10	<10	11
0399	Other Engineering &Related Technology	275	310	217	199	267	189	224	289	319	247
Sub-total	Engineering	1371	1524	1223	877	872	749	779	804	959	962

Women

0300	Engineering & Related Technologies nfd	25	16	<10	11	16	<10	<10	<10	<10	<10
0301	Manufacturing Engineering & Technology	<10	<10	<10	<10	15	20	20	28	37	54
0303	Process & Resource Engineering	19	19	27	23	20	26	16	21	12	41
0305	Automotive Engineering & Technology	0	0	0	0	0	<10	<10	<10	<10	<10
0307	Mechanical & Industrial Engineering	<10	<10	0	<10	0	0	<10	0	<10	<10
0309	Civil Engineering	<10	<10	<10	0	<10	<10	<10	0	<10	<10
0311	Geomatic Engineering	31	34	31	18	14	<10	15	10	<10	<10
0313	Electrical & Electronic Engineering	44	27	32	12	56	42	36	35	34	19
0315	Aerospace Engineering & Technology	39	48	36	41	35	35	51	55	57	52
0317	Maritime Engineering & Technology	0	<10	0	0	0	0	0	0	0	0
0399	Other Engineering &Related Technology	33	25	20	20	33	31	32	32	24	21
Sub-total	Engineering	205	178	164	128	191	171	175	187	179	196

Total

0300	Engineering & Related Technologies nfd	206	184	191	163	153	112	37	44	49	75
0301	Manufacturing Engineering & Technology	0	0	0	0	15	20	20	28	37	54
0303	Process & Resource Engineering	64	71	109	84	61	89	74	71	57	85
0305	Automotive Engineering & Technology	0	0	0	0	0	33	35	25	31	36
0307	Mechanical & Industrial Engineering	97	127	0	11	16	11	0	0	28	29
0309	Civil Engineering	41	27	29	48	23	19	10	0	14	12
0311	Geomatic Engineering	146	156	161	76	50	22	48	28	38	33
0313	Electrical & Electronic Engineering	414	447	366	145	247	160	194	154	164	134
0315	Aerospace Engineering & Technology	255	323	247	238	187	230	280	322	393	458
0317	Maritime Engineering & Technology	0	0	14	0	0	0	0	0	0	11
0399	Other Engineering &Related Technology	308	335	237	219	300	220	256	321	343	268
Total	Engineering	1576	1702	1387	1005	1063	920	954	991	1138	1158

Source: Provided by DEEWR

Note: The total rows in each panel are correct and the sum of the corresponding rows in the top two panels match the equivalent row in the third panel but the sum of rows in the top two panels may not match the total shown due to the Department's privacy policy

In 2010, there were 1,158 commencements in three year bachelors degrees in engineering compared to 1,576 in 2001, a fall of 418 or 26.5%. The women's share was 16.9%, up from 13.0% in 2001. The largest specialisation in 2010 was aerospace engineering where commencements have grown over the decade to 458 or 39.6% of commencements. At the beginning of the decade, electrical and electronic engineering was the largest specialisation with 414 or 26.3% of commencements. Commencements in this specialisation fell sharply over the decade to 134 or 11.6% of lower overall commencements in 2010.

The second largest area of commencements in three year bachelors degrees was the combined total of two general/other groups (0300 and 0399) that in 2010 accounted for 343 or 29.6% of commencements. The remaining commencements were distributed broadly across specialisations, all with less than 100 commencements Australia wide.

Annual commencements in four year bachelors degrees in engineering increased from 6,341 in 2001 to 7,967 in 2010, an increase of 1,626 or 25.6%. In 2001, the women's share of these commencements was 14.2%, falling to 12.3% by 2010.
In 2010, the two largest course areas were engineering and related technologies nfd with 1,821 or 22.9% and other engineering and related technologies with 1,778 or 22.3% of commencements. The first of these reflects difficulties that DEEWR experiences in obtaining accurate statistics from universities. There are no specific specialisations in this group making very difficult to understand what it represents other than a general degree. On the other hand, other engineering and related technologies includes biomedical engineering, environmental engineering, naval architecture as well as genuine other areas not included in

specific categories. The Table shows that in recent years commencements in this category have grown strongly.

Table 5.6: Detailed Domestic Commencements in Four Year Bachelor Degrees in Engineering

Men

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0300	Engineering & Related Technologies nfd	1204	550	632	694	888	1098	1341	1685	1515	1559
0301	Manufacturing Engineering & Technology	26	34	40	46	49	13	<10	0	0	0
0303	Process & Resource Engineering	416	386	378	455	479	503	608	602	552	518
0305	Automotive Engineering & Technology	19	29	24	27	63	84	54	29	31	43
0307	Mechanical & Industrial Engineering	547	598	714	726	786	720	747	712	886	864
0309	Civil Engineering	618	713	713	757	827	783	911	954	1234	1131
0311	Geomatic Engineering	171	135	192	229	168	126	158	143	135	133
0313	Electrical & Electronic Engineering	1271	1586	1357	1178	965	838	740	767	894	879
0315	Aerospace Engineering & Technology	158	226	226	195	242	206	195	217	211	280
0317	Maritime Engineering & Technology	37	22	21	41	26	25	26	28	34	40
0399	Other Engineering &Related Technology	972	689	744	706	851	1176	1311	1340	1333	1538
Sub-total	Engineering	5439	4968	5041	5054	5344	5572	6097	6477	6825	6985

Women

0300	Engineering & Related Technologies nfd	238	105	107	120	92	146	181	293	263	262
0301	Manufacturing Engineering & Technology	<10	<10	<10	<10	<10	<10	<10	0	0	0
0303	Process & Resource Engineering	123	121	95	92	81	115	137	132	148	128
0305	Automotive Engineering & Technology	0	<10	<10	0	<10	<10	<10	<10	<10	<10
0307	Mechanical & Industrial Engineering	48	46	39	56	40	51	54	49	75	67
0309	Civil Engineering	106	123	125	120	102	118	110	129	172	168
0311	Geomatic Engineering	23	22	17	22	14	16	16	11	10	<10
0313	Electrical & Electronic Engineering	178	184	169	133	72	58	57	49	82	75
0315	Aerospace Engineering & Technology	21	45	35	22	24	24	28	32	21	30
0317	Maritime Engineering & Technology	<10	0	0	<10	<10	<10	<10	<10	<10	0
0399	Other Engineering &Related Technology	160	151	136	127	151	180	212	204	245	240
Sub-total	Engineering	902	800	727	701	585	714	799	901	1018	982

Total

0300	Engineering & Related Technologies nfd	1442	655	739	814	980	1244	1522	1978	1778	1821
0301	Manufacturing Engineering & Technology	26	34	40	46	49	13	0	0	0	0
0303	Process & Resource Engineering	539	507	473	547	560	618	745	734	700	646
0305	Automotive Engineering & Technology	19	29	24	27	63	84	54	29	31	43
0307	Mechanical & Industrial Engineering	595	644	753	782	826	771	801	761	961	931
0309	Civil Engineering	724	836	838	877	929	901	1021	1083	1406	1299
0311	Geomatic Engineering	194	157	209	251	182	142	174	154	145	133
0313	Electrical & Electronic Engineering	1449	1770	1526	1311	1037	896	797	816	976	954
0315	Aerospace Engineering & Technology	179	271	261	217	266	230	223	249	232	310
0317	Maritime Engineering & Technology	37	22	21	41	26	25	26	28	34	40
0399	Other Engineering &Related Technology	1132	840	880	833	1002	1356	1523	1544	1578	1778
Total	Engineering	6341	5768	5768	5755	5929	6286	6896	7378	7843	7967

Source: Provided by DEEWR

Note: The total rows in each panel are correct and the sum of the corresponding rows in the top two panels match the equivalent row in the third panel but the sum of rows in the top two panels may not match the total shown due to the Department's privacy policy

In 2010, the next largest area of commencements was in civil engineering with 1,299 or 16.3%, although this figure was down from the 1,409 commencements in 2009. Commencements in civil engineering have almost doubled over the decade reflecting high labour market demand.

In contrast, course commencement in electrical and electronic engineering have fallen by 34.2% from 1,449 in 2001 to 954 in 2010. Despite this decline this specialisation is still the fourth highest for four year degrees.
In 2010, there were 931 four year degree commencements in mechanical engineering. This specialisation also experienced strong growth with commencements up 56.5% since 2001. It had a very low women's share of 7.2%.

There was moderate growth in commencements in four year process and resource engineering degrees which were up 19.9% from 2001 to be 646 in 2010. This specialisation includes mining engineering, materials engineering and chemical engineering. It had a particularly high women's share of 19.8%.

Commencements in four year aerospace engineering degrees were 310, up from 179 in 2001. Commencements in manufacturing engineers petered out to zero but there

commencements in automotive engineering emerged to be on a similar level to maritime engineering.

Table 5.7: Detailed Domestic Commencements in Four Year Double Bachelors Degrees in Engineering

Men

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0300	Engineering & Related Technologies nfd	776	685	779	836	959	936	922	1042	1120	1166
0301	Manufacturing Engineering & Technology	39	37	51	66	0	0	52	11	23	30
0303	Process & Resource Engineering	82	224	177	265	265	278	313	255	228	256
0305	Automotive Engineering & Technology	0	0	0	0	0	0	<10	<10	14	10
0307	Mechanical & Industrial Engineering	277	222	250	267	202	249	220	185	168	230
0309	Civil Engineering	137	147	156	276	271	344	354	331	358	388
0311	Geomatic Engineering	35	19	30	23	25	29	25	26	23	15
0313	Electrical & Electronic Engineering	639	692	611	551	409	370	251	232	202	289
0315	Aerospace Engineering & Technology	42	33	31	79	73	104	113	91	84	100
0317	Maritime Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0399	Other Engineering &Related Technology	409	334	430	476	398	458	500	420	475	562
Sub-total	Engineering	2345	2300	2403	2643	2447	2592	2584	2417	2516	2858

Women

0300	Engineering & Related Technologies nfd	144	124	137	157	171	161	189	200	195	278
0301	Manufacturing Engineering & Technology	<10	<10	<10	<10	0	0	<10	<10	0	<10
0303	Process & Resource Engineering	37	85	90	82	87	71	115	70	93	96
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering	49	26	27	41	21	33	45	45	37	40
0309	Civil Engineering	41	41	50	40	66	74	73	65	83	85
0311	Geomatic Engineering	11	19	<10	<10	<10	<10	12	<10	<10	<10
0313	Electrical & Electronic Engineering	115	109	92	60	40	34	42	26	37	36
0315	Aerospace Engineering & Technology	<10	<10	<10	14	15	14	19	19	14	17
0317	Maritime Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0399	Other Engineering &Related Technology	156	131	146	137	98	125	153	129	149	147
Sub-total	Engineering	531	508	531	507	481	489	617	509	555	650

Total

0300	Engineering & Related Technologies nfd	920	809	916	993	1130	1097	1111	1242	1315	1444
0301	Manufacturing Engineering & Technology	39	37	51	66	0	0	52	11	23	30
0303	Process & Resource Engineering	119	309	267	347	352	349	428	325	321	352
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	14	10
0307	Mechanical & Industrial Engineering	326	248	277	308	223	282	265	230	205	270
0309	Civil Engineering	178	188	206	316	337	418	427	396	441	473
0311	Geomatic Engineering	46	38	30	23	25	29	37	26	23	15
0313	Electrical & Electronic Engineering	754	801	703	611	449	404	293	258	239	325
0315	Aerospace Engineering & Technology	42	33	31	93	88	118	132	110	98	117
0317	Maritime Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0399	Other Engineering &Related Technology	565	465	576	613	496	583	653	549	624	709
Total	Engineering	2876	2808	2934	3150	2928	3081	3201	2926	3071	3508

Source: Provided by DEEWR

Note: The total rows in each panel are correct and the sum of the corresponding rows in the top two panels match the equivalent row in the third panel but the sum of rows in the top two panels may not match the total shown due to

Table 5.7 shows the trends for commencements in four year double degrees in engineering and another subject. Overall commencements fluctuated around an average a little less than 3,000 until 2009. In 2010, commencements increased sharply to 3,508. Proportionally, there are more women commencing double degrees than either three year or four year degrees in engineering at 18.5%.

Just under two-thirds of the commencements are in the general degree categories discussed above with 1,444 in engineering and related technologies nfd and 709 in other engineering and related technologies. This concentration limits the utility of the figures. In other categories, growth in commencements in process and resource engineering, civil engineering and aerospace engineering was offset by a strong decline in commencements in electrical and electronic engineering.

5.3 Enrolments

Increasing commencements in engineering courses have increased the engineering student populations attending universities. Tables 5.8 and 5.9 show how the domestic and overseas student populations have grown and Tables 5.10 and 5.11 show how the overall engineering student population has changed.

Since 2001, the domestic student population has grown by 10,984 from 46,917 to 57,901 in 2010, an increase of 23.4%. In comparison, the overseas student population has more than doubled increasing from 11,381 in 2001 to 27,447 in 2010, a similar numerical increase to the domestic student population but much greater proportionally. The overall student population increased from 58,298 in 2001 to 85,348 in 2010, an increase of 27,050 or 46.4%.

The overall proportion of women students in the student population was steady at about 16.0% over the decade. The women's share for domestic students in 2001 was 15.6% and fell to 15.0% by 2010. For overseas students, the women's shares were higher and increased over the decade; 17.5% in 2001 to 18.3% in 2010.

The main body of the engineering student population continues to be students studying bachelors degrees in engineering. This group increased from 46,897 in 2001 to 61,518 in 2010, an increase of 14,621 or 31.2%. About 60% of this increase came from overseas students and 40% from domestic students. Only 13% of the increase came from women.

There was significant change in other elements of the student population and this caused the bachelors degree student population to fall from over 80% of the population to about 72%. The number of doctoral degree students increased by 72% to 5,567 in 2010. The number of coursework masters degree students more than doubled, increasing from 3,799 in 2001 to 9,266 in 2010. There was also comparatively strong growth in student numbers studying associate degrees and advanced diplomas and other diplomas, particularly in recent years.

The two areas were student populations remained relatively stable were research masters degrees and sub-masters postgraduate courses.

Table 5.8: Domestic Students Enrolled in Engineering & Related Technologies Courses

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	1989	2058	2239	2365	2364	2314	2287	2212	2211	2271
Research masters	778	810	741	747	673	635	590	491	561	615
Coursework masters	1459	1713	1874	1905	1880	1884	2076	2259	2626	3001
Other postgraduate	1509	1494	1682	1662	1709	1717	1634	1715	1689	1731
Bachelors	32934	32872	32769	32405	31994	32553	33759	35119	36852	38453
Assoc degrees & advanced diplomas	628	618	593	624	651	799	1070	1501	1897	2458
Diplomas	46	87	68	56	69	73	191	196	281	374
Other undergraduate	247	580	579	526	414	450	449	172	210	324
Total	39590	40232	40545	40290	39754	40425	42056	43665	46327	49227

Women

Doctoral	562	562	599	636	635	621	630	640	655	711
Research masters	159	158	173	187	184	162	142	131	136	154
Coursework masters	314	343	376	390	388	429	460	505	538	629
Other postgraduate	327	346	334	344	363	405	374	407	396	422
Bachelors	5896	5839	5675	5416	5117	5069	5299	5574	5874	6203
Assoc degrees & advanced diplomas	35	54	45	29	53	81	132	180	198	282
Diplomas	0	4	3	1	1	4	18	32	44	43
Other undergraduate	34	61	60	34	72	102	113	109	136	230
Total	7327	7367	7265	7037	6813	6873	7168	7578	7977	8674

All domestic enrollments

Doctoral	2551	2620	2838	3001	2999	2935	2917	2852	2866	2982
Research masters	937	968	914	934	857	797	732	622	697	769
Coursework masters	1773	2056	2250	2295	2268	2313	2536	2764	3164	3630
Other postgraduate	1836	1840	2016	2006	2072	2122	2008	2122	2085	2153
Bachelors	38830	38711	38444	37821	37111	37622	39058	40693	42726	44656
Assoc degrees & advanced diplomas	663	672	638	653	704	880	1202	1681	2095	2740
Diplomas	46	91	71	57	70	77	209	228	325	417
Other undergraduate	281	641	639	560	486	552	562	281	346	554
Total	46917	47599	47810	47327	46567	47298	49224	51243	54304	57901

Source: Data provided by DEEWR

Table 5.9: Overseas Students Enrolled in Engineering & Related Technologies Courses

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	560	617	704	791	901	1001	1113	1284	1620	1903
Research masters	197	213	232	306	320	338	334	309	297	340
Coursework masters	1647	2193	3674	4051	4109	3662	3743	4065	4532	4617
Other postgraduate	278	332	219	208	335	359	332	346	406	389
Bachelors	6673	7815	9045	9613	9683	9931	10507	11414	12471	13899
Assoc degrees & advanced diplomas	29	43	31	43	55	73	180	233	311	291
Diplomas	1	36	32	40	82	94	526	527	652	927
Other undergraduate	2	12	53	42	48	72	36	54	46	54
Total	9387	11261	13990	15094	15533	15530	16771	18232	20335	22420

Women

Doctoral	134	137	157	193	210	263	310	423	568	682
Research masters	38	47	49	54	81	90	112	111	126	136
Coursework masters	379	457	660	758	803	682	690	861	934	1019
Other postgraduate	43	51	33	32	45	63	59	66	65	74
Bachelors	1394	1682	1919	2025	2061	2125	2284	2449	2645	2963
Assoc degrees & advanced diplomas	2	2	3	3	1	2	5	7	13	19
Diplomas	0	18	31	31	51	112	167	110	86	120
Other undergraduate	4	1	18	10	12	12	20	14	15	14
Total	1994	2395	2870	3106	3264	3349	3647	4041	4452	5027

All overseas enrollments

Doctoral	694	754	861	984	1111	1264	1423	1707	2188	2585
Research masters	235	260	281	360	401	428	446	420	423	476
Coursework masters	2026	2650	4334	4809	4912	4344	4433	4926	5466	5636
Other postgraduate	321	383	252	240	380	422	391	412	471	463
Bachelors	8067	9497	10964	11638	11744	12056	12791	13863	15116	16862
Assoc degrees & advanced diplomas	31	45	34	46	56	75	185	240	324	310
Diplomas	1	54	63	71	133	206	693	637	738	1047
Other undergraduate	6	13	71	52	60	84	56	68	61	68
Total	11381	13656	16860	18200	18797	18879	20418	22273	24787	27447

Source: Data provided by DEEWR

Table 5.10: Students Enrolled in Engineering & Related Technologies Courses, by Country of Domicile

Domestic

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	2551	2620	2838	3001	2999	2935	2917	2852	2866	2982
Research masters	937	968	914	934	857	797	732	622	697	769
Coursework masters	1773	2056	2250	2295	2268	2313	2536	2764	3164	3630
Other postgraduate	1836	1840	2016	2006	2072	2122	2008	2122	2085	2153
Bachelors	38830	38711	38444	37821	37111	37622	39058	40693	42726	44656
Assoc degrees & advanced diplomas	663	672	638	653	704	880	1202	1681	2095	2740
Diplomas	46	91	71	57	70	77	209	228	325	417
Other undergraduate	281	641	639	560	486	552	562	281	346	554
Total	46917	47599	47810	47327	46567	47298	49224	51243	54304	57901

Overseas

Doctoral	694	754	861	984	1111	1264	1423	1707	2188	2585
Research masters	235	260	281	360	401	428	446	420	423	476
Coursework masters	2026	2650	4334	4809	4912	4344	4433	4926	5466	5636
Other postgraduate	321	383	252	240	380	422	391	412	471	463
Bachelors	8067	9497	10964	11638	11744	12056	12791	13863	15116	16862
Assoc degrees & advanced diplomas	31	45	34	46	56	75	185	240	324	310
Diplomas	1	54	63	71	133	206	693	637	738	1047
Other undergraduate	6	13	71	52	60	84	56	68	61	68
Total	11381	13656	16860	18200	18797	18879	20418	22273	24787	27447

All students enrolled

Doctoral	3245	3374	3699	3985	4110	4199	4340	4559	5054	5567
Research masters	1172	1228	1195	1294	1258	1225	1178	1042	1120	1245
Coursework masters	3799	4706	6584	7104	7180	6657	6969	7690	8630	9266
Other postgraduate	2157	2223	2268	2246	2452	2544	2399	2534	2556	2616
Bachelors	46897	48208	49408	49459	48855	49678	51849	54556	57842	61518
Assoc degrees & advanced diplomas	694	717	672	699	760	955	1387	1921	2419	3050
Diplomas	47	145	134	128	203	283	902	865	1063	1464
Other undergraduate	287	654	710	612	546	636	618	349	407	622
Total	58298	61255	64670	65527	65364	66177	69642	73516	79091	85348

Source: Data provided by DEEWR

Table 5.11: Students Enrolled in Engineering & Related Technologies Courses, by Gender

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	2549	2675	2943	3156	3265	3315	3400	3496	3831	4174
Research masters	975	1023	973	1053	993	973	924	800	858	955
Coursework masters	3106	3906	5548	5956	5989	5546	5819	6324	7158	7618
Other postgraduate	1787	1826	1901	1870	2044	2076	1966	2061	2095	2120
Bachelors	39607	40687	41814	42018	41677	42484	44266	46533	49323	52352
Assoc degrees & advanced diplomas	657	661	624	667	706	872	1250	1734	2208	2749
Diplomas	47	123	100	96	151	167	717	723	933	1301
Other undergraduate	249	592	632	568	462	522	485	226	256	378
Total	48977	51493	54535	55384	55287	55955	58827	61897	66662	71647

Women

Doctoral	696	699	756	829	845	884	940	1063	1223	1393
Research masters	197	205	222	241	265	252	254	242	262	290
Coursework masters	693	800	1036	1148	1191	1111	1150	1366	1472	1648
Other postgraduate	370	397	367	376	408	468	433	473	461	496
Bachelors	7290	7521	7594	7441	7178	7194	7583	8023	8519	9166
Assoc degrees & advanced diplomas	37	56	48	32	54	83	137	187	211	301
Diplomas	0	22	34	32	52	116	185	142	130	163
Other undergraduate	38	62	78	44	84	114	133	123	151	244
Total	9321	9762	10135	10143	10077	10222	10815	11619	12429	13701

All enrolled students

Doctoral	3245	3374	3699	3985	4110	4199	4340	4559	5054	5567
Research masters	1172	1228	1195	1294	1258	1225	1178	1042	1120	1245
Coursework masters	3799	4706	6584	7104	7180	6657	6969	7690	8630	9266
Other postgraduate	2157	2223	2268	2246	2452	2544	2399	2534	2556	2616
Bachelors	46897	48208	49408	49459	48855	49678	51849	54556	57842	61518
Assoc degrees & advanced diplomas	694	717	672	699	760	955	1387	1921	2419	3050
Diplomas	47	145	134	128	203	283	902	865	1063	1464
Other undergraduate	287	654	710	612	546	636	618	349	407	622
Total	58298	61255	64670	65527	65364	66177	69642	73516	79091	85348

Source: Data provided by DEEWR

5.4 Completions

This section looks at completions of engineering courses. Tables 5.12 to 5.15 are the completions counterparts to the commencements and enrolments Tables considered above.

Domestic engineering completions increased from 7,856 in 2001 to 8,935 in 2010, an increase of 1,079 or 13.7%. In 2001, three-quarters of domestic completions were bachelors degrees. However, as Table 5.12 shows, these completions were stable through most of the decade and increased only in 2010. The decade increase was just 176 completions or 2.9%. By 2010, completions of bachelors degrees had fallen to 69.8%.

Most of the growth in domestic completions was in postgraduate qualifications. Doctoral degree completions increased from 324 to 474; completions of research masters degrees fell; completions of coursework masters degrees increased from 636 to 1,024 and completions of sub-masters postgraduate courses increased from 409 to 672. There was also some growth in completions of sub-degree courses. The proportion of completions by women fell slightly from 16.5% to 15.9% in 2010.

Engineering completions by overseas students more than doubled, increasing from 2,857 to 6,655 in 2010. Significant increases occurred in most course levels, the main exception was research masters degrees where a small increase was registered in line with the loss of popularity of these courses generally. Doctoral degree completions increased by 220 to 318; coursework masters degree completions grew by 1,744 to 2,660 in 2010; bachelors degree completions increased by 1,254 to 2,912 in 2010 and completions of diploma level courses grew from almost nothing to 389 in 2010.

Overall completions of engineering courses increased by 4,877 from 10,713 in 2001 to 15,590 in 2010, an increase of 45.5%. Completions by overseas students accounted for 77.9% of this growth and completions by domestic student for just 22.1%. Postgraduate completions more than doubled growing from 2,697 to 5,623, bachelors degree completions

Table 5.12: Domestic Students Completing Courses in Engineering & Related Technologies

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	261	317	333	335	357	390	410	389	380	370
Research masters	119	114	120	125	102	105	100	102	81	76
Coursework masters	529	511	551	538	521	487	548	564	649	834
Other postgraduate	344	279	337	327	298	350	347	413	485	526
Bachelors	5034	4753	4847	5005	4732	5062	4931	5184	5161	5320
Assoc degrees & advanced diplomas	135	122	90	92	87	83	121	155	254	285
Diplomas	27	54	51	23	47	35	62	51	55	100
Other undergraduate	108	279	206	443	168	218	156	0	0	0
Total	6557	6429	6535	6888	6312	6730	6675	6858	7065	7511

Women

Doctoral	63	65	89	88	96	98	111	124	102	104
Research masters	28	33	28	25	31	34	35	25	18	23
Coursework masters	107	113	112	107	114	89	138	126	139	190
Other postgraduate	65	55	74	82	65	77	100	109	112	146
Bachelors	1027	968	984	975	948	964	855	893	902	917
Assoc degrees & advanced diplomas	5	<10	14	9	7	<10	12	20	24	35
Diplomas	0	<10	1	0	0	<10	11	9	5	9
Other undergraduate	4	13	6	1	5	3	4	0	0	0
Total	1299	1257	1308	1287	1266	1271	1266	1306	1302	1424

All domestic completions

Doctoral	324	382	422	423	453	488	521	513	482	474
Research masters	147	147	148	150	133	139	135	127	99	99
Coursework masters	636	624	663	645	635	576	686	690	788	1024
Other postgraduate	409	334	411	409	363	427	447	522	597	672
Bachelors	6061	5721	5831	5980	5680	6026	5786	6077	6063	6237
Assoc degrees & advanced diplomas	140	122	104	101	94	83	133	175	278	320
Diplomas	27	54	52	23	47	35	73	60	60	109
Other undergraduate	112	292	212	444	173	221	160	0	0	0
Total	7856	7686	7843	8175	7578	8001	7941	8164	8367	8935

Source: Data provided by DEEWR

Table 5.13: Overseas Students Completing Courses in Engineering & Related Technologies

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	78	84	86	127	154	173	207	152	181	255
Research masters	45	36	35	59	59	104	75	76	64	65
Coursework masters	718	870	1441	1610	1909	1539	1607	1785	1906	2162
Other postgraduate	93	128	121	103	156	207	181	194	200	235
Bachelors	1373	1424	1618	1794	1958	1904	1836	2036	2115	2375
Assoc degrees & advanced diplomas	16	19	12	12	21	10	24	67	87	85
Diplomas	1	17	13	21	21	42	188	239	204	263
Other undergraduate	1	4	41	10	13	28	8	11	15	0
Total	2325	2582	3367	3736	4291	4007	4126	4560	4772	5440

Women

Doctoral	19	15	23	24	31	35	46	32	45	63
Research masters	15	5	11	14	16	22	20	25	22	32
Coursework masters	198	201	275	332	390	291	293	403	440	498
Other postgraduate	15	22	24	16	37	31	31	47	41	44
Bachelors	285	324	379	426	438	439	454	548	474	537
Assoc degrees & advanced diplomas	0	0	0	2	0	0	1	4	4	9
Diplomas	0	0	10	23	7	43	80	77	32	32
Other undergraduate	0	1	11	2	5	5	2	5	3	0
Total	532	568	733	839	924	866	927	1141	1061	1215

All overseas completions

Doctoral	97	99	109	151	185	208	253	184	226	318
Research masters	60	41	46	73	75	126	95	101	86	97
Coursework masters	916	1071	1716	1942	2299	1830	1900	2188	2346	2660
Other postgraduate	108	150	145	119	193	238	212	241	241	279
Bachelors	1658	1748	1997	2220	2396	2343	2290	2584	2589	2912
Assoc degrees & advanced diplomas	16	19	12	14	21	10	25	71	91	94
Diplomas	1	17	23	44	28	85	268	316	236	295
Other undergraduate	1	5	52	12	18	33	10	16	18	0
Total	2857	3150	4100	4575	5215	4873	5053	5701	5833	6655

Source: Data provided by DEEWR

Table 5.14: Students Completing Courses in Engineering & Related Technologies, by Country of Domicile

Domestic

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	324	382	422	423	453	488	521	513	482	474
Research masters	147	147	148	150	133	139	135	127	99	99
Coursework masters	636	624	663	645	635	576	686	690	788	1024
Other postgraduate	409	334	411	409	363	427	447	522	597	672
Bachelors	6061	5721	5831	5980	5680	6026	5786	6077	6063	6237
Assoc degrees & advanced diplomas	140	122	104	101	94	83	133	175	278	320
Diplomas	27	54	52	23	47	35	73	60	60	109
Other undergraduate	112	292	212	444	173	221	160	0	0	0
Total	7856	7686	7843	8175	7578	8001	7941	8164	8367	8935

Overseas

Doctoral	97	99	109	151	185	208	253	184	226	318
Research masters	60	41	46	73	75	126	95	101	86	97
Coursework masters	916	1071	1716	1942	2299	1830	1900	2188	2346	2660
Other postgraduate	108	150	145	119	193	238	212	241	241	279
Bachelors	1658	1748	1997	2220	2396	2343	2290	2584	2589	2912
Assoc degrees & advanced diplomas	16	19	12	14	21	10	25	71	91	94
Diplomas	1	17	23	44	28	85	268	316	236	295
Other undergraduate	1	5	52	12	18	33	10	16	18	0
Total	2857	3150	4100	4575	5215	4873	5053	5701	5833	6655

All student completions

Doctoral	421	481	531	574	638	696	774	697	708	792
Research masters	207	188	194	223	208	265	230	228	185	196
Coursework masters	1552	1695	2379	2587	2934	2406	2586	2878	3134	3684
Other postgraduate	517	484	556	528	556	665	659	763	838	951
Bachelors	7719	7469	7828	8200	8076	8369	8076	8661	8652	9149
Assoc degrees & advanced diplomas	156	141	116	115	115	93	158	246	369	414
Diplomas	28	71	75	67	75	120	341	376	296	404
Other undergraduate	113	297	264	456	191	254	170	16	18	0
Total	10713	10836	11943	12750	12793	12874	12994	13865	14200	15590

Source: Data provided by DEEWR

Table 5.15: Students Completing Courses in Engineering & Related Technologies, by Gender

Men

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctoral	339	401	419	462	511	563	617	541	561	625
Research masters	164	150	155	184	161	209	175	178	145	141
Coursework masters	1247	1381	1992	2148	2430	2026	2155	2349	2555	2996
Other postgraduate	437	407	458	430	454	557	528	607	685	761
Bachelors	6407	6177	6465	6799	6690	6966	6767	7220	7276	7695
Assoc degrees & advanced diplomas	151	141	102	104	108	93	145	222	341	370
Diplomas	28	71	64	44	68	77	250	290	259	363
Other undergraduate	109	283	247	453	181	246	164	11	15	0
Total	8882	9011	9902	10624	10603	10737	10801	11418	11837	12951

Women

Doctoral	82	80	112	112	127	133	157	156	147	167
Research masters	43	38	39	39	47	56	55	50	40	55
Coursework masters	305	314	387	439	504	380	431	529	579	688
Other postgraduate	80	77	98	98	102	108	131	156	153	190
Bachelors	1312	1292	1363	1401	1386	1403	1309	1441	1376	1454
Assoc degrees & advanced diplomas	5	0	14	11	7	0	13	24	28	44
Diplomas	0	0	11	23	7	43	91	86	37	41
Other undergraduate	4	14	17	3	10	8	6	5	3	0
Total	1831	1825	2041	2126	2190	2137	2193	2447	2363	2639

All overseas completions

Doctoral	421	481	531	574	638	696	774	697	708	792
Research masters	207	188	194	223	208	265	230	228	185	196
Coursework masters	1552	1695	2379	2587	2934	2406	2586	2878	3134	3684
Other postgraduate	517	484	556	528	556	665	659	763	838	951
Bachelors	7719	7469	7828	8200	8076	8369	8076	8661	8652	9149
Assoc degrees & advanced diplomas	156	141	116	115	115	93	158	246	369	414
Diplomas	28	71	75	67	75	120	341	376	296	404
Other undergraduate	113	297	264	456	191	254	170	16	18	0
Total	10713	10836	11943	12750	12793	12874	12994	13865	14200	15590

Source: Data provided by DEEWR

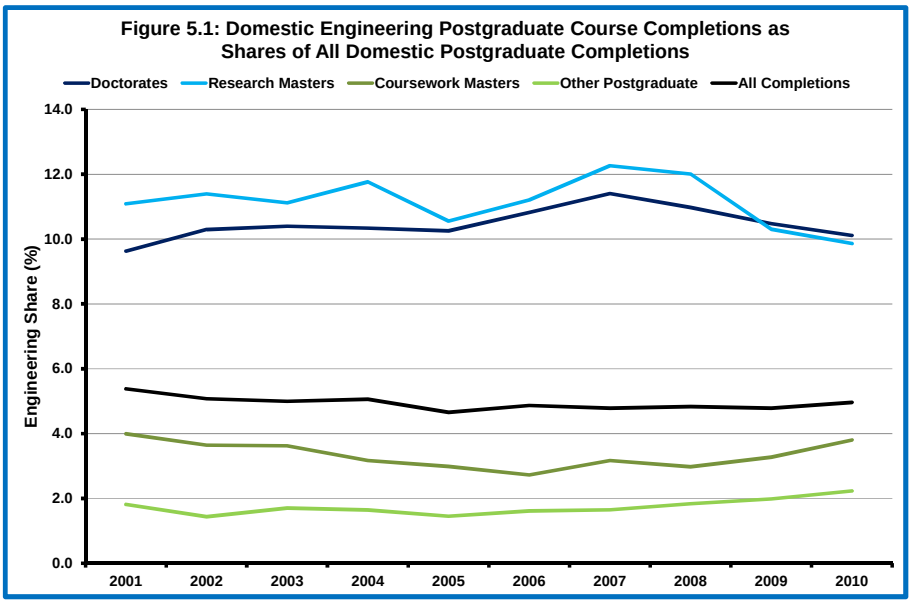
increased from 7,719 to 9,149, nearly all from overseas student and diploma level completions grew from 184 to 818 in 2010. Completion of engineering courses continues to be low, particularly in the domestic component.

5.5 Comparing Engineering Completions to Other Disciplines

This section looks at the relative importance of engineering course completions compared to course completions in all subjects. The engineering share of domestic completions was 5.4% in 2001 and fluctuated in a narrow band to be 5.0% in 2010. For overseas completions, engineering's share was 6.9% in 2001 and increased to a peak of 7.5% in 2005 before decreasing to 6.2% in 2010. The trends in these shares are used as benchmarks in the comparisons that follow.

Figures 5.1 and 5.2 compare domestic and overseas engineering completions shares during the last decade. Figure 5.1 shows that the engineering domestic shares of doctorate and research masters completions track well above engineering's share of all domestic completions. In contrast, the engineering domestic shares of coursework master and other postgraduate completions track below engineering's share of all domestic completions. Figure 5.2 shows that completions of doctorates and research masters degrees are even more important for overseas completions. Completions of coursework masters degrees closely track the benchmark putting these apparent large numbers into perspective.

Figure 5.3 and 5.4 show similar comparisons for engineering's shares of domestic and overseas and entry level completions respectively. Once again the benchmarks for comparison are engineering's shares of all domestic and all overseas completions. In both cases the trends in completions of bachelors degrees determine the movements in engineering's shares. There has been some change in the relative importance of associate degrees and diploma qualifications. In the case of overseas completions, relatively high shares collapsed mid-decade. There was a recovery in the share for associate degrees and advanced diplomas but not for other diplomas. In the case of domestic completions, the trend for associate degrees and advanced diplomas was similar to the corresponding trend for overseas completions. However, the share of domestic diploma qualifications has continued to increase from a low base.



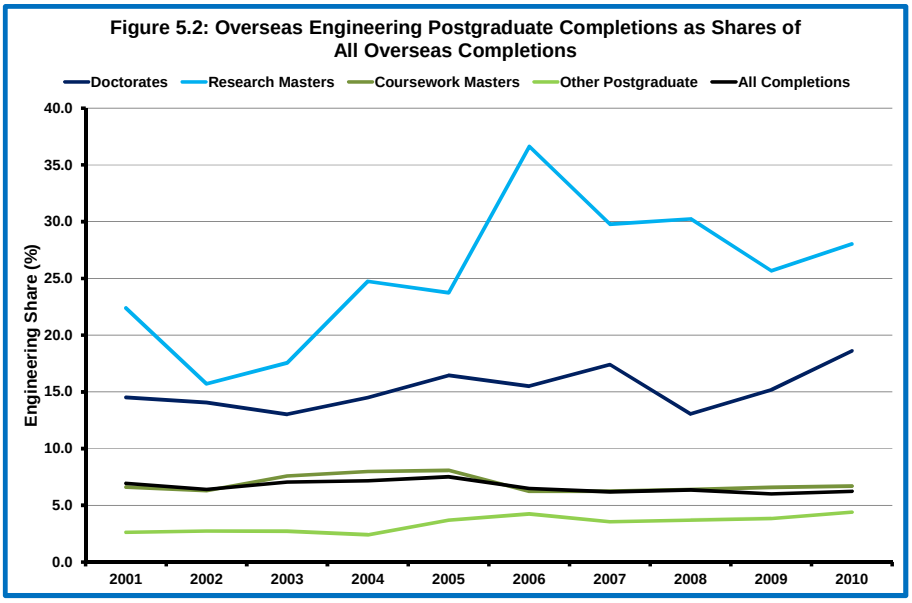


Figure 5.2: Overseas Engineering Postgraduate Completions as Shares of All Overseas Completions
Doctorates
Research Masters
Coursework Masters
Other Postgraduate
All Completions
Engineering Share (%)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

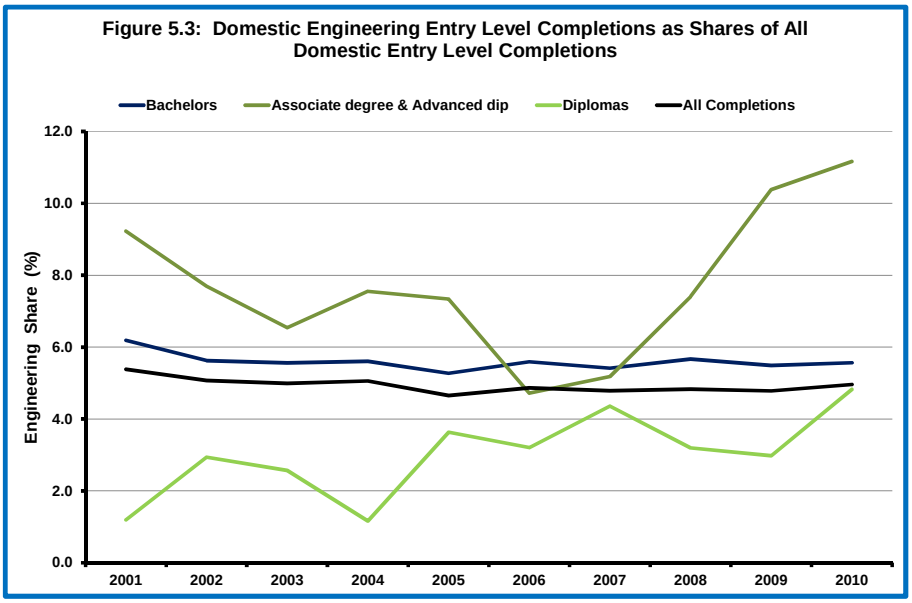


Figure 5.3: Domestic Engineering Entry Level Completions as Shares of All Domestic Entry Level Completions
Bachelors
Associate degree & Advanced dip
Diplomas
All Completions
Engineering Share (%)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

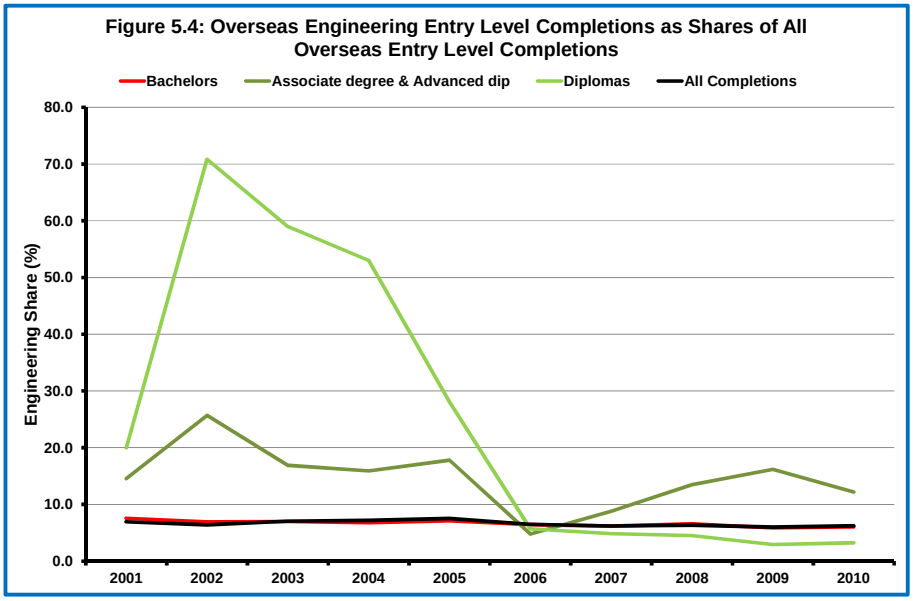


Figure 5.4: Overseas Engineering Entry Level Completions as Shares of All Overseas Entry Level Completions
Bachelors
Associate degree & Advanced dip
Diplomas
All Completions
Engineering Share (%)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

6. INCREASING THE SUPPLY OF ENGINEERS THROUGH EDUCATION

Key Messages

This Chapter considers completions of entry level qualifications in greater detail and brings together university and TAFE college completions to estimate the annual flows of newly qualified engineers into the engineering work force.

The flow of new engineering technologists fell by 12.3% to 487 in 2010. Over 70% of completions were in three fields; aerospace, electrical and electronic and "other" engineering.

Although the flow of new professional engineers with four year bachelor degrees marked time in 2009 and 2010, completions in these two years were about 5% higher than the decade average. In 2010, there were 4,218 new professional engineers.

Some new professional engineers complete four year double bachelor degrees. The flow of these completions increased by 30.9% to 1,706 in 2010. This was well above the decade average of about 1,400.

Overall, the flow of new professional engineers increased by 7.6% to 5,924 in 2010.

Gauging the fields of specialisation for new professional engineers is complicated by the high proportion of completions in the "other" and "not further defined categories". In 2010, this was 35.5% of completions. Of the remainder, 12.6% were process and resource engineers, 13.5% were mechanical and industrial engineers, 17.5% were civil engineers, 13.4% were electrical and electronic engineers and 4.3% were aerospace engineers. All completions trended downwards until about 2005. Since then civil engineering has experienced the highest growth. In contrast, completions by electrical and electronic engineers have halved.

The flow of new associate engineers is from universities and TAFE colleges. University completions increased by 15.1% to 320 in 2010. An estimate for TAFE suggests an increase of about 10% to 1,417. In aggregate the flow of new associate engineers increased by 11.3% to 1,737 in 2010. The fields of specialisations in this flow reflected State emphases rather than the spread of specialisations familiar in engineering. The main fields were manufacturing engineers and electrical and electronic engineers.

Since the latest available statistics are for 2010, simple extrapolation techniques were used to estimate the flow in 2011. This showed that the flow of associate engineers may have increased by 3.5% to 1,797; the flow of engineering technologists was likely stable at its decade average of about 600 and the flow of professional engineers was also stable at present level. Overall, the annual flow into engineering team may increase from 8,148 in 2010 to about 8,321 in 2011.

6.1 Fields of Engineering Included in Statistics

This chapter considers annual completions of entry level engineering courses in more detail. The objective is to highlight the annual additions to the supply of engineers in Australia from domestic sources, that is, from among citizens and permanent residents. Additions to the supply of engineers from skilled migration, that is, non-citizens who are temporary residents of Australia or who reside in another country, are considered in Chapter 7.

The statistics covered in this Chapter are constrained by ABS education statistics protocols and the level of disaggregation that allows meaningful trends over time to be compiled. Some of the nomenclature used is not immediately obvious even to those familiar with most common fields of engineering. The list that follows shows the fields of engineering included in the headings used in the Tables.

- 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
    - 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

6.2 Engineering Technologists

The qualification required to become an engineering technologist is the completion of an accredited three year full time (or part time equivalent) bachelors degree in engineering. Chapter 5 showed that commencements in these programs were small relative to other courses and have fallen over time. This pattern is reflected in domestic completions of three year engineering degrees as shown in Table 6.1.

The statistics in Table 6.1 include corrections to previous editions of the Statistical Overview to include elements previously overlooked and to correct some transcription errors. The changes are minor and do not change substantive conclusions about the number of completions and the trend in completions.

In 2010, there were 487 completions of three year degrees in engineering by domestic students, 368 men and 119 women. In 2001, there were 629 completions and these increased to 847 in 2006 but this increasing trend was not sustained and completions have generally fallen since then. An interesting aspect of these changes is that the women's share of completions has risen and in 2010 was 24.4%.

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
0300	Engineering & Related Technologies	66	59	64	62	63	59	45	54	42	20
0301	Manufacturing Engineering & Technology	18	14	3	3	5	4	5	0	1	<10
0303	Process & Resource Engineering	43	27	32	18	19	54	19	23	23	18
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	1	9	<10
0307	Mechanical & Industrial Engineering & Technology	34	49	30	21	22	35	9	13	4	<10
0309	Civil Engineering	14	13	7	19	23	39	13	18	12	<10
0311	Geomatic Engineering	42	65	75	48	23	22	17	18	26	18
0313	Electrical & Electronic Engineering & Technology	124	106	102	110	159	203	130	112	73	69
0315	Aerospace Engineering & Technology	79	102	111	109	147	175	140	171	130	129
0317	Martime Engineering & Technology	2	3	4	2	6	0	2	1	4	<10
0399	Other Engineering & Technology	109	102	96	96	94	100	110	91	115	89
	Total	531	540	524	488	561	691	490	502	439	368

Women

0300	Engineering & Related Technologies	18	4	12	7	15	3	7	1	4	<10
0301	Manufacturing Engineering & Technology	2	3	5	4	13	10	8	23	29	44
0303	Process & Resource Engineering	18	20	14	10	<10	31	12	20	10	<10
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	1	0
0307	Mechanical & Industrial Engineering & Technology	3	3	2	1	2	2	1	1	0	0
0309	Civil Engineering	0	2	4	0	4	12	0	<10	0	0
0311	Geomatic Engineering	10	24	16	17	12	14	9	12	11	<10
0313	Electrical & Electronic Engineering & Technology	12	9	6	18	52	41	34	24	29	21
0315	Aerospace Engineering & Technology	14	22	19	23	28	29	31	39	25	25
0317	Maritime Engineering & Technology	1	1	0	0	1	0	0	0	0	0
0399	Other Engineering & Technology	20	13	10	8	7	14	5	9	7	11
	Total	98	101	88	88	139	156	109	130	116	119

All domestic graduations

0300	Engineering & Related Technologies	84	63	76	69	78	62	52	55	46	20
0301	Manufacturing Engineering & Technology	20	17	8	7	18	14	13	23	30	44
0303	Process & Resource Engineering	61	47	46	28	19	85	31	43	33	18
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	1	10	0
0307	Mechanical & Industrial Engineering & Technology	37	52	32	22	24	37	10	14	4	0
0309	Civil Engineering	14	15	11	19	27	51	13	18	12	0
0311	Geomatic Engineering	52	89	91	65	35	36	26	30	37	18
0313	Electrical & Electronic Engineering & Technology	136	115	108	128	211	244	164	136	102	90
0315	Aerospace Engineering & Technology	93	124	130	132	175	204	171	210	155	154
0317	Maritime Engineering & Technology	3	4	4	2	7	0	2	1	4	0
0399	Other Engineering & Technology	129	115	106	104	101	114	115	100	122	100
	Total	629	641	612	576	700	847	599	632	555	487

Source: Data supplied by DEEWR

Only a few fields of engineering account for most completions. The largest being aeronautical engineering with 154 completions in 2010. In line with the falling trend in commencements, completions in electrical and electronic engineering have fallen and were down to 90 in 2010. Although there were 100 completions in “other engineering and related technologies” these were spread across biomedical engineering, environmental engineering as well as the other category. Falling trends in mechanical and industrial engineering, civil engineering and maritime engineering meant there were no completions in these fields. There were a significant fall in completions in process and resource engineering and in the general field but completions in manufacturing engineering held steady albeit at a low level.

Professional Engineers

The qualification necessary for a professional engineer is completion of a four year full time (or equivalent part time) bachelors degree in engineering. Some students complete this qualification as a stand-alone degree and statistics on these completions are shown in Table 6.2[12]. Other students complete four year degrees in engineering in combination with a second degree in another subject area. Statistics on double degree completions are shown in Table 6.3.

[12] Table 6.2 includes 248 completions (204 men and 44 women) in 2005 from courses of unknown duration. This situation resulted from coding abnormalities by some universities. Inspection of past completions and completions since 2005 for those universities suggest that the unknown durations were most likely four year courses and they have been treated as such.

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
0300	Engineering & Related Technologies	98	134	90	59	215	246	286	273	356	322
0301	Manufacturing Engineering & Technology	13	10	16	23	19	17	21	12	8	<10
0303	Process & Resource Engineering	410	332	285	319	281	271	346	378	413	447
0305	Automotive Engineering & Technology	0	0	0	3	19	20	22	22	28	28
0307	Mechanical & Industrial Engineering & Technology	503	556	528	553	475	527	574	610	560	573
0309	Civil Engineering	585	574	554	502	488	448	573	706	712	752
0311	Geomatic Engineering	118	113	94	117	113	120	128	121	106	93
0313	Electrical & Electronic Engineering & Technology	1007	992	1136	1111	1062	796	811	703	621	553
0315	Aerospace Engineering & Technology	124	118	117	151	169	130	165	190	158	173
0317	Martime Engineering & Technology	11	12	2	23	11	23	13	16	14	10
0399	Other Engineering & Technology	540	472	450	441	458	581	478	617	677	722
	Total	3409	3313	3272	3302	3310	3179	3417	3648	3653	3674

Women

0300	Engineering & Related Technologies	9	26	23	11	46	34	41	36	44	55
0301	Manufacturing Engineering & Technology	5	3	5	2	2	3	5	0	0	<10
0303	Process & Resource Engineering	135	137	128	126	99	98	106	110	116	120
0305	Automotive Engineering & Technology	0	0	0	0	0	2	<10	0	1	<10
0307	Mechanical & Industrial Engineering & Technology	56	57	66	58	44	32	43	51	55	48
0309	Civil Engineering	140	122	90	98	89	81	88	102	120	94
0311	Geomatic Engineering	22	20	15	29	18	23	13	22	18	12
0313	Electrical & Electronic Engineering & Technology	140	143	181	180	150	101	79	53	48	49
0315	Aerospace Engineering & Technology	19	24	23	20	30	16	18	24	15	21
0317	Maritime Engineering & Technology	0	0	0	1	0	1	0	2	0	<10
0399	Other Engineering & Technology	169	124	132	111	126	137	112	123	135	141
	Total	691	656	663	636	604	528	506	523	552	544

All domestic graduations

0300	Engineering & Related Technologies	107	160	113	70	261	280	327	309	400	377
0301	Manufacturing Engineering & Technology	18	13	21	25	21	20	26	12	8	0
0303	Process & Resource Engineering	545	469	413	445	380	369	452	488	529	567
0305	Automotive Engineering & Technology	0	0	0	3	19	22	22	22	29	28
0307	Mechanical & Industrial Engineering & Technology	559	613	594	611	519	559	617	661	615	621
0309	Civil Engineering	725	696	644	600	577	529	661	808	832	846
0311	Geomatic Engineering	140	133	109	146	131	143	141	143	124	105
0313	Electrical & Electronic Engineering & Technology	1147	1135	1317	1291	1212	897	890	756	669	602
0315	Aerospace Engineering & Technology	143	142	140	171	199	146	183	214	173	194
0317	Maritime Engineering & Technology	11	12	2	24	11	24	13	18	14	10
0399	Other Engineering & Technology	709	596	582	552	584	718	590	740	812	863
	Total	4100	3969	3935	3938	3914	3707	3923	4171	4205	4218

Source: Data supplied by DEEWR

Both Tables 6.2 and 6.3 include corrections and updates as a result of the audit undertaken for this edition of the Statistical Overview.

In 2010, there were 4,218 completions of four year bachelors degrees in engineering, a small (13) increase on the previous year and just 118 more than in 2001. The key changes were the fall in completions from 2001 to 2006 and the subsequent increase to present levels. Since 2006, completions have increased by 511 or 13.8%. In 2001, the women's share of completions was 16.9% but by 2010 it had fallen to 12.9% as women completions fell but overall completions increased.

All fields of engineering experienced the mid-decade decline in completions. Some notable changes include:

- Electrical and electronic engineering had 1,147 completions in 2001 and these increased to 1,212 in 2005 but have since collapsed to 602 in 2010.
- Civil engineering had 725 completions in 2001, falling to 529 in 2006, before increasing strongly to 846 in 2010.
- Process and resource engineering had similar completion numbers at the beginning (559) and end (567) of the decade but were as low as 369 in 2006.
- Mechanical and industrial engineering completions were 559 in 2001 and experienced a lesser fall than other fields to 519 in 2005 before showing moderate growth to 621 in 2010.
- Completions in manufacturing engineering fell to zero in 2010.
- Completions in aerospace engineering showed slow growth in the latter part of the decade and were 194 in 2010.
- From 2004, small and increasing numbers of automotive engineering completions emerged with 28 in 2010.
- There was a steady but small flow of completions in maritime engineering with 10 in 2010.

- Completions in other engineering and related technologies which include biomedical engineering, environmental engineering, naval architecture as well as “other” engineering have grown over the decade and were 863 or 20.5% of completions in 2010.

Completions also increased in the 0300 category best seen as general engineering and were 377 in 2010.There was considerable variation across engineering fields in the women’s shares of completions. In 2010, the highest share was in process and resource engineering where 21.2% of completions were women. The next two highest shares were in other engineering (16.3%) and the general category (14.6%). The women’s share of civil engineering completions was 11.1% and 10.8% in aeronautical engineering. Much lower shares were recorded electrical and electronic engineering (8.1%) and mechanical and industrial engineering (7.7%).

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

Men

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0300	Engineering & Related Technologies	136	162	261	320	481	372	375	405	406	505
0301	Manufacturing Engineering & Technology	27	28	28	40	2	0	13	11	22	52
0303	Process & Resource Engineering	63	129	120	151	83	132	124	136	130	143
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	207	126	125	115	64	76	89	98	100	155
0309	Civil Engineering	135	75	126	102	86	66	74	104	86	152
0311	Geomatic Engineering	22	<10	<10	12	<10	<10	<10	<10	<10	14
0313	Electrical & Electronic Engineering & Technology	388	252	271	337	320	325	298	212	132	173
0315	Aerospace Engineering & Technology	26	14	2	30	36	36	37	54	48	62
0317	Martime Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0399	Other Engineering & Technology	141	146	140	172	161	221	199	215	195	215
	Total	1100	900	1051	1215	1195	1192	1165	1179	1069	1433

Women

0300	Engineering & Related Technologies	30	28	51	49	117	79	73	74	74	89
0301	Manufacturing Engineering & Technology	2	4	3	4	0	0	1	0	4	<10
0303	Process & Resource Engineering	24	55	28	55	33	64	69	57	33	36
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	37	21	19	22	13	15	19	14	26	25
0309	Civil Engineering	30	23	30	22	27	22	28	22	23	38
0311	Geomatic Engineering	<10	0	0	<10	<10	0	0	0	0	<10
0313	Electrical & Electronic Engineering & Technology	56	43	56	61	45	40	24	26	25	17
0315	Aerospace Engineering & Technology	<10	<10	<10	<10	<10	<10	<10	14	13	<10
0317	Maritime Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0399	Other Engineering & Technology	62	45	66	59	52	70	67	75	46	57
	Total	238	211	233	251	275	280	274	270	234	273

All domestic graduations

0300	Engineering & Related Technologies	166	190	312	369	598	451	448	479	480	594
0301	Manufacturing Engineering & Technology	29	32	31	44	2	0	14	11	26	52
0303	Process & Resource Engineering	87	184	148	206	116	196	193	193	163	179
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	244	147	144	137	77	91	108	112	126	180
0309	Civil Engineering	165	98	156	124	113	88	102	126	109	190
0311	Geomatic Engineering	22	0	0	12	0	0	0	0	0	14
0313	Electrical & Electronic Engineering & Technology	444	295	327	398	365	365	322	238	157	190
0315	Aerospace Engineering & Technology	26	14	2	30	36	36	37	68	61	62
0317	Maritime Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0399	Other Engineering & Technology	203	191	206	231	213	291	266	290	241	272
	Total	1338	1111	1284	1466	1470	1472	1439	1449	1303	1706

Source: Data supplied by DEEWR

In 2001, there were 1,338 completions of double degrees including four year degrees in engineering. The mid-decade slump that occurred for four year completions was not evident and there was a comparatively stable pattern with completions varying between 1,350 and 1,450 until a sharp increase to 1,706 occurred in 2010. At the beginning of the decade, the women’s share was 17.8%, much higher than for the other courses covered above, but by 2010 it had fallen to 16.0% as the increase in completions that year was primarily by men.

The difficulties that the two general/other categories pose are particularly acute when trying to understand the trends in double degree completions. Completions grew in the general category (0300) from 166 to 594 in 2010 and there was slower growth from 203 to 272 in the other (0399) category. By 2010, over half of double degree completions were in these categories. In the other fields, changes include:

- There was a fairly steady stream of completions in process and resource engineering with 179 in 2010.

- Mechanical and industrial engineering completions suffered a severe mid-decade slump falling from 244 in 2001 to 77 in 2005 before increasing to 180 in 2010.
- A similar pattern occurred in civil engineering where there were 165 completions in 2001, falling to 88 in 2005 before increasing to 190 in 2010.
- As was the case in other courses, completions of double degrees in electrical and electronic engineering collapsed from 444 in 2001 to 190 in 2010.
- There was a low but steady stream of completions in aeronautical engineering increasing over the past three years to be 62 in 2010.
- Completions in manufacturing engineering collapsed to zero in 2006 before resurgence led to 52 completions in 2010.

6.3 Associate Engineers

Associate engineers require either a two year full time Associate degree in engineering or a two year full time advanced diploma in engineering. Courses leading to these qualifications are offered by Australian universities and by Australian TAFE colleges. Table 6.4 shows the completions for these courses from Australian universities and Table 6.5 shows the completions from these courses from Australian TAFE colleges.

In past editions of the Statistical Overview, the statistics presented combined all Associate degree and diploma courses in engineering. These statistics are separated in this Edition to focus more clearly on the annual increase in the supply of new associate engineers. To facilitate reconciliation between the statistics in this Edition and past Editions, Table 6.6 provides statistics for the completion of other diplomas in engineering from Australian TAFE colleges.

Compared to completions of degrees in engineering from Australian universities, there are comparatively few completions of associate degrees and advanced diplomas in engineering but there has been strong growth in recent years. In 2001, there were about 135, with fewer than ten women graduates. Completions fell to a low of 83 in 2006, suggesting these courses were being phased out; however, instead completion numbers have grown to 320 in 2010.

The majority of these university completions were in the general/other engineering categories with small numbers of completions scattered across many fields. Consistent numbers were available in only two other fields; maritime engineering where relatively stable completions varied around an average of 27 per year and electrical and electronic engineering where completion numbers fell over the decade with 16 in 2010.

Statistics on completions of Associate degrees and advanced diplomas from Australian TAFE colleges are available to 2009. In 2001, there were 1,137 completions in associate degrees and advanced diplomas in engineering. The next six years saw completions annual grow by 541 to a peak of 1,678 in 2008. The following year saw completions fall by 395 or 23.5% to 1,283. In general, the women's share of these completions was low; in 2001, it was 6.7%, at the height of completions in 2008, it was 6.9% but in 2010 it rose to 9.7% with completions by women holding up and all of the fall recorded for men.

The pattern of completions by field was somewhat different to degree completions and with substantial differences between States. In NSW the dominant fields were mechanical engineering and electrical and electronic engineering; in Victoria they were manufacturing engineering and electrical and electronic engineering; in Queensland, they were electrical and electronic engineering and other engineering; in SA, it was mechanical engineering, in WA, completions were spread over mechanical, electrical and electronic and civil engineering. The patterns pointed to specialisation in fields important to States and where their resources lay.

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
0300	Engineering & Related Technologies	13	11	<10	13	14	<10	11	20	24	35
0301	Manufacturing Engineering & Technology	<10	<10	<10	0	0	0	0	0	0	0
0303	Process & Resource Engineering	0	0	0	13	0	0	0	0	<10	<10
0305	Automotive Engineering & Technology	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
0309	Civil Engineering	18	15	13	<10	12	<10	<10	<10	<10	11
0311	Geomatic Engineering	14	<10	15	<10	<10	<10	<10	<10	0	<10
0313	Electrical & Electronic Engineering & Technology	21	24	14	15	13	10	11	11	<10	16
0315	Aerospace Engineering & Technology	24	<10	<10	0	0	0	0	0	27	<10
0317	Martime Engineering & Technology	<10	16	22	26	32	31	28	24	32	33
0399	Other Engineering & Technology	22	11	<10	<10	<10	22	51	82	148	166
	Total	135	122	90	92	87	83	121	155	254	285

Women

0300	Engineering & Related Technologies	0	0	0	<10	0	0	<10	<10	0	<10
0301	Manufacturing Engineering & Technology	0	0	<10	0	0	0	0	0	0	0
0303	Process & Resource Engineering	0	0	0	0	0	0	0	0	<10	0
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	0	<10	0	<10	0	0	0	0	<10	0
0309	Civil Engineering	<10	<10	<10	<10	<10	<10	0	0	<10	0
0311	Geomatic Engineering	<10	<10	<10	<10	0	0	<10	0	0	0
0313	Electrical & Electronic Engineering & Technology	0	<10	<10	<10	<10	0	0	0	0	<10
0315	Aerospace Engineering & Technology	<10	<10	0	0	0	0	<10	0	<10	<10
0317	Maritime Engineering & Technology	<10	<10	<10	0	<10	<10	<10	<10	<10	<10
0399	Other Engineering & Technology	0	<10	<10	0	<10	<10	<10	16	16	27
	Total	<10	<10	14	<10	<10	<10	12	20	24	35

All domestic graduations

0300	Engineering & Related Technologies	13	11	0	13	14	0	11	20	24	35
0301	Manufacturing Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0303	Process & Resource Engineering	0	0	0	13	0	0	0	0	0	0
0305	Automotive Engineering & Technology	0	0	0	0	0	0	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	14	21	10	0	0	0	0	0	14	16
0309	Civil Engineering	18	15	13	0	12	0	0	0	0	11
0311	Geomatic Engineering	14	0	15	0	0	0	0	0	0	0
0313	Electrical & Electronic Engineering & Technology	21	24	14	15	13	10	11	11	0	16
0315	Aerospace Engineering & Technology	24	0	0	0	0	0	0	0	27	0
0317	Maritime Engineering & Technology	0	16	22	26	32	31	28	24	32	33
0399	Other Engineering & Technology	22	11	0	0	0	22	51	98	164	193
	Total	135	122	104	92	87	83	133	175	278	320

Source: Data supplied by DEEWR

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
0300	Engineering & Related Technologies	0	0	0	0	0	0	0	0
0301	Manufacturing Engineering & Technology	195	181	302	199	181	344	234	186
0303	Process & Resource Engineering	2	2	26	8	15	14	19	25
0305	Automotive Engineering & Technology	2	1	3	7	2	3	1	0
0307	Mechanical & Industrial Engineering & Technology	196	220	185	207	175	186	183	183
0309	Civil Engineering	25	42	61	79	122	153	178	118
0311	Geomatic Engineering	22	29	27	20	22	26	38	38
0313	Electrical & Electronic Engineering & Technology	461	642	573	692	576	555	804	542
0315	Aerospace Engineering & Technology	44	21	32	23	16	29	40	32
0317	Martime Engineering & Technology	31	66	16	18	29	39	41	24
0399	Other Engineering & Technology	83	56	32	53	137	89	24	11
	Total	1059	1260	1257	1306	1275	1438	1562	1159

Women

0300	Engineering & Related Technologies	0	0	0	0	0	0	0	0
0301	Manufacturing Engineering & Technology	40	45	47	60	68	93	76	73
0303	Process & Resource Engineering	0	1	1	0	2	1	0	1
0305	Automotive Engineering & Technology	0	0	0	1	0	0	0	0
0307	Mechanical & Industrial Engineering & Technology	4	7	8	8	10	6	3	1
0309	Civil Engineering	6	8	3	5	13	9	9	22
0311	Geomatic Engineering	1	1	0	3	1	1	2	6
0313	Electrical & Electronic Engineering & Technology	19	26	18	52	27	16	22	18
0315	Aerospace Engineering & Technology	1	3	1	1	0	4	3	2
0317	Maritime Engineering & Technology	0	12	0	1	0	2	0	0
0399	Other Engineering & Technology	7	4	0	1	5	3	1	1
	Total	78	107	78	132	126	135	116	124

All Completions

0300	Engineering & Related Technologies	0	0	0	0	0	0	0	0
0301	Manufacturing Engineering & Technology	235	226	349	259	249	437	310	259
0303	Process & Resource Engineering	2	3	27	8	17	15	19	26
0305	Automotive Engineering & Technology	2	1	3	8	2	3	1	0
0307	Mechanical & Industrial Engineering & Technology	200	227	193	215	185	192	186	184
0309	Civil Engineering	31	50	64	84	135	162	187	140
0311	Geomatic Engineering	23	30	27	23	23	27	40	44
0313	Electrical & Electronic Engineering & Technology	461	642	573	692	576	555	804	542
0315	Aerospace Engineering & Technology	45	24	33	24	16	33	43	34
0317	Maritime Engineering & Technology	31	78	16	19	29	41	41	24
0399	Other Engineering & Technology	90	60	32	54	142	92	25	12
	TOTAL	1137	1367	1335	1438	1401	1573	1678	1283

Source: NCVER, VOCSTATS Databases

Table 6.6: Completions of Diploma Qualifications in Engineering from Australian TAFE Colleges

ASCED	Specialisation	2002	2003	2004	2005	2006	2007	2008	2009
0300	Engineering & Related Technologies	0	0	0	0	0	0	0	0
0301	Manufacturing Engineering & Technology	175	186	180	238	183	163	199	172
0303	Process & Resource Engineering	34	78	85	103	63	76	121	156
0305	Automotive Engineering & Technology	6	17	11	48	26	29	35	56
0307	Mechanical & Industrial Engineering & Technology	397	368	330	334	222	232	311	302
0309	Civil Engineering	102	78	100	120	182	139	170	156
0311	Geomatic Engineering	90	44	32	53	38	76	100	110
0313	Electrical & Electronic Engineering & Technology	578	554	363	360	334	486	572	368
0315	Aerospace Engineering & Technology	34	46	42	56	45	31	33	39
0317	Martime Engineering & Technology	65	64	44	28	54	63	68	84
0399	Other Engineering & Technology	40	61	57	208	204	75	80	68
	Total	1521	1496	1244	1548	1351	1370	1689	1511
Women									
0300	Engineering & Related Technologies	0	0	0	0	0	0	0	0
0301	Manufacturing Engineering & Technology	188	228	242	323	335	324	316	305
0303	Process & Resource Engineering	16	20	40	51	12	12	27	16
0305	Automotive Engineering & Technology	0	0	1	1	1	2	2	0
0307	Mechanical & Industrial Engineering & Technology	23	21	20	12	9	10	13	19
0309	Civil Engineering	11	7	7	18	15	13	28	30
0311	Geomatic Engineering	16	7	10	16	12	10	7	26
0313	Electrical & Electronic Engineering & Technology	40	26	12	25	8	12	28	9
0315	Aerospace Engineering & Technology	6	12	11	5	8	3	5	1
0317	Maritime Engineering & Technology	11	3	5	5	2	0	1	5
0399	Other Engineering & Technology	1	0	4	15	13	10	15	12
	Total	312	324	352	470	415	396	442	423
All Completions									
0300	Engineering & Related Technologies	0	0	0	0	0	0	0	0
0301	Manufacturing Engineering & Technology	363	414	422	561	518	487	515	477
0303	Process & Resource Engineering	50	98	125	154	75	88	148	172
0305	Automotive Engineering & Technology	6	17	12	49	27	31	37	56
0307	Mechanical & Industrial Engineering & Technology	420	389	350	346	231	242	324	321
0309	Civil Engineering	113	85	107	138	197	152	198	186
0311	Geomatic Engineering	106	51	42	69	50	86	107	136
0313	Electrical & Electronic Engineering & Technology	618	580	375	385	342	498	600	377
0315	Aerospace Engineering & Technology	40	58	53	61	53	34	38	40
0317	Maritime Engineering & Technology	76	67	49	33	56	63	69	89
0399	Other Engineering & Technology	41	61	61	223	217	85	95	80
	TOTAL	1833	1820	1596	2018	1766	1766	2131	1934

Source: NCVER, VOCSTATS Databases

Looked at in aggregate:

- There was a stable pattern of completions in manufacturing engineering averaging about 258 annually.
- A lower stable pattern, averaging about 176 completions per year in mechanical engineering.
- Maritime engineering completions averaged about 31 per year.
- Completions in civil engineering grew from 31 in 2001 to 187 in 2008 before falling back to 140 in 2009.
- Aerospace completions fell from 45 in 2001 to 16 in 2006, recovering to 34 in 2009.
- The other category contained comparatively large numbers that petered out to almost zero in the last two years.

Completions of diplomas in engineering from Australian TAFE colleges was higher and showed more stability than completions of associate degrees and advanced diplomas. The fields of engineering covered were similar between the two sets of courses. A notable feature was the much higher share of women; in 2001 it was 17.0% and by 2009 it had increased to 21.9%.

6.4 Increase in the Supply of New Engineers

This section summarises the changes in the annual increase in supply of engineers from domestic education completions. Because there is a one year delay in university completions and longer for TAFE completions, estimates of likely completions were made to bring the statistics up to 2011. Table 6.7 shows this summary with estimated statistics in red.

Table 6.7: The Additional Supply of Engineers from Education

Source	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Men										
Associate Engineers										
Universities	122	90	92	87	83	121	155	254	285	340
TAFE Colleges	1059	1260	1257	1306	1275	1438	1562	1159	1290	1290
Sub-total	1181	1350	1349	1393	1358	1559	1717	1413	1575	1630
Engineering Technologists	540	524	488	561	691	490	502	439	368	498
Professional Engineers										
Four year degree	3313	3272	3302	3310	3179	3417	3648	3653	3674	3700
Four year double degree	900	1051	1215	1195	1192	1165	1179	1069	1433	1400
Sub-total	4213	4323	4517	4505	4371	4582	4827	4722	5107	5100
Engineering Team	5934	6197	6354	6459	6420	6631	7046	6574	7050	7228
Women										
Associate Engineers										
Universities	<10	14	<10	<10	<10	12	20	24	35	40
TAFE Colleges	78	107	78	132	126	135	116	124	127	127
Sub-total	78	121	78	132	126	147	136	148	162	167
Engineering Technologists	101	88	88	139	156	109	130	116	119	126
Professional Engineers										
Four year degree	656	663	636	604	528	506	523	552	544	540
Four year double degree	211	233	251	275	280	274	270	234	273	260
Sub-total	867	896	887	879	808	780	793	786	817	800
Engineering Team	1046	1105	1053	1150	1090	1036	1059	1050	1098	1093
Total										
Associate Engineers										
Universities	122	104	92	87	83	133	175	278	320	380
TAFE Colleges	1137	1367	1335	1438	1401	1573	1678	1283	1417	1417
Sub-total	1259	1471	1427	1525	1484	1706	1853	1561	1737	1797
Engineering Technologists	641	612	576	700	847	599	632	555	487	624
Professional Engineers										
Four year degree	3969	3935	3938	3914	3707	3923	4171	4205	4218	4240
Four year double degree	1111	1284	1466	1470	1472	1439	1449	1303	1706	1660
Sub-total	5080	5219	5404	5384	5179	5362	5620	5508	5924	5900
Engineering Team	6980	7302	7407	7609	7510	7667	8105	7624	8148	8321

In 2001, the new supply of engineers to the engineering team was 6,980 and comprised 1,259 new associate engineers, 641 new engineering technologists and 5,080 new professional engineers. The composition was heavily skewed towards new professional engineers; professional engineers accounted for 72.8% of new supply, engineering technologists added 15.8% and associate engineers 6.2%. The gender balance varied considerably between components; it was lowest for associate engineers at 6.2%; highest for professional engineers at 17.1%; it was 15.8% for engineering technologists and was 15.0% overall.

The last year for which firm statistics were available for each of the three occupational groups of the engineering team was 2009. The annual addition to the new supply of engineers had increased by 644 or 9.2% to 7,624. The share of new professional engineers was unchanged at 72.2% but the relative contributions of associate engineers and engineering technologists changed. The growth that had occurred in completions of associate degrees and advanced diplomas increased this group to 20.5% of new supply and the fall in three year bachelors degree completions reduced the technologists group to 7.2% of new annual supply. The women's share of new associates increased to 9.5% and to 20.9% for new technologists, but fell to 13.8% for new professionals. Overall there was a fall in the women's share to 13.8% of new supply.

The estimated figures for 2010 and 2011 were made in variously ways including five year averages (TAFE) and extrapolating the relationship between commencements and completions (universities). There is no pretence of precision here but the figure give some guide to likely outcomes.

It is likely that in 2011, an additional 8,321 new engineers were added to supply; 5,900 new professional engineers, 624 new engineering technologists and 1,797 new associate engineers. The most problematic estimate is the latter because it presumes that TAFE completions recover from the slump in completions in 2009 and resume the earlier growth trend.

Overall, the annual addition to supply has grown 1,341 or 19.2%. The contributors to this growth are new completions of professional engineers, up by 820 per year and new completions of associate engineers qualifications, up by 538 per year. There was effectively no change in the completions of technologist qualifications. The sensitivity of the estimate for 2011 to recovery in TAFE completions is not high. Should TAFE completions continue at the 2009 level, the estimated increase in the engineering team in 2011 is 1.6% lower at 8,187.

In summary, growth in education completions has meant that the annual new supply of engineers in Australia has grown by about 19%. Whether this growth is adequate to meet increases in the demand for engineers will be examined in a later chapter.

7. INCREASING THE SUPPLY OF ENGINEERS THROUGH SKILLED MIGRATION

Key Messages

This Chapter provides a stocktake of skilled migration statistics using the framework of the Skilled Occupation List (SOL) and incorporates a switch in employment classifications systems to the contemporary ANZSCO classification. It was made possible by the assistance of DIAC staff.

The annual flow of new permanent migrant engineers into Australia increased by 114% from 2,946 in 2003-04 to 6,301 in 2010-11. In 2010-11, 84.5% were professional engineers, 6.6% were engineering technologists and 8.9% were associate engineers. The year's flow adds to the size of the engineering labour force.

In addition, annually large numbers of new temporary migrant engineers were granted visas to work in Australia. In 2003-04, 2,260 were approved and by 2010-11 this had increased to 6,940. Temporary visas are time limited and the time period covered by them varies. Thus although each year's intake adds to new supply in that year, the engineering labour force is increased only for the average duration of visas granted that year. Statistics on the net flow of temporary migrant engineers are not available. Some temporary migrants are subsequently sponsored for permanent visa by employers and when approved are included in permanent visa statistics.

Temporary migrant visas are intended to be short term responses to skills shortages. When skill shortages are high, temporary migration is expected to be high. Statistics show that temporary migration increased annually until the GFC impacts were felt in Australia. Employers clearly absorbed some of the impact on engineering employment through a large reduction in temporary migration. Since then temporary migration of engineers has increased to record levels.

Permanent migration intakes are switching in favour of employer and State/Territory sponsorship and away from independent skilled migrants. Since changes in legislation to permit on-shore applications for permanent visas, an increasing number of permanent migrants are from this source; either temporary migrants converting to permanent or overseas students in Australia granted permanent visas.

All engineering specialisations are represented in both permanent and temporary visa statistics. Recent developments such as the NBN and coal seam gas are reflected in the statistics by intakes of telecommunications specialists and geotechnical engineers in recent years.

Education completions and skilled migration add to the supply of engineers each year and retirements reduce it. Over time the proportional contribution of education completions has fallen while the proportional contribution of skilled migration has increased. In 2003-04, the addition to supply of professional engineers was 9,597; 5219 (54.4%) from education completions, 2,508 (26.1%) from permanent migration and 1,870 (19.5%) from temporary migration. By 2010-11, the addition to supply was 16,216; 5,924 (36.5%), 5,322 (32.8%) from permanent migration and 4,970 (30.7%) from temporary migration. Similar, but smaller scale comparisons apply to engineering technologists and associate engineers.

7.1 Australia's Skilled Migration Policy

During 2008, the Federal Government reviewed key elements of Australia's skilled migration policies. New policies were announced and came into effect on 1 July 2010. Former policies were supply driven and dominated by efforts to address skill shortages. Occupations that were in short supply were included on a Migration Occupations in Demand List (MODL) that over time had lost relevance because excessive numbers of occupations were included, many of which required only short periods of training. Prospective visa applicants were assessed and ranked according to a points test which gave undue weight to low value MODL occupations and there were no mechanisms to ensure that the skills admitted were those most in demand by employers. Conversely, many so-called skilled migrants admitted experienced difficulties in finding employment.

The main changes to skilled migration policies were:

- Both labour demand and labour supply considerations were built into policy design.
- A clear distinction was drawn between policy to meet short term requirements and policy to meet medium to longer term requirements.
    - Short term policy was geared to meeting skills shortages
    - Medium to long term policy was geared to supplementing Australian skills in areas where the output of Australia's education system was insufficient for future needs.
- Dealing with skills shortages was made the responsibility of employers, and to a lesser extent, States and Territories.
    - Employers can take advantage of temporary visas with faster visa processing and could also sponsor permanent migrants. The usual route for this was to sponsor temporary migrants in their employ but priority processing for others was also provided. In both cases the obligation on employers was to commit to employing the migrants concerned under stipulated minimum conditions.
    - States and Territories were invited to prepare and agree State migration plans with the Commonwealth. These led to priority processing for State sponsored visa applicants behind employers but ahead of independent visa applicants. It also opened the way to including occupations of specific interest to States in migration arrangements.
- A new Skilled Occupations List (SOL) is prepared and recommended by a new agency outside the immigration portfolio, Skills Australia. All applicants for permanent visas who are not sponsored by an employer or a State or Territory (independent visa applicants) can only apply for an occupation on the SOL. With the agreement of the Commonwealth Minister, States can nominate occupations to the SOL providing the Minister accepts supporting research and substantiation.
- The Minister for Immigration was given legislated powers to cap the overall annual skilled migration intake and to cap the intake of occupations within the overall cap so to provide reserve powers to meet economic requirements.

The Skilled Occupation List (SOL) is prepared and reviewed annually by Skills Australia which recommends it to the Minister for Immigration. Skills Australia bases the SOL on its Specialised Occupations List compiled using four criteria; long training lead time in specialised skills, high degree of relationship between the area of training and subsequent employment, high risk of labour market and economic disruption if the skills are in short supply and skills for which there is sufficient high quality information to assess future skills requirements. Schedule 1 of the SOL lists the occupations approved by the Minister for Immigration based on recommendations by Skills Australia. Nearly all well-known professional engineer and engineering technologist occupations are included on Schedule 1. However, only half the engineering associate occupations are included. Under the new policies, Schedule 2 of the SOL lists occupations included in approved State or Territory

migration plans. The engineering associate occupations not on schedule 1 are on schedule 2.

The new policies respond to the demand for skilled labour by according priority to employer sponsorship. Prospective visa applicants who are sponsored by employers and are applying for an occupation on schedule 1 of the SOL are assessed first. Prospective visa applicants who are sponsored by a State or Territory government and are applying for an occupation on either schedule 1 or 2 of the SOL are processed next. Applicants for independent skilled migration visas are processed after applicants who are sponsored by employers and/or States and Territories. In principle, applicants for independent visas could be crowded out depending on the relationship between annual quotas for the occupation concerned and the requirements of employers and/or States and Territories.

The points test has been substantially revised. The maximum age for skilled migrants has been increased and for the first time points are awarded for either overseas or Australian work experience. Consistent with an emphasis on high value skills additional points are awarded for higher qualifications such as doctorates and lower points are awarded to qualifications of short duration. The points test provides for minimum English competency standards but awards additional points for superior competency.

Employer sponsorship for permanent migration visas requires employers to provide full time employment for either two or three years depending on whether sponsorship is under the regional sponsored migration scheme or the employer nomination scheme. Regulations are also in place to ensure that salaries are in line with Australian awards. Visa applicants must remain with the sponsoring employer for the stipulated period but are then free to move elsewhere.

The main vehicle for employers to quickly respond to short term skills shortages are temporary visas. Temporary visas are not limited by the annual migration target, inclusion on the SOL nor do they require qualifications to be assessed. State and Territory Governments are also in a position to sponsor temporary migrants. The most common temporary visa is the 457 business long stay visa, although other options are available for specific cases.

Employers and State and Territory Governments can choose to respond to skill shortages using permanent visas. For employers, sponsoring an applicant for a permanent skilled migration visa entails an employment commitment as mentioned earlier and, although applicants are processed at the head of the queue, skills assessments are mandatory and can slow the process. An alternative approach is for employers to sponsor temporary visa holders for a permanent visa. This approach is being encouraged by more recent changes in skilled migration policies.

There continues to be a place for independent skilled migration but the system has been heavily skewed towards the requirements of employers and States and Territories and towards supplementing skills where Australia's output is insufficient. This changes the historical emphasis on independent migration. The direct connection between employment and skills intake in the new arrangement is intended to ensure that the skilled migration program focuses supply on jobs that employers want to fill in locations where the jobs are, minimising the possibility of migrants to gravitate to large cities where employment in the area of their skill is more problematic.

7.2 Assessing Overseas Engineering Qualifications

Skilled migration has been the Australian Government's main response to skills shortages. Applicants for permanent visas are required to have their qualifications assessed by an assessment authority appointed by the Department of Immigration and Citizenship (DIAC) before submitting their visa application. For engineering, Engineers Australia is the

authorised assessing authority for nearly all engineering occupations and assessments are conducted in line with the qualifications and competencies required for the engineering team as outlined earlier.

Engineering qualifications can be recognised through two distinct pathways[13]:

- Qualifications may treated as accredited qualifications if they are:
  - Australian qualifications;
  - Accredited under the Washington Accord which is an agreement between international engineering accreditation bodies[14] to recognise the equivalence of each other's undergraduate qualifications for professional engineers (the equivalent of an Australian four year full time bachelors degree);
  - Accredited under the Sydney Accord which is an agreement between international engineering accreditation bodies[15] 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).
- Qualifications that are not accredited can be recognised by undergoing a 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. These competency standards are available on Engineers Australia's web-site[16].

Engineers who come to Australia on temporary 457 visas do not have their qualifications assessed by an assessment authority. Provided their visa application is accompanied by an employer's offer of employment under conditions that meet stipulated criteria, skills assessments are deemed to be unnecessary. Under current policy, holders of 457 temporary visas who apply for permanent visas are required to undergo skills assessments in the same way as all applications for permanent migration. However, there are moves underway to change this policy in cases of employer sponsorship. The proposal is, temporary migrants who have been employed for a stipulated minimum period and who are sponsored for permanent migration with an employer guarantee of further employment for a minimum period, will no longer require a skills assessment.

7.3 Aggregate Skilled Migration of Engineers

As well as the policy changes discussed above, there were administrative changes made by DIAC to its statistical systems. With these changes in mind, Engineers Australia sought and obtained the Department's assistance to compile a stocktake review of engineering migration over the past decade. The framework used for the review was the engineering team and SOL occupations. Past editions of the Statistical Overview contained rather less information than proposed by this framework. As well little could be said about how skilled migrants fitted into the engineering team. Another objective was to obtain detailed statistics on SOL occupations for both permanent and temporary visas.

Table 7.1 shows the number of engineers who have come to Australia under the Skilled Migration Program since 2003-04. The Table covers all permanent and temporary visa classes, sponsored and independent migrants. Statistics for permanent visas were available back to 2000-01, but statistics for temporary visas could be obtained only for 2003-04 onwards. The shorted period was used for comparative purposes. Key trends from Table 1 are illustrated in Figure 1.

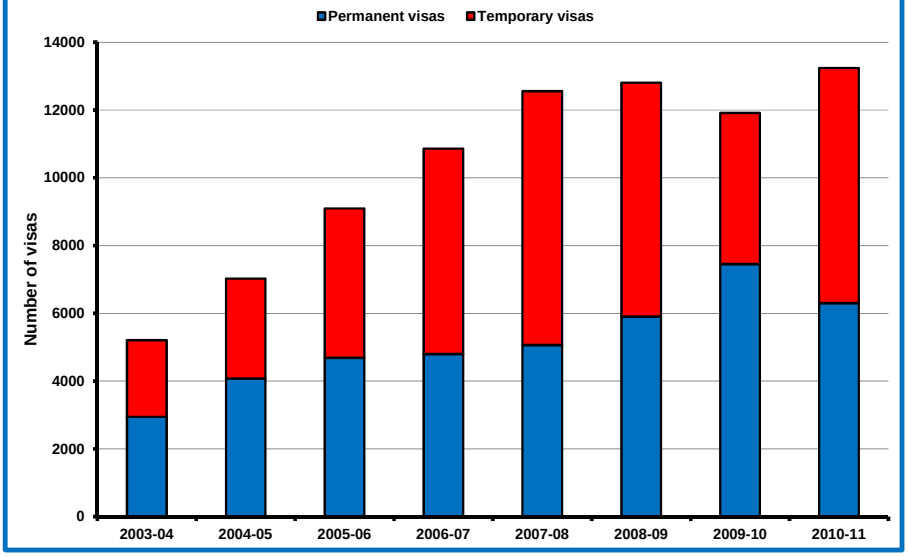
[13] www.engineersaustralia.org.au
[14] The signatories to the Washington Accord are Canada, Hong Kong SAR, Ireland, New Zealand, South Africa, the United Kingdom, the United States of America and Australia.
[15] The signatories to the Sydney Accord are Canada, Hong Kong SAR, Ireland, New Zealand, South Africa, the United Kingdom and Australia.
[16] See www.engineersaustralia.org.au

Table 7.1: An Overview of Skilled Migration of Engineers to Australia

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Permanent visas								
Professional engineers	2508	3414	3941	4226	4467	5245	6865	5322
Engineering technologists	320	519	508	357	335	291	177	414
Engineering associates	118	143	237	215	264	370	409	565
Total	2946	4076	4686	4798	5066	5906	7451	6301
Temporary visas								
Professional engineers	1870	2310	3270	4230	5290	4500	3040	4970
Engineering technologists	100	160	250	310	360	330	150	150
Engineering associates	290	480	890	1520	1840	2070	1270	1820
Total	2260	2950	4410	6060	7490	6900	4460	6940
All visas								
Professional engineers	4378	5724	7211	8456	9757	9745	9905	10292
Engineering technologists	420	679	758	667	695	621	327	564
Engineering associates	408	623	1127	1735	2104	2440	1679	2385
Total	5206	7026	9096	10858	12556	12806	11911	13241

Source: Statistics supplied by DIAC

Figure 7.1: Skilled Migration Visas Granted to Engineering SOL Occupations



In 2003-04, the engineering unemployment rate was 3.4%[17], just above the level of frictional unemployment. Engineering arrivals were 5,206; 2,946 on permanent visas and 2,260 on temporary visas. Arrivals on permanent visas increased each year and peaked at 7,451 in 2009-10, falling to 6,301 in 2010-11. Although lower than the previous year, this was still the second highest permanent intake of engineers on record. Since 2003-04, the cumulative total of arrivals was 41,230 (35,988 professional engineers, 2,921 engineering technologists and 2,321 engineering associates).

The intake of engineers on temporary visas peaked a year earlier at 7,490 in 2007-08. By this time engineering unemployment had fallen to 2.4%, consistent with frictional unemployment. The following year, the impact of the global financial crisis (GFC) was felt and the response of employers was evident in two forms; first, the engineering unemployment rate increased to 4.1% in 2008-09, reflecting some easing in the demand for engineers (an additional 6,500 engineers became unemployed), and second, the intake of engineers on temporary visas fell to 6,900 in 2008-09 and then to 4,460 in 2009-10. By 2010-11, the engineering unemployment rate had eased to 3.7%.

[17] See Engineers Australia, The Engineering Labour Force, 2001 to 2010,2011, www.engineersaustralia.org.au

Prior to the GFC, total migration of engineers was 12,806, and the main impact of the GFC on engineering migration appears to have been a small fall to 11,911 the following year. By 2010-11, the total migration of engineers had achieved a new peak of 13,241. What is significant about these figures is their scale, compared to earlier years, and that immigration continued to contribute strongly to the supply of engineers, well above the adjustment in demand evidenced by the increase in unemployment.

In considering these changes the relationship between temporary and permanent migration needs to be borne in mind. Current policy encourages employers to sponsor temporary migrants for permanent visa status. In 2008-09, temporary migration fell but permanent migration increased giving an overall increase. The fall in temporary migration was most likely due in part to some former temporary migrants changing status to permanent and the early stages of employers cutting back on temporary migration. The full adjustment of temporary migration became evident the following year, as anticipated by skilled migration policy. At the height of this adjustment, the temporary intake of engineers did not fall below 2005-06 when skill shortages were considered widespread.

As noted, some care is necessary when considering temporary and permanent migrants together; some temporary migrants can change status while others return home when the tenure of contracts are complete. The sum of temporary and permanent migration is, however, a solid indicator of how immigration is contributing to the new supply of engineers in the year to which the statistics apply. Similarly, the growth of total migration is a good indicator of the degree to which the supply of engineers has increased to accommodate increased demand. In the Australian case, engineering unemployment fell in all years examined with the exception of one year when the easing of demand was much less than the addition to supply, suggesting that geography may have played a role in the adjustment.

7.4 Permanent Migrant Engineers

This section looks at the permanent migration of engineers in greater detail. Table 7.2 divides the permanent visa statistics in Table 7.1 by the type of visas granted and whether applicants were located in Australia or off-shore. The Table includes statistics from 2000-01. Figure 7.2 illustrates the changes that have occurred in respect to the type of permanent visas approved and Figure 7.3 illustrates the changes that have occurred in respect to the location of visa applicants. Both diagrams cumulatively stack the factors in their legends.

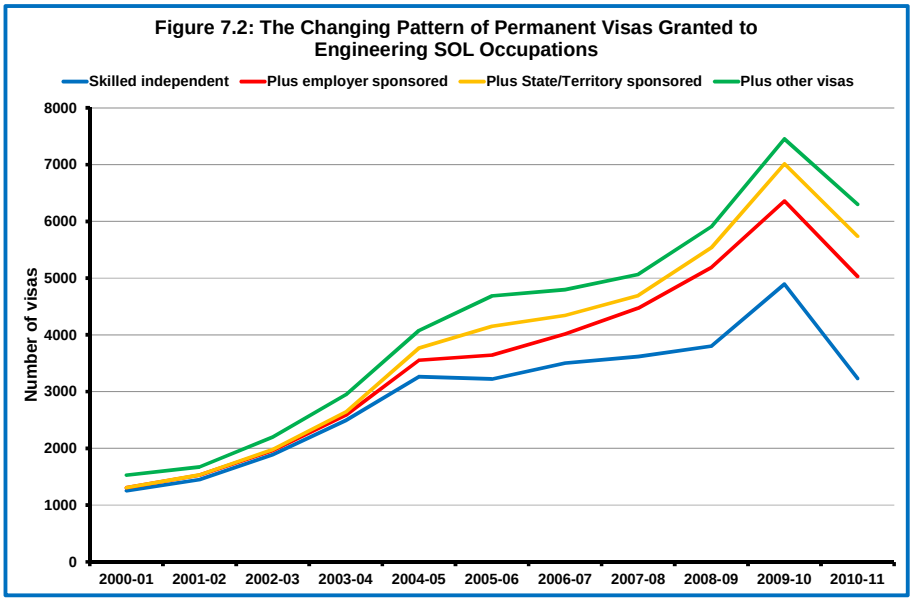
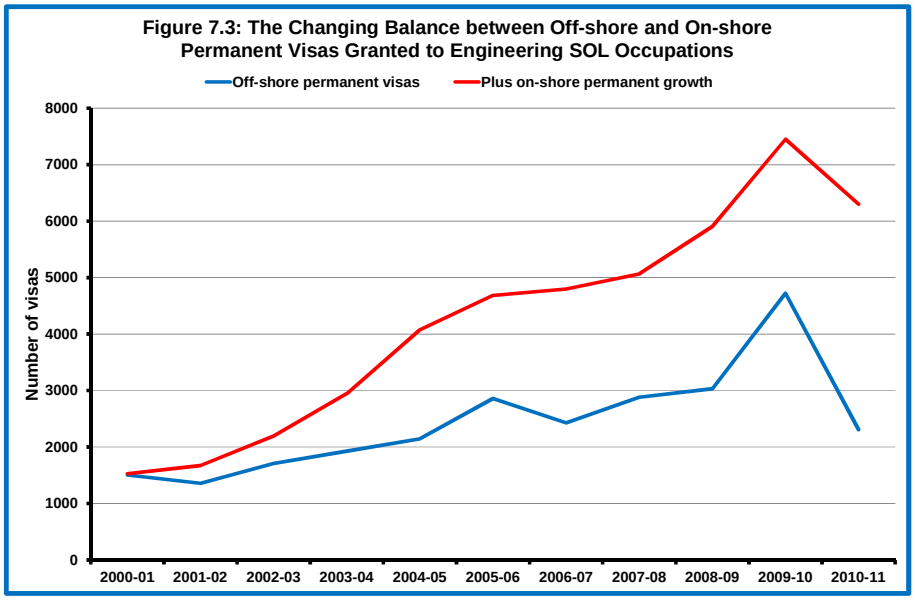


Figure 7.2 shows that although the intakes of engineers with independent visas slowed during the middle years of the decade, this visa category remains the core of the permanent migrant intake. Over time, however, visas sponsored by employers and by State and Territory Governments have gradually grown from nothing to be 39.8% of permanent visas in 2010-11 (employers 28.6% and State/Territories 11.2%). This change occurred before the change in skilled migration policies and can be expected to accelerate as the impact of the policy changes become evident.

Table 7.2: Permanent Visas Approved for Skilled Engineers to Emmigrate to Australia

Visa Category	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Off-shore											
Business Skills	5	3	5	3	0	7	3	0	3	0	3
Distinguished Talent	2	0	0	0	1	0	2	0	2	0	0
Employer Sponsored	29	37	39	38	52	53	65	77	85	64	68
Skilled Australian Sponsored	213	137	200	279	273	435	321	245	195	286	272
Skilled Independent	1255	1177	1452	1551	1605	1890	1747	2357	2521	3880	1397
State/Territory Sponsored	1	2	15	55	214	475	291	204	225	496	567
Total Off-shore	1505	1356	1711	1926	2145	2860	2429	2882	3031	4724	2307
On-shore											
Business Skills	0	0	0	0	0	0	0	0	0	0	0
Distinguished Talent	0	0	0	0	1	0	0	0	1	2	0
Employer Sponsored	23	42	37	55	237	368	448	776	1301	1402	1732
Skilled Australian Sponsored	0	2	14	23	33	93	130	127	170	152	288
Skilled Independent	0	272	436	942	1659	1332	1756	1262	1280	1014	1834
State/Territory Sponsored	0	0	0	0	1	33	35	19	123	157	140
Total On-shore	23	316	487	1020	1931	1826	2369	2184	2875	2727	3994
All permanent visas											
Business Skills	5	3	5	3	0	7	3	0	3	0	3
Distinguished Talent	2	0	0	0	2	0	2	0	3	2	0
Employer Sponsored	52	79	76	93	289	421	513	853	1386	1466	1800
Skilled Australian Sponsored	213	139	214	302	306	528	451	372	365	438	560
Skilled Independent	1255	1449	1888	2493	3264	3222	3503	3619	3801	4894	3231
State/Territory Sponsored	1	2	15	55	215	508	326	223	348	653	707
Total	1528	1672	2198	2946	4076	4686	4798	5066	5906	7451	6301

Source: Statistics supplied by DIAC



At the beginning of the decade, skilled migration policies were changed to permit on-shore applications for permanent visas instead of requiring prospective applicants to first return to their home country and then apply as an off-shore applicant as previously was the case. Present skilled migration policies continue to support applications from both off-shore and on-shore applicants. Figure 7.3 illustrates the impact of extending eligibility to on-shore applicants. It shows that off-shore permanent migration continues to be important to the intake of engineers on permanent visas, but that most of the growth in the permanent intake

has been from on-shore applicants. There are two key groups of on-shore applicants; first, overseas students studying engineering in Australia on temporary student visas that apply and are granted permanent visas, and second, temporary visa holders working in Australia who apply for and are granted permanent visas.

Table 7.3: Engineering Specialisations Granted Permanent Migration Visas

Specialisation	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Professionals											
Chemical Engineer	88	89	148	131	229	299	358	289	435	524	357
Materials Engineer	18	22	15	29	42	32	44	43	30	14	76
Civil Engineer	240	265	333	355	448	695	809	921	1144	1637	1066
Geotechnical Engineer	0	0	0	0	0	0	0	0	0	0	16
Quantity Surveyor	71	67	98	105	116	111	90	119	176	253	158
Structural Engineer	0	0	0	0	0	0	0	0	0	0	27
Transport Engineer	0	0	0	0	0	0	0	0	0	0	1
Electrical Engineer	134	129	174	224	277	311	533	621	741	854	497
Electronics Engineer	104	107	110	188	345	449	505	598	744	1408	861
Industrial Engineer	29	19	36	60	87	88	79	95	77	26	154
Mechanical Engineer	209	182	315	389	523	653	859	1007	1192	1659	1018
Production Engineer	17	11	16	34	59	56	63	52	62	94	85
Mining Engineer	16	21	16	18	26	43	40	70	98	151	110
Petroleum Engineer	11	9	10	12	18	43	36	37	46	25	68
Aeronautical Engineer	14	18	15	25	50	46	61	34	58	11	76
Agricultural Engineer	9	9	6	11	7	8	12	6	9	3	10
Biomedical Engineer	2	1	6	2	6	17	17	16	18	10	68
Environmental Engineer	0	0	0	0	0	0	0	0	0	0	33
Naval Architect	2	4	4	7	11	8	13	7	6	9	7
Other Engineering Professionals	240	333	468	566	908	743	373	281	253	112	173
Telecommunications Engineer	0	0	0	0	0	0	0	0	0	0	59
Telecommunications Network Engineer	0	0	0	0	0	0	0	0	0	0	37
Software Engineer	103	120	126	352	262	339	334	271	156	75	328
Computer N/W & Systems Engineer	0	0	0	0	0	0	0	0	0	0	37
TOTAL	1307	1406	1896	2508	3414	3941	4226	4467	5245	6865	5322
Engineering Technologists	121	193	222	320	519	508	357	335	291	177	414
Associates											
Civil	15	14	17	33	33	58	51	63	92	109	132
Electrical	17	13	15	18	20	28	24	34	56	69	122
Electronics	31	22	17	15	33	48	29	32	45	43	65
Mechanical	28	13	13	16	30	36	45	72	106	115	156
Other Engineering	9	11	18	36	27	67	66	63	71	73	86
Telecommunications	0	0	0	0	0	0	0	0	0	0	4
TOTAL	100	73	80	118	143	237	215	264	370	409	565
OVERALL TOTAL	1528	1672	2198	2946	4076	4686	4798	5066	5906	7451	6301

Source: Statistics supplied by DIAC

Table 7.3 sets out statistics on permanent visas granted to engineers by field of specialisation and by engineering team occupational category. When comparing these statistics to the educational outcomes covered in Chapters 5 and 6, it is important to note that the educational outcomes are classified according to the ASCED system whereas migration statistics are classified according to the ANZSCO system. How the congruence between these systems was established is covered elsewhere[18].

Bearing in mind that the objective of permanent migration is to supplement the output of Australia's education system, some features of Table 7.3 and how these relate to educational outcomes are as follows:

- Professional process and resource engineering: this group includes chemical engineers, materials engineers, mining engineers and petroleum engineers;
    - In 2000-01, there were 133 permanent visas granted to this group, increasing to 190 in 2003-04, peaking at 714 in 2009-10 and falling back to 611 in 2010-11.
    - In 2000-01, education outcomes were 632, falling to 561 in 2003-04, and then trended upwards to be 746 in 2010-11

[18] Engineers Australia, The Supply of Engineers in Australia: A Decade of Skilled Migration, 23 March 2012, www.engineersaustralia.org.au

- Professional civil engineering: this group includes civil engineers, structural engineers, transport engineers and geotechnical engineers;
    - In 2000-01, there were 240 permanent visas granted, increasing to 355 in 2003-04, continuing to increase to a peak of 1,637 in 2009-10 and falling to 1,110 in 2010-11.
    - Until 2009-10, all permanent visas were granted to civil engineers but in 2010-11, for the first time visas were granted to the other three fields.
    - In 2000-01, 890 professional civil engineers completed their courses, falling to 724 in 2003-04 and then trending upwards to 1,036 in 2010-11.
- Professional mechanical and industrial engineers: this group comprises the two nominated fields;
    - In 2000-01, there were 239 permanent visas granted, increasing to 449 in 2003-04 and trending to a peak of 1,685 in 2009-10 before falling back to 1,172 in 2010-11.
    - In most years the number of industrial engineers granted a visa was small but the sudden increase in 2010-11 is noteworthy.
    - In 2000-01, 803 professional mechanical and industrial engineers completed their courses; falling to 748 in 2003-04 and remaining approximately steady at this level through to 2009-10. In 2010-11, education completion increased to 1,001.
- Professional electrical and electronic engineers: this field includes electrical engineers, electronic engineers, computer engineers and communications technologists; in Australia this field of education includes computer engineers who may specialise in either hardware or software areas. Migration statistics include the occupation “software engineer” and some of these may be four year trained engineers but others may be trained in a non-engineering computer degree; for completeness both elements are included below;
    - In 2000-01, 238 permanent visas were granted (341 including software engineers), increasing to 412 in 2003-04 (674 including software engineers. There was rapid growth in visa numbers peaking at 2,262 in 2009-10 (2,337 including software engineers) before falling back to 1,358 in 2010-11 (1,686 including software engineers).
    - In civil and mechanical engineering, Australian education completions increased or were maintained. In electrical and electronic engineering, education completions fell dramatically.
    - In 2000-01, 1,591 four year or four year double degrees were completed with a small increase to 1,689 by 2003-04. Completions then trended downwards and in 2010-11 were 792.
    - Statistics on visas granted to engineering technologists were only available at aggregate level and not by field
    - The numbers of permanent visas granted to engineering technologists were small compared to professional engineers. In 2000-01, there were only 121. Numbers increased to a peak in 2004-05, ahead of the resource boom inspired engineering shortage, and then numbers fell but with significant fluctuations. In 2010-11, 414 permanent visas were granted.
    - In 2000-01, 629 engineering technologists completed their degrees. Coinciding with peak permanent migration, education outcomes also peaked at 847. Since then completions have fallen to 487.
- The number of engineering associates granted permanent migration visas has been comparatively small but there is a noticeable rising trend and 565 permanent visas were granted in 2010-11.
    - The trend in permanent visas mimicked a similar trend in university completion of associate engineering qualifications.
    - TAFE completions of these qualifications trended upwards from 1,137 in 2002-03 to 1,678 in 2008-09 but then fell. As discussed in Chapter 6 there is some uncertainty about the trend since then.

Similar comparisons are possible for other occupations where both education outcomes and permanent visas granted are smaller than the fields just discussed. In general, the new skilled migration emphasis on complementing Australian education outcomes simply legitimates what has been occurring. In most instances, education outcomes have either been steady or have increased. A key exception has been professional level degrees in electrical and electronic engineering where completions have collapsed. Commencement statistics suggest this pattern will continue. Without skilled permanent migration, there is no doubt that Australia's engineering skills shortage would be severe.

7.5 Temporary Migrant Engineers

Table 7.4 shows that the entry of temporary migrant engineers typically exceeded the number of permanent visas granted. A note of caution is essential before proceeding. Most temporary migration is covered by temporary 457 visas and these visas cover employment in Australia from one day to four years. There are no available statistics on stay durations of temporary migrants but the presumption is that a high proportion of migrants on these visas are employed for periods exceeding a year. While the sum of permanent and temporary migrants in a given year provides a reliable guide to the number of engineers being added to the supply of engineers, these statistics should not be cumulated because the net impact of departures of completed temporary employment engagements would not be included.

A second reason why temporary visa statistics should not be cumulated in that under current skilled migration policy, employers are actively encouraged to sponsor temporary visa holders for permanent visas. As the discussion above showed, this interaction between the two visa types was evident as employer adjusted to the GFC. Having said this, temporary migration is formally the safety valve that employers are expected to use when faced with temporary skill shortages and thus the statistics in Table 7.4 are measures of engineering skills shortages.

In 2003-04, 2,260 engineers came to Australia on temporary 457 visas; 1,870 or 82.7% were professional engineers, 100 or 4.4% were engineering technologists and 12.8% were engineering associates. Temporary visa numbers increased rapidly in subsequent years, peaking at 7,490 in 2007-08. The safety valve function of temporary migration is evident in the pattern since then. In 2008-09, temporary visas fell to 6,900 and to 4,460 in 2009-10 as employers adjusted engineering workforces to deal with the impact of the GFC. However, by 2010-11, temporary migration had increased by 55.6% over the previous year and was back to 6,940 with 71.6% professional engineers, 2.2% engineering technologists and 26.2% engineering associates.

The pattern of field covered by temporary visas is broadly similar to permanent visas but there are some important differences, including:

- The rapid and large increase in temporary engineering associates, particularly in occupations nominated by States and Territories; in 2003-04, 290 temporary visas were granted to engineering associates. By 2008-09, this had grown to 2,070 and post-GFC was still at 1,820.
- In 2010-11, several fields were granted temporary visas for the first time including; geotechnical engineers, structural engineers, transport engineers, environmental engineers and several fields of communications and ICT systems engineer. These fields cover increasing demands for engineers in coal seam gas, infrastructure development and the development of the NBN.

Table 7.4: Temporary Visas Granted to Engineers on the SOL in the Skilled Migration Program

Professionals

ANZSCO	Occupation	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
233111	Chemical engineer	50	70	120	160	250	190	140	140
233112	Materials engineer	10	20	30	40	50	50	30	50
233211	Civil engineer	190	330	580	750	1190	1040	560	820
233212	Geotechnical engineer	0	0	0	0	0	0	0	110
233213	Quantity surveyor	50	60	100	130	180	180	170	250
233214	Structural engineer	0	0	0	0	0	0	0	100
233215	Transport engineer	0	0	0	0	0	0	0	50
233311	Electrical engineer	110	130	320	400	460	380	210	320
233411	Electronic engineer	100	170	210	310	240	180	120	110
233511	Industrial engineer	10	30	30	40	60	60	50	130
233512	Mechanical engineer	280	360	640	620	840	670	400	510
233513	Production or plant engineer	70	80	130	120	180	130	90	150
233611	Mining engineer (excl petroleum)	70	80	160	170	270	200	70	170
233612	Petroleum engineer	70	110	130	190	180	160	160	200
233911	Aeronautical engineer	20	40	40	30	50	40	40	30
233912	Agricultural engineer	< 5	< 5	< 5	< 5	10	< 5	< 5	< 5
233913	Biomedical engineer	10	10	20	10	10	20	10	20
233915	Environmental engineer	0	0	0	0	0	0	0	60
233916	Naval architect	< 5	10	10	10	20	20	10	20
233999	Engineering professionals nec*	160	200	300	350	440	370	220	450
261313	Software engineer	670	610	450	900	860	810	760	880
263311	Telecommunications engineer	0	0	0	0	0	0	0	20
263312	Telecommunications network engineer	0	0	0	0	0	0	0	50
263111	Computer network & systems engineer*	0	0	0	0	0	0	0	150
263213	ICT Systems Test engineer*	0	0	0	0	0	0	0	180
	Total professionals	1870	2310	3270	4230	5290	4500	3040	4970

Technologists

233914	Engineering technologist	100	160	250	310	360	330	150	150

Associates

312211	Civil engineering draftsperson	20	50	80	140	210	270	100	130
312212	Civil engineering technician	10	10	30	40	90	90	30	110
312311	Electrical engineering draftsperson	20	30	50	110	180	150	90	70
312312	Electrical engineering technician	30	40	100	180	230	230	130	310
313211	Radiocommunications technician	0	0	0	0	0	0	0	10
313212	Telecommunications field engineer	0	0	0	0	0	0	0	30
313213	Telecommunications network planner	0	0	0	0	0	0	0	< 5
313214	Telecommunications technical officer	0	0	0	0	0	0	0	10
312411	Electronic engineer draftsperson*	10	60	50	220	60	60	50	20
312412	Electronic engineers technician*	30	40	50	100	140	200	120	150
312511	Mechanical engineering draftsperson*	70	100	110	160	200	220	120	120
312512	Mechanical engineering technician*	40	80	230	290	410	540	440	630
312912	Metallurgical or materials technician*	10	20	40	80	140	90	40	70
312913	Mine deputy*	10	10	30	40	30	20	20	20
312999	Building & engineering technicians nec*	40	40	120	160	150	200	130	140
	Total associates	290	480	890	1520	1840	2070	1270	1820
	TOTAL SOL	2260	2950	4410	6060	7490	6900	4460	6940

Source: Statistics supplied by DIAC
*** Schedule 2 of SOL**

7.6 Education, Migration and the Supply of Engineers

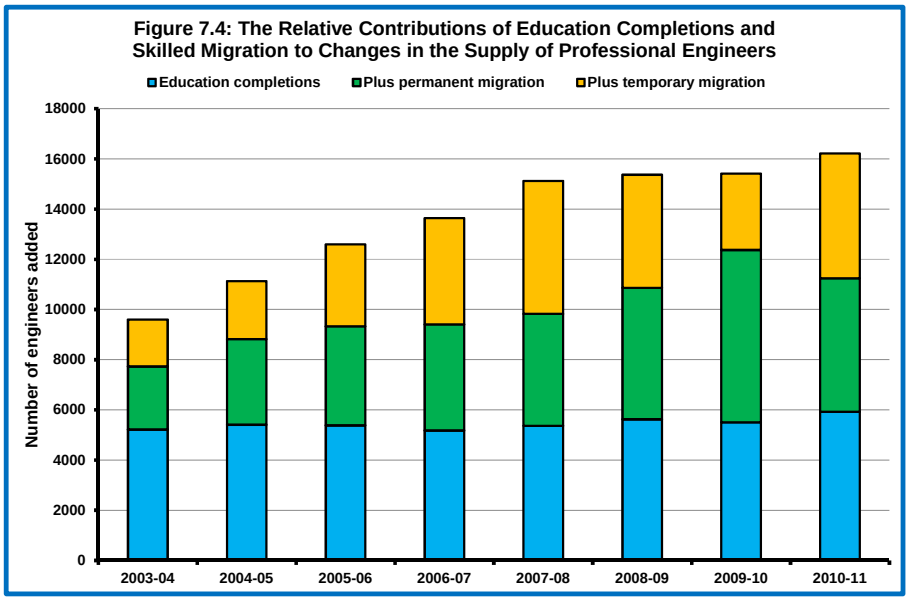
This section briefly reproduces material reported in detail elsewhere[19] about the relative contributions that education outcomes and skilled migration contribute to increases in the supply of engineers. A focus on the supply of engineers is particularly useful when engineering unemployment is low and at, or close, to frictional levels of unemployment, that is when demand for engineers exceeds supply. In practice, the low levels of unemployment in these circumstances are unlikely to meaningfully contribute to easing excess demand. Those engineers who are “frictionally” unemployed are between jobs and in that sense already employed with a timing difference to when unemployment statistics were collected. The small unemployed residual contend with being in the wrong locational labour market, having engineering specialisations for which demand may not be as high and having the right blend of work experience and skills to meet employer demands.

[19] Engineers Australia, The Supply of Engineers in Australia, op cit

Chapter 2 showed that engineering unemployment was particularly low during the period covered by the skilled migration statistics in Tables 7.3 and 7.4 so that an examination of changes in supply is particularly pertinent. The supply of engineers changes because existing engineers leave or retire from the labour force, because new engineers join the labour force on completion of their qualifications and because migrant engineers join the labour force having been granted a permanent or temporary migration visa.

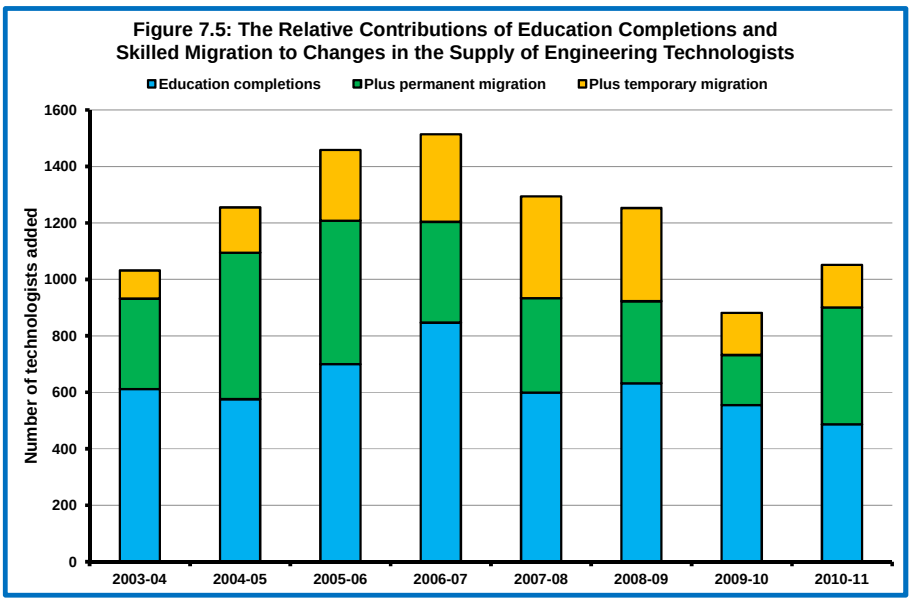
Very little is known about the rate at which engineers leave the labour force. It is expected that useful information will become available when 2011 census statistics are released. This release will enable stock statistics for the engineering labour force in 2006 and 2011 to be analysed in conjunction with flow statistics and retirements can be estimated as residuals.

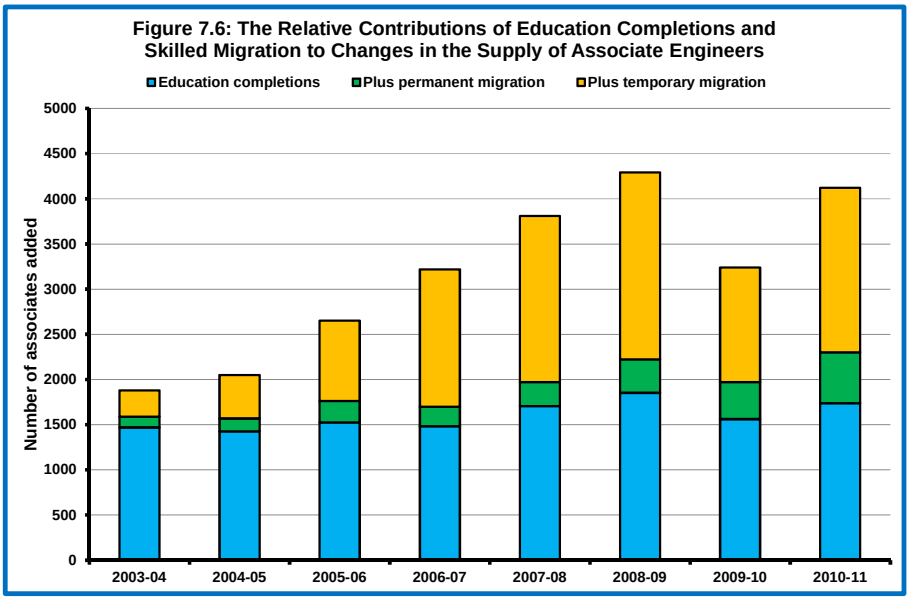
In the meantime, the analysis that follows compares the relative contributions of education outcomes and skilled migration to changes in the supply of engineers. Figure 7.4 uses the statistics on education completions from Chapter 6 with the statistics on permanent and temporary migration to consider changes in the supply of professional engineers. Figure 7.5 considers engineering technologists and Figure 7.6 considers engineering associates. The size of histograms indicates the annual change in supply from the two sources being examined and the segments the contributions of education, permanent and temporary migration.



The feature of Figure 7.4 is that education completions have barely grown while annual changes in the supply of engineers from education and migration combined have increased from 9,597 in 2003-04 to 16,216 in 2010-11. The change in annual new supply of engineers was 6,619 or 69.0%. Education completions contributed 705 or 10.7% of the increase while skilled migration contributed 5,914 or 89.3% of the increase. In turn, permanent migration contributed 42.5% of the increase in new supply and temporary migration contributed 46.8%.

The statistics engineering technologists in Figure 7.5 are smaller and more variable and do not lend themselves to detailed analysis. The new annual supply of engineering technologists was much the same at the beginning and end of the period examined with an intervening rise and fall in new supply during the middle of the decade. Both education and skilled migration contributed to this change but at the end of the decade education outcomes played a less important role in contributing to new supply than skilled migration. An interesting feature is that despite the low numbers, temporary migration still played an important role suggesting that some employers value engineering technologists and regarded them to be in shortage.





The feature of Figure 7.6 is that temporary skilled migration has become an important source of new supply of associate engineers. Although there has been some increase in education completions, annual new supply of engineering associates has increased from 1,879 to 4,122, an increase of 2,243 or 119.4%. Temporary migration accounts for 68.2% of this change and growing permanent migration for 19.9%. Growth in education completions accounts for 11.9% of growth in new supply and explains why the share education completions add to new supply has slipped from 78.3% to 42.1%.

The analysis in this section shows that Australia's education system has not kept up with the demand for engineers in each of the three occupational categories of the engineering team. There is evidence of skills shortages across the board and this is in addition to large increases in permanent migration.

8. AGE, EXPERIENCE AND SALARIES

Key Messages

This Chapter deals with some important attributes of professional engineers; ages, levels of experience and remuneration. The statistics used are from salaries surveys.

Census statistics indicate that in 2006, the average of the engineering labour force was 41.7 years (42.3 years for men and 36.5 years for women). In that year, the average age of professional engineers was 42.1 years having steadily increased from 38.7 years in 1997. Since 2006, average age has stabilised but in 2011 dipped to 40.8 years. In general private sector professional engineers are younger than public sector professional engineers. In both sectors, junior professional engineers (levels 1 and 2) appear to be becoming younger while more senior professional engineers appear to becoming older.

Professional engineers in the public sector generally have had more years of work experience up to level 4 with convergence between the sectors as seniority increased. In 2011, a level 1 professional engineer in the public sector had an average of 3.9 years of experience (private sector 1.6 year); at level 2, 7.5 years (private sector 4.7 years); at level 3, 19.1 years (private sector 14.1 years); at level 4, 24.2 years (private sector 21.8 years); at level 5, 26 years (private sector 26.3 years) and above level 5, 28.4 years (private sector 28.6 years). Movements in average years of work experience at different levels are smaller than anticipation in an environment of excess demand.

Compared to average earnings, professional engineers are well remunerated. An environment of excess demand for professional engineers suggests that salary movements are likely to move ahead of economy wide salary movements. This was evident in the case of private sector level 3,4 and 5 professional engineers since about 2005. Less senior levels moved approximately in line with average earnings. Public sector salaries moved broadly in line with average earnings irrespective of level.

8.1 Introduction

This Chapter considers several important characteristics of engineers; age, work experience and salaries. The statistics used are drawn from the December salary survey conducted by the Association of Professional Engineers, Scientists and Managers, Australia (APESMA)[20]. These surveys, undertaken since 1974, use a random sample of APESMA and Engineers Australia members. APESMA only recognises professional engineers and not the engineering team. This limitation should be borne in mind when evaluating any conclusions. Similarly, although the sample is randomly drawn, response rates vary from year to year.

8.2 Engineering Responsibility Levels

Engineering responsibility levels are an important way to segment the engineering labour force. They indicate the degree of practical expertise an individual has, they determine the remuneration of individual engineers and time spent at a given level is an indicator of the

[20] APESMA, Professional Engineer Remuneration Survey Reports, December 2000 to 2011, www.apesma.asn.au

pressures that govern movement through the ranks of the labour force. APESMA defines 6 responsibility levels[21]. They are:

- **Level 1 Professional Engineer**; this is the graduate engineer entry level. The engineer undertakes engineering tasks of limited scope and complexity in offices, plants, in the field or in laboratories under the supervision of more senior engineers.
- **Level 2 Professional Engineer**; this level recognizes the experience and competence gained as a Level 1 Engineer. At this level engineers have greater independence and less supervision, but guidance on unusual features is provided by engineers with more substantial experience.
- **Level 3 Professional Engineer**; this level requires the application of mature engineering knowledge with scope for individual accomplishment and problem solving that require modification of established guides. Original contributions to engineering approaches and techniques are common. This level outlines and assigns work, reviews it for technical accuracy and adequacy and may plan, direct, coordinate and supervise other professional and technical staff.
- **Level 4 Professional Engineers**; this level requires considerable independence in approach with a high degree of originality, ingenuity and judgment. Positions' responsibilities often include independent decisions on engineering policies and procedures for overall programs, provision of technical advice to management, detailed technical responsibility for product development and the provision of specialized engineering systems and facilities and the coordination of work programs, administrative function, directing several professional and other groups engaged in inter-related engineering responsibilities or as an engineering consultant. This level independently conceives programs and problems to be investigated and participates in their resolution within existing organizational operating and management arrangements. Typical reporting line is to senior management.
- **Above Level 5 Professional Engineer**; this level is predominantly engineering senior management positions including, Managing Director, Chief Executive Officer and Group General Manager.
-

8.3 The Ages of Engineers

Census statistics show that the average age of the engineering team in 2006 was 41.7 years; 42.3 years for men and 36.5 years for women. Because the ABS treats Bachelors degrees as having durations between three and six years, it is not feasible to establish similar figures for professional engineers, so at best census statistics serve as an approximate benchmark.

The average ages for private sector professional engineers since 2000 are shown in Table 8.1. Public sector equivalents are shown in Table 8.2. In both cases, responsibility levels are employed to establish a perspective on the ages of engineers at different stages of their careers. The trends in these Tables are illustrated in Figures 8.1 and 8.2 respectively.

In general, average ages are younger in the private sector than in the public sector. The smallest sectoral difference is at level 1 and the largest at level 2, suggesting a greater reluctance in the public sector to promote engineers. From level 2 onwards, the sectoral difference diminishes with seniority but remains substantial.

[21] APESMA, op cit, December 2007, pp8-9

Table 8.1: The Average Ages of Private Sector Professional Engineers

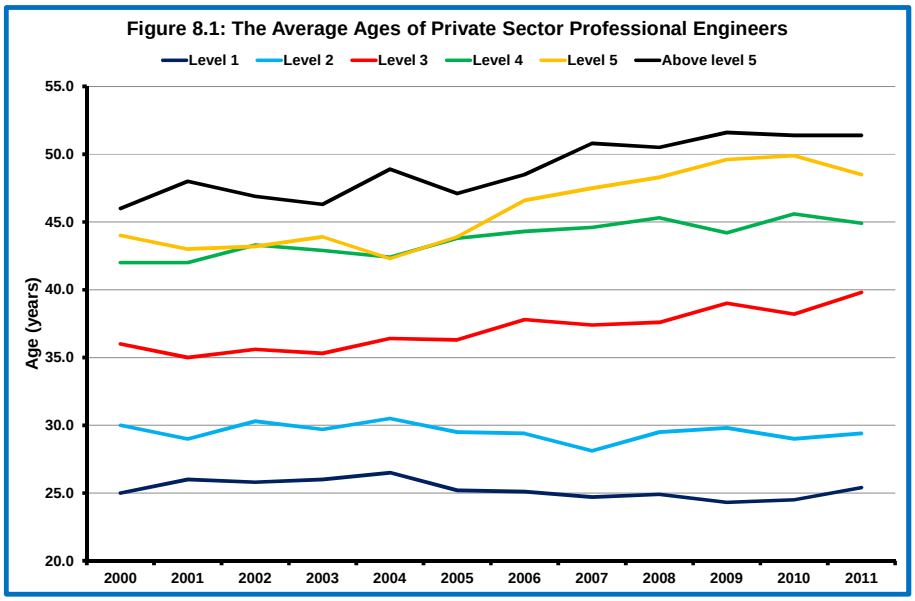
Year	Level 1	Level 2	Level 3	Level 4	Level 5	> Level 5
2000	25.0	30.0	36.0	42.0	44.0	46.0
2001	26.0	29.0	35.0	42.0	43.0	48.0
2002	25.8	30.3	35.6	43.3	43.2	46.9
2003	26.0	29.7	35.3	42.9	43.9	46.3
2004	26.5	30.5	36.4	42.4	42.3	48.9
2005	25.2	29.5	36.3	43.8	43.9	47.1
2006	25.1	29.4	37.8	44.3	46.6	48.5
2007	24.7	28.1	37.4	44.6	47.5	50.8
2008	24.9	29.5	37.6	45.3	48.3	50.5
2009	24.3	29.8	39.0	44.2	49.6	51.6
2010	24.5	29.0	38.2	45.6	49.9	51.4
2011	25.4	29.4	39.8	44.9	48.5	51.4

Source: APESMA, Professional Engineer Remuneration Survey Reports

Table 8.2: The Average Ages of Public Sector Professional Engineers

Year	Level 1	Level 2	Level 3	Level 4	Level 5	> Level 5
2000	28.0	37.0	42.0	47.0	48.0	49.0
2001	29.0	37.0	41.0	47.0	48.0	50.0
2002	29.2	39.7	41.5	47.2	48.2	50.0
2003	28.4	37.3	42.5	47.4	49.0	51.1
2004	28.2	39.3	40.4	46.5	47.2	50.7
2005	27.1	38.1	42.5	47.2	47.1	52.2
2006	27.0	33.4	42.6	47.4	50.5	52.2
2007	25.4	33.7	43.8	47.7	49.1	53.6
2008	26.5	34.6	41.7	48.6	49.7	53.8
2009	25.9	35.2	42.3	48.0	51.9	55.1
2010	26.4	31.4	43.8	48.7	50.3	53.5
2011	28.0	33.7	44.6	48.7	50.1	51.6

Source: APESMA, Professional Engineer Remuneration Survey Reports



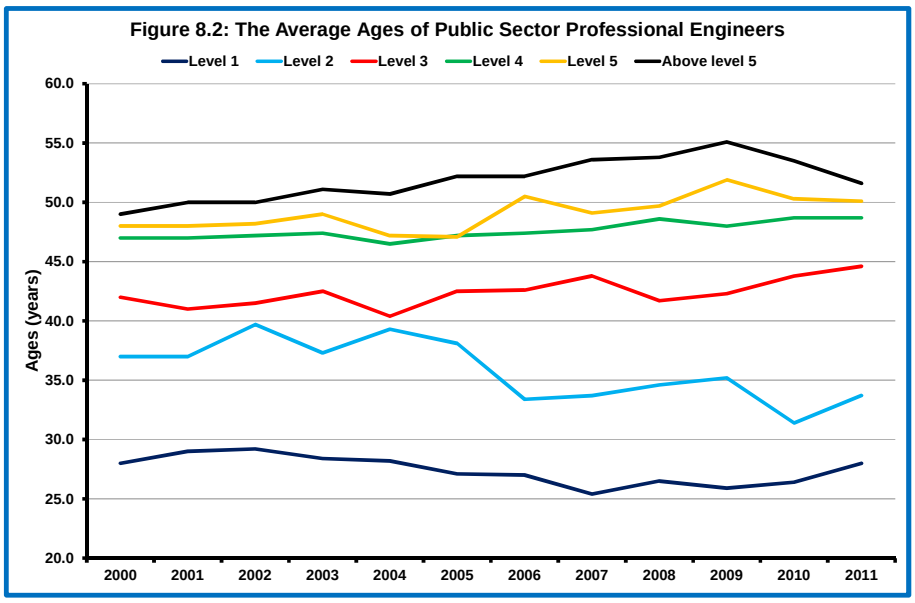
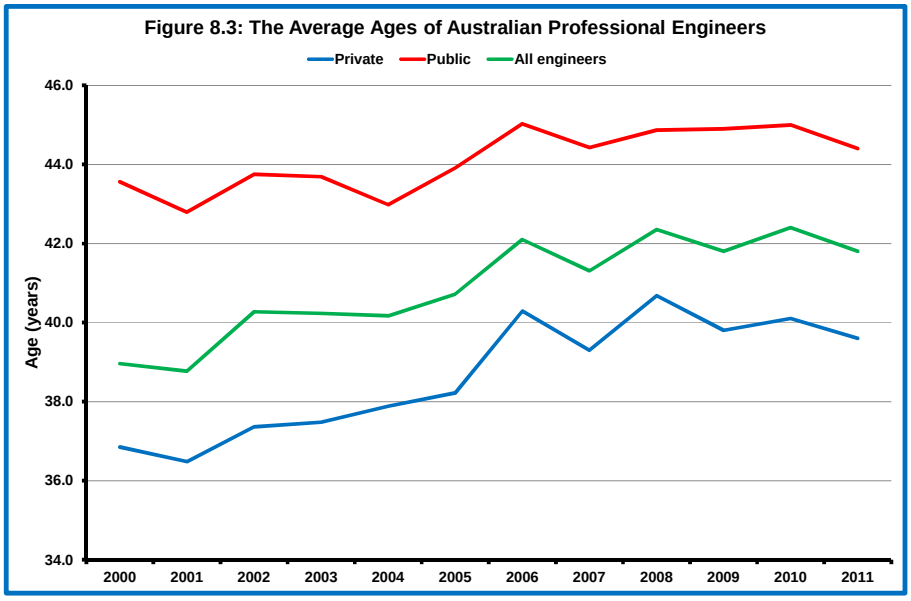


Table 8.3: The Average Ages of Professional Engineers Overall

Year	Private sector	Public sector	All engineers
1997	35.6	42.2	38.7
1998	35.9	42.6	38.3
1999	36.4	42.4	38.3
2000	36.9	43.6	39.0
2001	36.5	42.8	38.8
2002	37.4	43.8	40.3
2003	37.5	43.7	40.2
2004	37.9	43.0	40.2
2005	38.2	43.9	40.7
2006	40.3	45.0	42.1
2007	39.3	44.4	41.3
2008	40.7	44.9	42.4
2009	39.8	44.9	41.8
2010	39.1	45.3	42.0
2011	38.5	43.6	40.8

The average ages for responsibility levels 1 and 2 in both sectors have trended downwards since 2000, more so in the public than in the private sector but there was a change in the last year. The trend for levels 3 onwards in both sectors show average ages increasing, with the degree of increase rising with seniority. In other words, junior engineers have been getting younger but more senior engineers have been getting older.

The net effect of these changes is summarised in Table 8.3 which shows the average ages for each sectors and the two combined. The average ages of professional engineers have increased in both sectors. There was a noticeable change in 2011, most likely reflecting the heavy dependence on skilled migration where policy favours younger ages.



8.4 Work Experience

Engineers, like other professions, are expected to demonstrate their capacity to practice engineering independently of supervision, in part through work experience. Work experience is also a key factor in the decisions made by employers to engage engineers. Thus Tables 8.4 and 8.5 set out the average periods of work experience of engineers in the two sectors of the economy and Figures 8.3 and 8.4 illustrate salient trends.

The parallel between age and work experience is fairly evident in the illustrations. As was the case for age, public sector engineers have longer work experience at all responsibility levels than private sector engineers. The smallest difference is at responsibility level 1 and the greatest difference is at responsibility 2 with the degree of difference steadily diminishing with seniority.

Table 8.4: Average Work Experience of Public Sector Professional Engineers

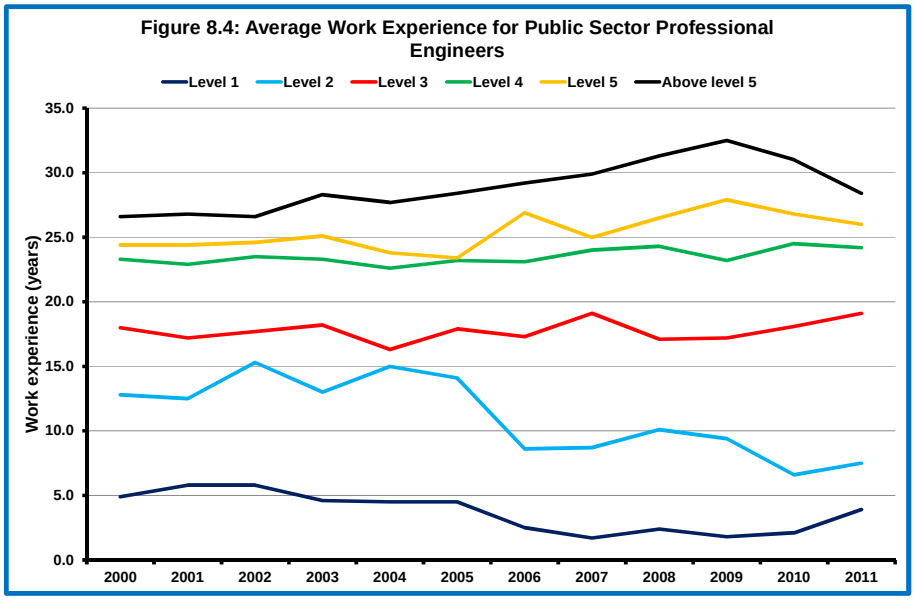
Year	Level 1	Level 2	Level 3	Level 4	Level 5	> Level 5
2000	4.9	12.8	18.0	23.3	24.4	26.6
2001	5.8	12.5	17.2	22.9	24.4	26.8
2002	5.8	15.3	17.7	23.5	24.6	26.6
2003	4.6	13.0	18.2	23.3	25.1	28.3
2004	4.5	15.0	16.3	22.6	23.8	27.7
2005	4.5	14.1	17.9	23.2	23.4	28.4
2006	2.5	8.6	17.3	23.1	26.9	29.2
2007	1.7	8.7	19.1	24.0	25.0	29.9
2008	2.4	10.1	17.1	24.3	26.5	31.3
2009	1.8	9.4	17.2	23.2	27.9	32.5
2010	2.1	6.6	18.1	24.5	26.8	31.0
2011	3.9	7.5	19.1	24.2	26.0	28.4

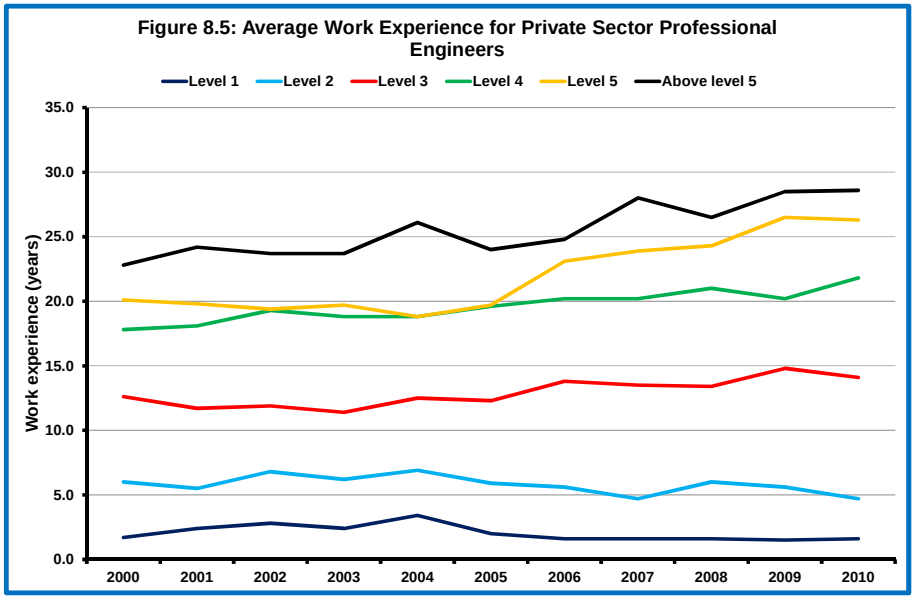
Source: APESMA, Professional Engineer Remuneration Survey Reports

TABLE 8.5: Average Work Experience for Private Sector Professional Engineers

Year	Level 1	Level 2	Level 3	Level 4	Level 5	> Level 5
2000	1.7	6.0	12.6	17.8	20.1	22.8
2001	2.4	5.5	11.7	18.1	19.8	24.2
2002	2.8	6.8	11.9	19.3	19.4	23.7
2003	2.4	6.2	11.4	18.8	19.7	23.7
2004	3.4	6.9	12.5	18.8	18.8	26.1
2005	2.0	5.9	12.3	19.6	19.7	24.0
2006	1.6	5.6	13.8	20.2	23.1	24.8
2007	1.6	4.7	13.5	20.2	23.9	28.0
2008	1.6	6.0	13.4	21.0	24.3	26.5
2009	1.5	5.6	14.8	20.2	26.5	28.5
2010	1.6	4.7	14.1	21.8	26.3	28.6

Source: APESMA, Professional Engineer Remuneration Survey Reports





Once again, there are downwards trends for responsibility levels 1 and 2 in both sectors, suggesting that younger engineers are moving from these ranks to higher levels of responsibility faster than was previously the case. From level 3 onwards, the trends show

that average work experience rises with the degree of increase depending on seniority. In the public sector, the trends for responsibility levels 5 and above 5 have departed from this pattern in recent years, possibly reflecting the retirements of incumbents and their replacement by younger individuals. There also appears to be some change at responsibility level 1 with the length of work experience increasing.

8.5 Salary Packages

Trends in salary packages for professional engineers in the public and private sectors are summarised in Tables 8.6 and 8.7 respectively.

Table 8.6: Average Salary Packages for Public Sector Professional Engineers

Year	Level 1	Level 2	Level 3	Level 4	Level 5	> Level 5
2000	46631	63423	73361	88824	103265	181818
2001	53055	65426	76451	91863	110276	162933
2002	54373	68744	78240	95105	114067	152316
2003	54606	69536	79941	99881	118755	154710
2004	54599	70524	79676	100533	119385	156599
2005	58287	74843	83329	107197	122616	174749
2006	63285	84328	91844	111052	133185	192196
2007	63535	85384	98664	118833	142997	176529
2008	70754	88651	103325	125394	151387	198850
2009	71571	95034	110307	132450	159729	228699
2010	83200	94878	113198	139449	165396	222321
2011	78081	96575	117019	144523	171126	209184

Source: APESMA, Professional Engineer Remuneration Survey Reports

Table 8.7: Average Salary Packages for Private Sector Professional Engineers

Year	Level 1	Level 2	Level 3	Level 4	Level 5	> Level 5
2000	48081	60897	74765	95275	114206	187468
2001	51503	60484	75707	97547	115901	173646
2002	50597	64995	81192	106729	120076	181688
2003	51455	65438	80574	103891	127149	181468
2004	53277	64989	81045	108929	125415	192623
2005	56757	71121	84590	113328	131810	219408
2006	60006	77148	96671	129719	157797	224784
2007	66098	80726	103971	136672	173580	267480
2008	69684	92838	112678	150957	183428	263493
2009	76717	89658	116856	154179	199355	248915
2010	74359	95562	122389	163535	224035	300165
2011	74840	97219	126394	167203	225139	323502

Source: APESMA, Professional Engineer Remuneration Survey Report

There is a perception in the community that engineers are well remunerated and the statistics in the Tables support this view. However, there are also attractive salaries available in occupations outside of engineering. As well as the value of salary packages, movements in values over time are important to decisions made by individuals.

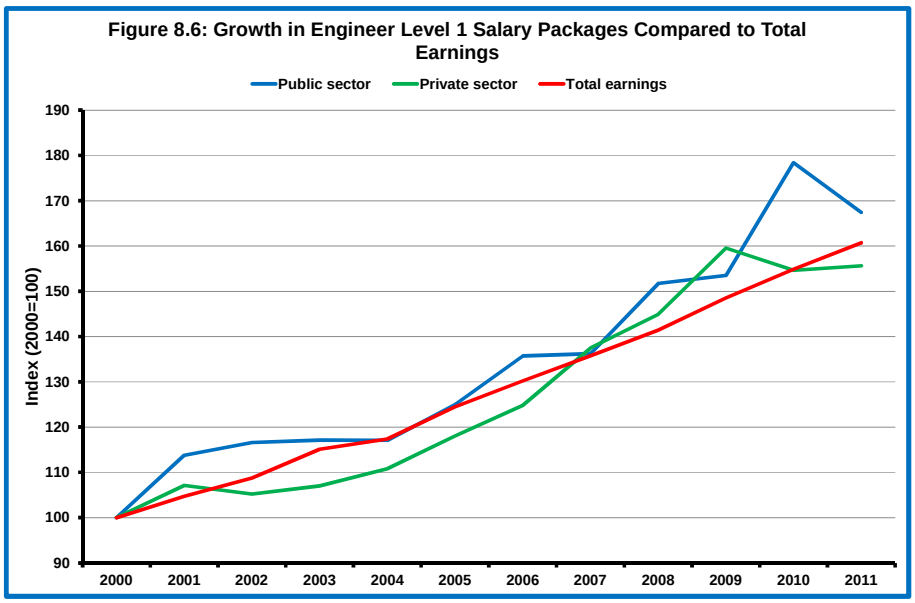


Figure 8.6: Growth in Engineer Level 1 Salary Packages Compared to Total Earnings
Public sector
Private sector
Total earnings
Index (2000=100)
190
180
170
160
150
140
130
120
110
100
90
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

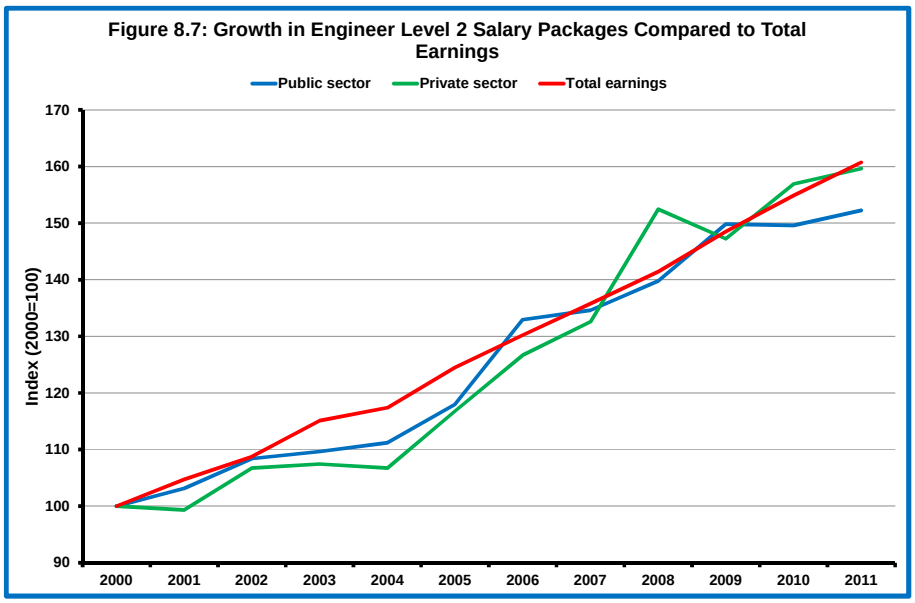


Figure 8.7: Growth in Engineer Level 2 Salary Packages Compared to Total Earnings
Public sector
Private sector
Total earnings
Index (2000=100)
170
160
150
140
130
120
110
100
90
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

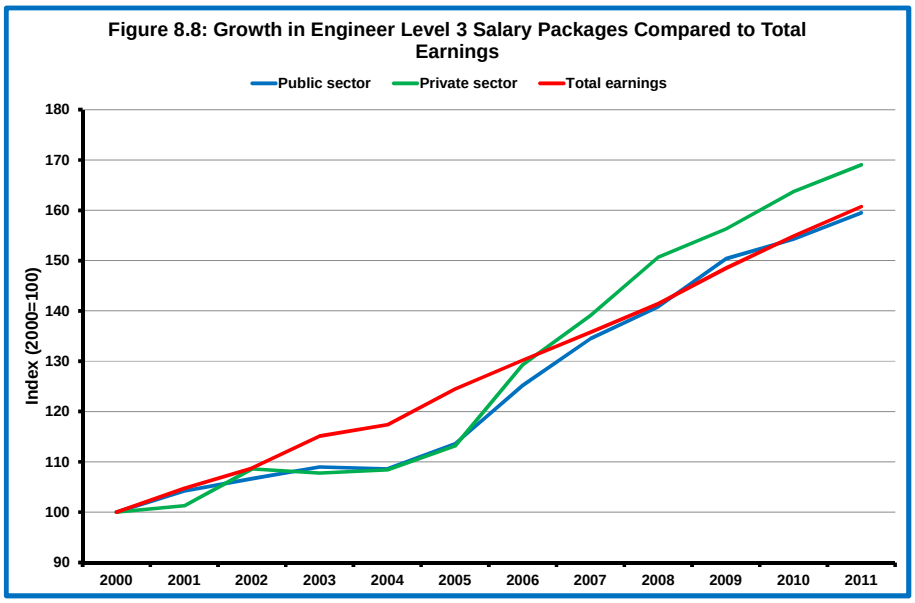


Figure 8.8: Growth in Engineer Level 3 Salary Packages Compared to Total Earnings
Public sector
Private sector
Total earnings
Index (2000=100)
180
170
160
150
140
130
120
110
100
90
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

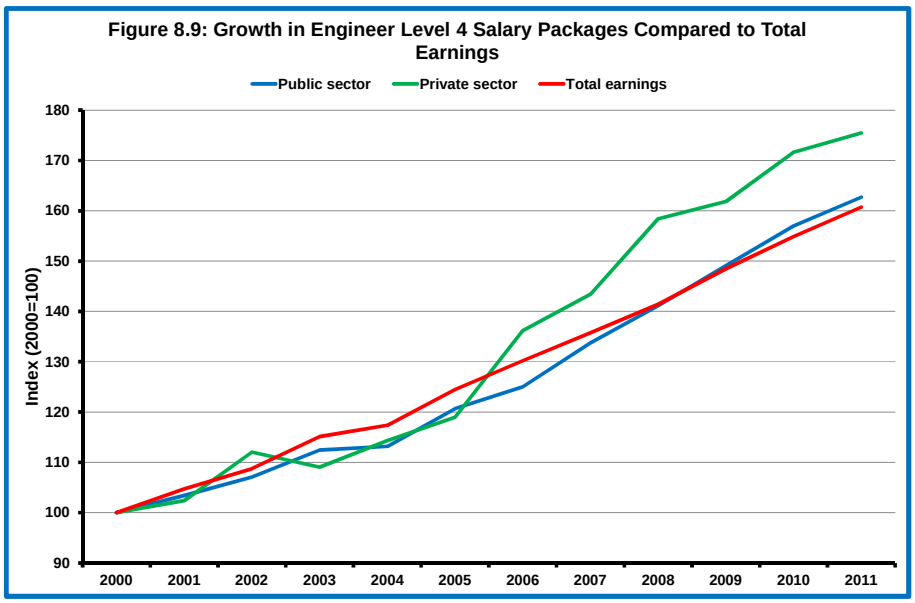


Figure 8.9: Growth in Engineer Level 4 Salary Packages Compared to Total Earnings
Public sector
Private sector
Total earnings
Index (2000=100)
180
170
160
150
140
130
120
110
100
90
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

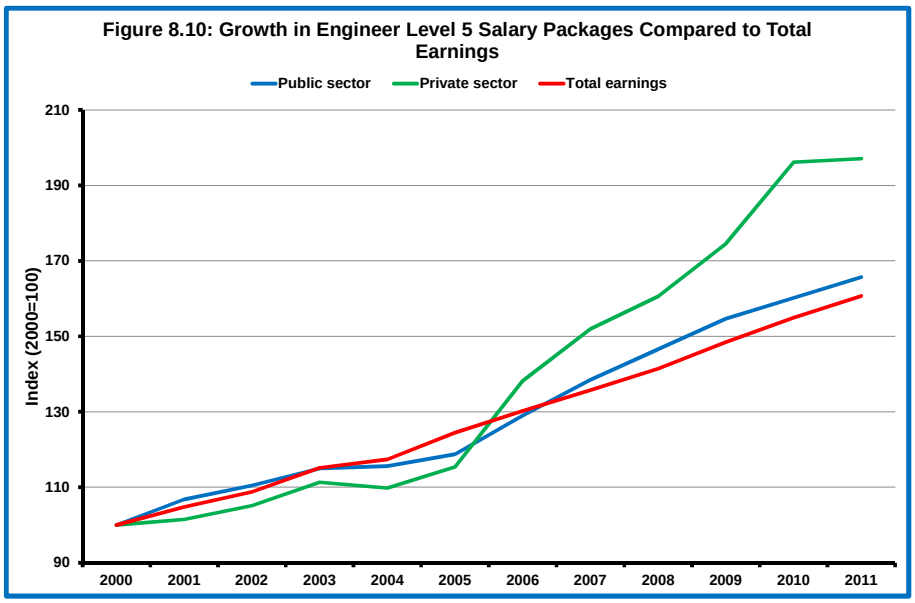


Figure 8.10: Growth in Engineer Level 5 Salary Packages Compared to Total Earnings
Public sector
Private sector
Total earnings
Index (2000=100)
210
190
170
150
130
110
90
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

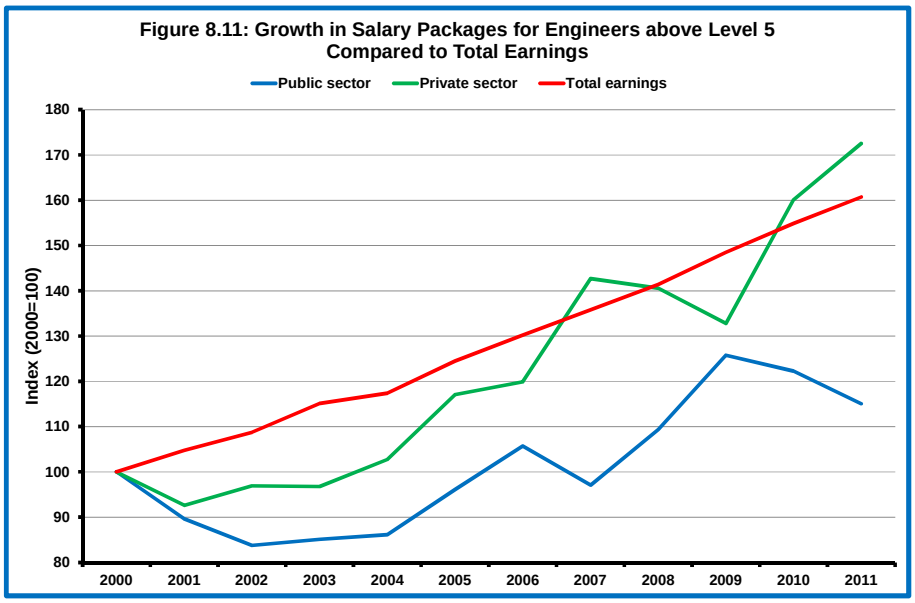


Figure 8.11: Growth in Salary Packages for Engineers above Level 5 Compared to Total Earnings
Public sector
Private sector
Total earnings
Index (2000=100)
180
170
160
150
140
130
120
110
100
90
80
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011

Figures 8.6 to 8.11 explore how changes in the value of public and private sector salary packages for professional engineers compare to changes in total earnings[22]. Changes in total earnings are often used as a benchmark indicator in the economy generally and as a proxy for competitive pressures from other opportunities. To avoid complexities associated with salary levels, index numbers are used to facilitate comparisons. Key observations are:

- Level 1: Public sector salary packages have generally tracked above total earning but in the private sector there was a prolonged period up to 2007 where salaries tracked slower than total earnings. During the last year salary packages in both sectors fell, with the private sector tracking slower than total earnings.
- Level 2: Salary packages in both sectors have tracked below total earning for much of the decade except for isolated years. Last year saw deterioration in relative salaries growth.
- Level 3: Until about 2007, salary packages in both sectors grew slower than total earnings. From then onwards, private sector packages grew well above total earnings and this continued in the last year. Public sector package growth has barely kept up with total earnings during this period, including the last year.
- Level 4: Private sector salary packages grew below total earnings until 2006 and then accelerated to grow well above, growth that has continued over the past year. Public sector salary packages grew below total earnings until 2008 and since then have barely kept pace with total earnings.
- Level 5: Both sectors experienced salary package changes below total earnings until about 2005-06. There followed pronounced growth in private sector packages with some slow-down in growth in the last year but at a level well above total earnings. Public sector growth was below total earnings until 2006 and then experienced acceleration to above total earning but at a pace well below the private sector.
- Above Level 5: Both sectors experienced growth in salary packages well below growth in total earnings with the public sector lagging well behind the private sector.

One of the consequences of skills shortages is to build-up pressures on salaries. So far as the public sector is concerned there is little evidence of this, indeed, things point in the other direction, public sector salary packages for engineers have generally grown more slowly than total earnings with comparatively few exceptions.

Private sector salary packages for professional engineers have displayed some reaction to engineering skills shortages for levels 3 to 5. However, salary package changes for Levels 1 and 2 do not display this reaction, nor do the changes for the most senior level.

[22] ABS, Average Weekly Earnings, Australia, Cat. No 6302.0, electronic time series, original series, www.abs.gov.au

9 ASSESSING THE LABOUR MARKET

Key Messages

The engineering labour market is not homogeneous. It is segmented by fields of specialisation, experience and geography. Other important factors are the length of education and training to achieve the competence to operate independently, high demand for people with engineering qualifications outside of engineering and the inability to substitute other skills for engineering skills.

These considerations mean that conventional labour market statistics can be useful guides to the broad circumstances in the engineering labour market but are likely to be poor indicators of the market for engineers with specific skills and experience, especially when location is also an issue. Therefore, a range of indicators need to be employed.

At the aggregate level, the engineering labour market remains constrained but there are tentative signs of some easing. The markets for degree and diploma qualified engineers have moved in opposing decades and whether this continues is a factor. If it does the economic prospects of industries losing diploma qualified engineers will determine the amount of pressure that will develop in the degree market.

DEEWR vacancies survey still show high levels of vacancies for engineers in contrast to an easing market for other professionals. The survey also shows this to be geographically widespread and prevalent in resource boom jurisdictions but also in NSW, and to some extent, Victoria.

Engineers Australia's skill shortage survey indicates that the engineering labour market has weathered the impacts of the GFC and is moving towards the characteristics it displayed prior to the GFC; large proportions of employers experiencing difficulties finding the engineers they need, the problems distributed across several fields of engineering and geographically widespread. As yet the severe market tightness evident prior to the GFC is not evident but the change is in that direction.

Compounding these factors is the fact that about 60% of people qualified to be engineers choose to work in engineering. All fields of endeavour lose qualified people to other spheres of activity. In engineering, the high degree of variability in demand is a factor that warrants further research.

9.1 The Engineering Labour Market

The engineering labour market is often discussed as though it is a homogeneous market for engineering services. It is important to establish an overview of demand for, and supply of, engineering services, but it is just as important to consider the attributes of the market that distinguish it from other labour markets. These attributes include:

- Engineering skills are highly specialised and substitution of engineering skills with other skills does not work.
- But, engineering skills can successfully substitute for a wide range of analytical and management skills in non-engineering work.
- To become a fully competent engineer lengthy training is necessary. Academic entry level courses are up to four (sometimes five) years full time in duration and this is followed by a period of practical experience and professional formation of at least three years.

- There are numerous fields of specialisation in engineering; while large areas of knowledge are common to most fields of engineering, career development and the acquisition of practical experience occurs within specialisations so that in reality there is limited, and at times, no substitution between engineers from different fields.
- Practical experience is critical; in determining an engineer's capacity to make independent engineering and design decisions and in meeting the requirements of many projects and positions.
- Geographic location and labour mobility are also critical; technology has facilitated the remote delivery of some engineering services, but many continue to require on the ground attention from individuals with appropriate engineering work experience in the fields of engineering appropriate to the projects at hand.

These attributes were among the reasons why Skills Australia included nearly all engineering occupations in its list of specialised occupations[23]. When articulating this concept, Skills Australia noted that for specialised occupations "the impact of market failure is potentially significant"[24].

This Chapter reviews available statistics on the Australian engineering labour market in the light of these parameters to assess the current situation.

9.2 Aggregate Considerations

The key results outlined in Chapter 3 for the aggregate engineering labour market were:

- Since 2001, the engineering population (the population with engineering team qualifications) has grown by an average 4.5% per annum and in 2010 was 48.6% larger than in 2001.
- Since 2001, the supply of engineers has grown by an average 4.8% per annum, mainly reflecting growth in the engineering population, but also some growth in the labour force participation rate. In 2010, the supply of engineers grew by 2.8%.
- The labour force participation rate for engineers is exceptionally high and much higher than for other skilled areas. In 2010, the participation rate was 90.1%.Since 2001, the demand for engineers has grown at the same average rate as the supply of engineers, although there are annual differences. In 2010, demand grew by 3.2%.
- The changed circumstances resulting from the global financial crisis (GFC) reduced the demand for engineers below the decadal trend, and although there was some increase in the engineering unemployment, a larger number of engineers left the work force;
    - Between 2008 and 2009, the number of engineers who were unemployed increased by 6,500 (to 14,700) but by 2010 unemployment was falling (to 13,700).
    - In 2008, the labour force participation rate peaked at 91.5%. By 2009 it had begun to fall (to 91.2%) and continued falling in 2010 (to 90.1%). During this period 8,500 engineers left the labour market.

In 2010, the engineering unemployment rate was 3.7% and falling even though both demand and supply were weaker than before the GFC. These indicators suggest that that the aggregate engineering labour market had cooled but provide no further insight into the market attributes discussed above.

[23] Skills Australia, Australian Workforce Futures, A National Workforce Development Strategy, 2010, www.skillsaustralia.gov.au
[24] Op cit, p21

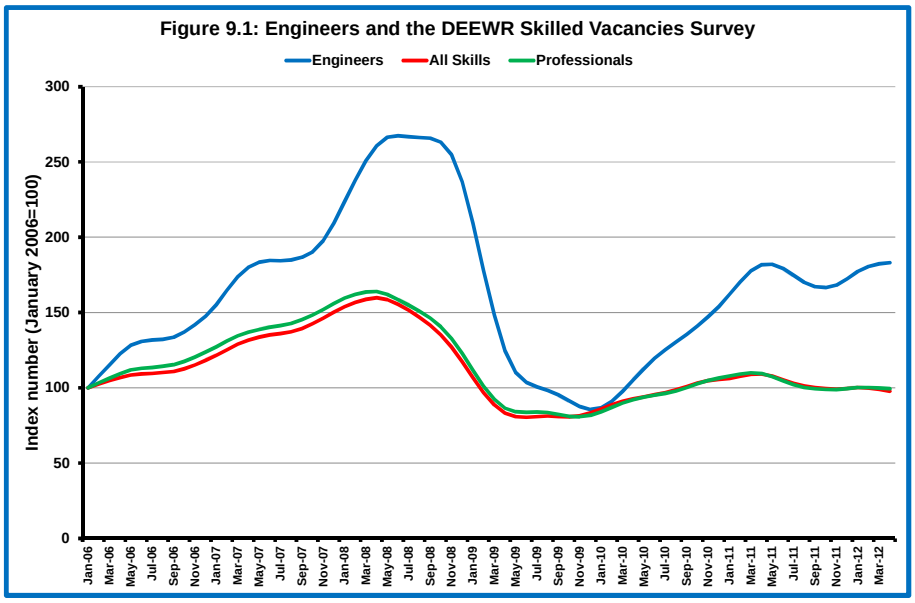
9.3 The DEEWR Skilled Vacancies Survey

This section provides an alternative approach to aggregate analysis of the engineering labour market. The basis for discussion is the DEEWR vacancies and skilled vacancies surveys. These surveys are part of the research that DEEWR undertakes to inform the decision-making process for the Skills Australia skilled occupation list and other policy decisions relating to skills shortages.

The surveys are essentially "informed intelligence" exercises that draw on the work of local DEEWR staff that have contact with employers. The focus of the research is employers who advertise vacancies in newspapers, on the internet and other methods. In some cases, information is gleaned directly from newspaper and internet advertisements and in other cases employers are contacted directly. The surveys are occupation based and use the ANZSCO classification. Details of the survey methodology are outlined in a paper available from DEEWR[25].

Before proceeding to discuss the results of the DEEWR survey, it is important to point out the relationship between the engineering labour force as it is used in the Statistical Overview and the term "engineers" as used in the DEEWR work. In the Statistical Overview, the engineering labour force is the segment of the population that has formal qualifications in engineering consistent with Engineers Australia's view of the engineering team. There are no limits on the occupations in which the engineering labour force is employed. In contrast, DEEWR does not rigorously impose educational qualifications and aims to cover all the occupations in the ANZSCO system; however the individuals in the occupations concerned are qualified. In practice, DEEWR's approach is reasonably consistent with the "engineering occupations" component of the engineering labour market, that is, the engineering professionals component of the ANZSCO classification that is about 25% of the engineering labour force.

Since DEEWR's research is an input to the decision on SOL occupations and these occupations are mainly engineering professionals, supplemented by small numbers of engineering technologists and engineering associates, the DEEWR vacancies index provide additional insights to changes in the engineering labour market and should be used for this purpose. The impression of precision conveyed by the index is not supported by its methodology.



[25] DEEWR, Skills Shortage Methodology, 2010, www.deewr.gov.au

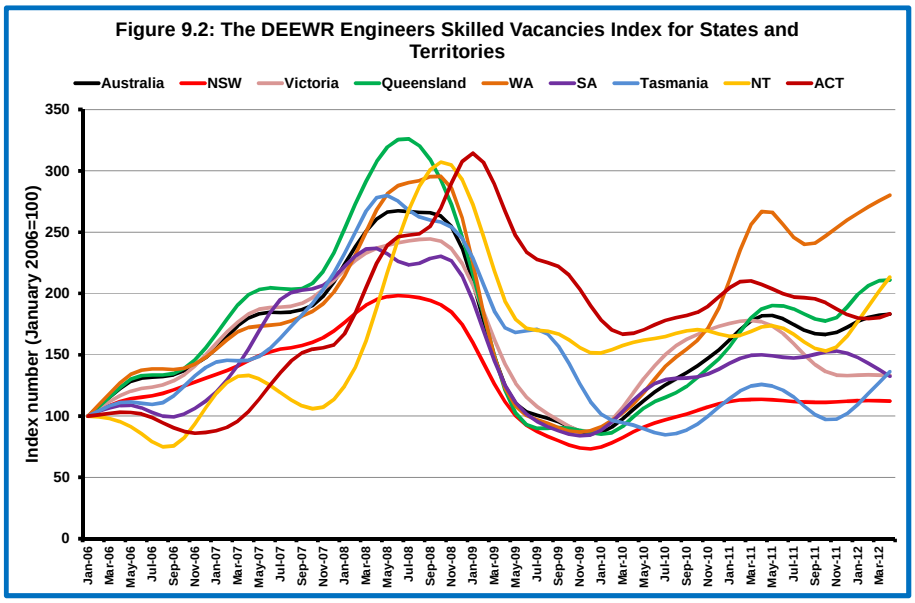


Figure 9.1 compares the DEEWR vacancies indexes for “engineers”, all skills and all vacancies for the six years to April 2012. The all skills index includes a range of professional, technician and trades skills. The “engineers” index shows the pressures from skills shortages prior to the GFC, the slump in demand for “engineers” that was caused by the GFC and the subsequent recovery. The comparison suggests that the demand for “engineers” has recovered but not to the pressure-cooker levels prior to the GFC. In April 2012, the “engineers” index was 183.1, compared to a peak of 267.4 in June 2008 and a low of 85.6 in December 2009. In Figure 9.1 there is a clear difference between the “engineers” index and the indexes for all skills and all vacancies where the indexes remain at or about the level of January 2006.

Figure 9.2 illustrates a disaggregation of the DEEWR “engineers” index for States and Territories. The black line in this illustration is the “engineers” index for Australia as shown in Figure 9.1. Several observations can be made:

- The vacancies indexes for all States and Territories have recovered to values above 100.
- In April 2012, the highest values for the indexes were in WA and Queensland. These values were considerably above the national level and suggest severe pressures. It is important to note the steep plunges in the indexes for these States in the GFC and the subsequent steep recoveries.
- NSW, Victoria, SA and Tasmania displayed the GFC contraction and subsequent recovery but the latter was below the level achieved nationally. The value of the index in NSW has recovered above 100 but is at its lowest level of all jurisdictions.
- The ACT and NT indexes did not show the GFC contraction into negative values evident in other jurisdictions and have remained at relatively high levels although some contraction was evident.

In summary, these indicators suggest a similar perspective to the Education and Work statistics discussed in the previous section. The GFC brought the severe pressures that had built up in the engineering labour market to an end. There has been a solid recovery since with a build-up in pressure but not to the extent evident before the GFC. This build-up of pressure is not uniform among jurisdictions with severe pressures in some but flat conditions in others.

9.4 The Labour Market for Particular Engineers

This section draws out the implications of the educational entry level completion statistics discussed in Chapter 6 and the skilled migration statistics covered in Chapter 7. The background to the analysis is the aggregate engineering labour market. Demand was growing faster than supply and larger than normal numbers had left the labour force. Disaggregated statistics are not available for demand and supply, but the annual increments in supply are and in the circumstances outlined can be used as an indicator of changes in disaggregated markets.

Professional Process and Resource Engineers

This group of engineers includes chemical engineers, petroleum engineers, materials engineers and mining engineers.

- In 2010-11, there were 746 completions of four year bachelors degrees (567 and increasing over past three years) and four year double bachelors degrees (179, down from peak of 196 in 2006).
- Education completions have grown slowly over the decade and were 114 higher than in 2001-2.
- In2010-11, education completions and permanent skilled migration increased the new supply of the group by 1,357 (55.0% education and 45.0% skilled migration)
- However, the increase in new supply was bolstered to 2,107 by 750 temporary migrants reducing the contribution of education to 35.4% (permanent migration 29.0% and temporary migration 35.6%).

Almost two-thirds of the increase in supply of professional process and resource engineers was sourced from skilled migration. In the context of falling unemployment, this suggests strong demand.

Professional Mechanical and Industrial Engineers

This group closely matches the above title.

- In 2010-11, there were 801 education completions of four year bachelors degrees (621) and four year double bachelors degrees (180). Completions fell until about 2005-06 and have grown slowly since.
- In 2010-11, education completions and permanent migration increased the new supply of mechanical and industrial engineers by 1,973 (40.6% education and 59.4% permanent migration).
- Temporary migration bolstered the increase in new supply to 2,613, further reducing the contribution of education (to 30.7% with permanent migration 44.9% and temporary migration 24.4%).

Seven out of ten new professional mechanical and industrial engineers joining the workforce were sourced from skilled migration at a time of falling aggregate unemployment. This suggests strong demand.

Professional Civil Engineers

This group includes civil engineers, structural engineers, transport engineers and geotechnical engineers.

- In 2010-11, there were 1,036 completions of four year bachelors degrees (846) and four year double bachelors degrees (190). Completions had fallen until 2006-07 but since then have increased faster than any other area of engineering.
- The addition to new supply in 2010-11 from education completions and permanent migration was 2,146 (48.3% education and 51.7% permanent migration).

- New supply also increased as a result of 1,080 temporary migrants coming to Australia so that total new supply for the year was 3,226 (education 32.1%, permanent migration 34.4% and temporary migration 33.5%).
- A feature of temporary migration was the inclusion of 110 geotechnical engineers for the first time.

Even though education completions grew fastest for this group, two-thirds of additional new supply came from skilled migration. In the context of falling aggregate unemployment, these indications suggest strong demand.

Professional Electrical and Electronic Engineers Australia

This group includes electrical engineers, electronic engineers, computer engineers and communications technologists. When matching education and migration statistics the question of where software engineers fits arises. Some computer engineers specialise in software engineering but many software engineers study IT degrees and not engineering. There is no simple way to resolve this problem, but a conservative approach to the purpose of this section suggests that software engineers be excluded in the comparison that follows.

- In 2010-11, there were 792 education completions; 602 four year bachelors degrees and 190 four year double degrees. This was about half the completions at the beginning of the decade when this group recorded more completions than any other field of engineering.
- The increase in new supply was 2,283 in 2010-11 (792 education completions or 35.7% and 1,491 permanent migrants or 64.3%).
- Although an 8.7% increase over 2003-04 (when the increase in new supply was 2,101), the relative shares of education and permanent migration were reversed (in 2003-04 there were 1,689 education completions or 80.4% and 412 permanent migrants or 19.6%).
- Most of the growth in new supply has been from temporary migrants; in 2010-11, there were 500 temporary migrants so that the addition to new supply increased to 2,783; in 2003-04, there were 210 temporary migrants, and the increase in new supply was 2,311.

In summary, these indications suggest that the demand for electrical and electronics engineers has experienced slow growth with evidence of some shortages. The main argument for maintaining permanent migration levels is to counter the reduction in education completions. The level of temporary migration suggests that demand is rising.

Professional Aeronautical Engineers Australia

This group is one of the smaller fields of engineering accounting for about 5% of engineering employment.

- In 2010-11, there were 256 education completions compared to 142 in 2003-04.
- Permanent migration was also a small share of engineering migration but moderately high compared to education outcomes. In 2010-11, 76 professional engineers migrated to Australia compared to 25 in 2003-04.
- Temporary migration was also quite low with 30 in 2010-11, compared to 20 in 2003-04.

The demand for professional aeronautical engineers continues to grow and outstrip entry level completions in Australia. The presence of temporary migration suggests a tight labour market with some shortages.

Other Professional Engineers

The presence of high numbers in "general" and "other" categories in statistical classification systems is a serious impediment to assessments of the engineering labour market. Rather than focus on the difficulties, the following are some observations on changes that stand-out.

- Although education outcomes in manufacturing engineering (52 in 2010-11) are exceptionally low and almost disappeared mid-decade, there was a surprisingly high permanent migration of 85 in 2010-11 and temporary migration of 235.
- The number of biomedical engineers (68 in 2010-11) and environmental engineers (33) among permanent migrant engineers has increased but the number of "other" professional engineers remains high.

Engineering Technologists

Migration statistics for engineering technologists are consolidated and not available by field;

- Education completions are very low and trending downwards. In 2010-11, there were 487 completions.
- Permanent migration has also trended downwards, but in 2010-11 numbers kicked up to 414. Whether this is just a recovery from a GFC dip or something else is unclear.
- Temporary migration has tended to be relatively high but has moved with economic cycles. In 2010-11, 564 engineering technologists came to Australia as temporary migrants.

These statistics suggest that there is a demand for engineering technologists in Australia that exceeds the entry level completions from universities. Migration is high compared to education completions but the two combined are still a small component of the engineering labour market.

Engineering Associates

The majority of education completions are from TAFE colleges but over twenty per cent are from universities. Enrolment statistics suggest the latter may be increasing.

- Total education completions grew from 1,471 in 2003-04 to 1,737 in 2010-11.
- In 2003-04, permanent migration of associate engineers was quite low with only 118 coming to Australia. However, by 2010-11, this had grown to 565.
- Temporary migration has been higher than permanent migration; in 2003-04, 290 temporary associate engineers came to Australia and numbers grew rapidly to 2,070 in 2008-09, falling back to 1,820 in 2010-11 under the influence of the GFC.

Skilled migration of associate engineers is currently much higher than entry level education completions and temporary migration has been dominant.

9.5 Engineers Australia Skills Shortage Survey

This section discusses the results of Engineers Australia's survey of skills shortages. Engineers Australia conducts an annual salaries survey to track trends in engineering salary and benefits packages[26]. The survey includes several questions dealing with difficulties experienced recruiting engineers. The survey has now been undertaken in six consecutive years, building up a substantial body of information on the experiences that private and public sector entities have in recruiting engineers.

Figure 9.3 shows an overview of survey results and compares them with the corresponding unemployment rate for the engineering labour force from chapter 3. During the first three

[26] See www.engineersmedia.com.au

years of the Engineers Australia survey, Australia experienced severe shortages of skilled engineers and the surveys showed that over 70% of employers had experienced difficulties recruiting engineers in the preceding 12 months in those years.

The 2009 survey results reflected the impact of the global financial crisis. There was a sharp drop in the number of employers who experienced difficulties recruiting engineers accompanied by an increase in the unemployment rate. Over half of employers surveyed still experienced difficulties recruiting engineers even though the higher unemployment rate had increased to 4.1%, reflecting the complex of geographic and specialty issues embedded in the aggregate results. By 2010, the worst of the GFC was over and the proportion of employers experiencing recruiting difficulties increased to 62%, below the levels experienced in the first of the three years shown, but well over half. This trend continued into 2011.

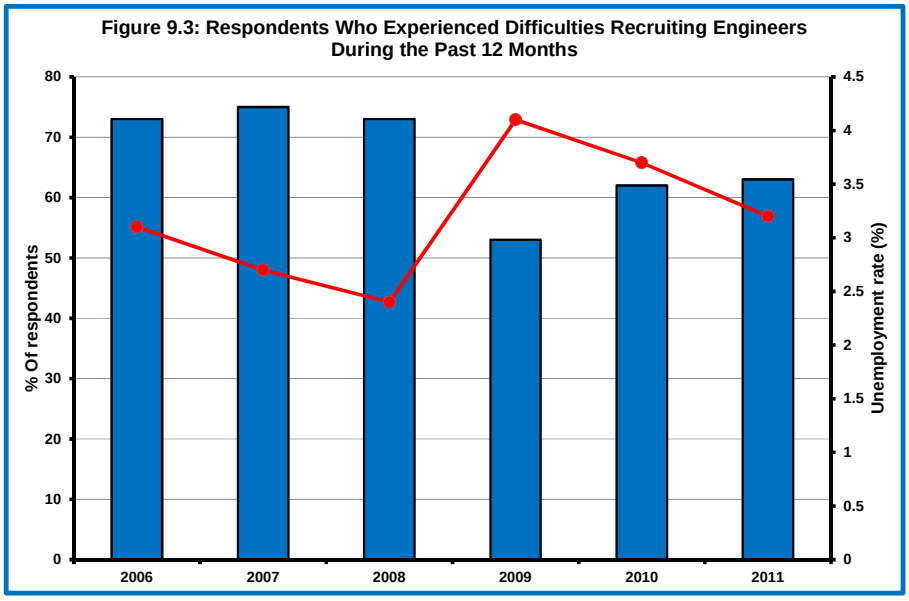
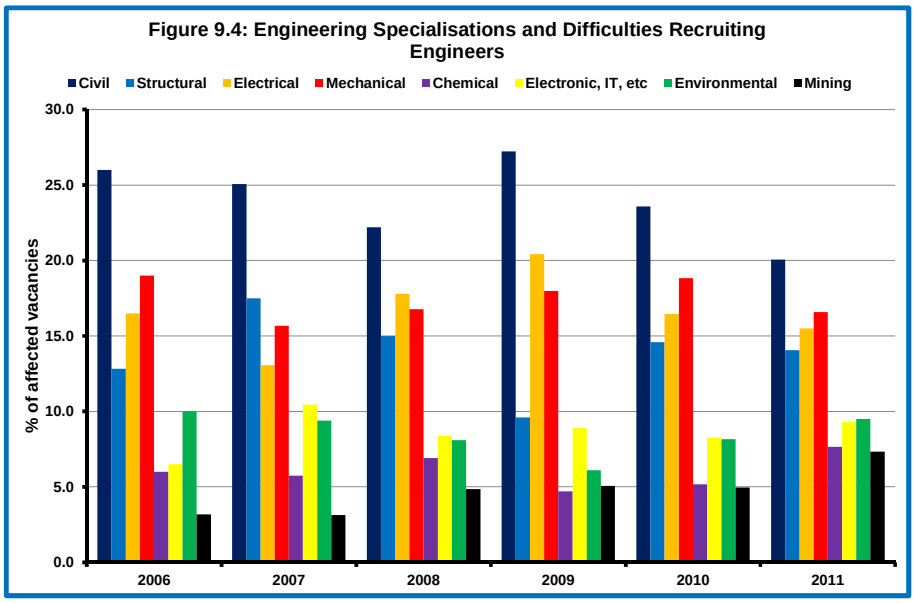


Figure 9.4 shows that recruiting difficulties were widespread among engineering fields of specialisations. Civil engineers consistently featured as the group where most recruiting difficulties occurred, even during the global financial crisis. Mechanical, electrical and structural engineers were other specialisations where significant difficulties were experienced. In the case of structural engineers, the reduction of commercial building during 2009 is reflected in a sharp reduction in difficulties experienced. In the case of electrical engineers, the upsurge of infrastructure work, particularly in electricity transmission and distribution, is reflected in an increase in recruiting difficulties from 2007, peaking in 2009. Mining engineers did not figure as highly as other fields but this should not obscure the critical roles they play. In 2011, there was some evening out of recruiting difficulties across fields of engineering.

Figure 9.5 shows that recruiting difficulties were particularly acute for engineers level 3; average ages for this group are in the upper thirties and a requirement for 14 to 17 years of experience is the norm. This result supports the view that skilled migration policies need to contain provisions for older experienced engineers as well as younger ones to accommodate areas of greatest need. The skilled migration points test has been changed to accommodate this issue. The pattern in 2011 conformed to the historical pattern but with an increase in difficulties experienced for level 1 engineers and a small reduction in difficulties experienced for level 3 engineers.



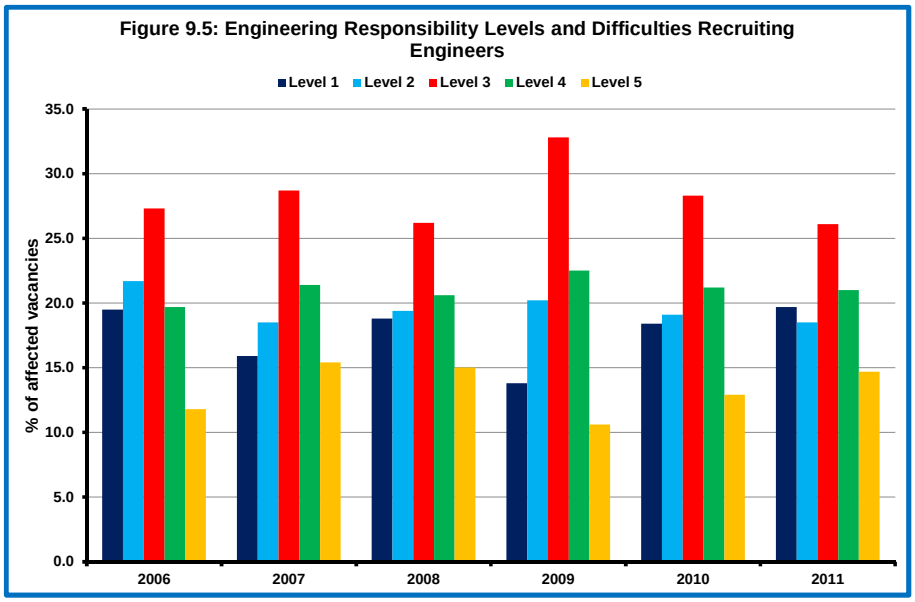


Figure 9.6 shows that persistent recruiting difficulties were experienced in the resource States of Western Australia and Queensland. There were also significant difficulties experienced in NSW and to a lesser degree in Victoria. Figure 9.6 reminds us that the demand for engineers is increased by infrastructure developments as well as the exploitation of commodities.

Multiple difficulties were experienced by respondents recruiting engineers as shown in Table 9.1. The most common difficulty was an inability to recruit the desired skill set. Between 2006 and 2008, at least 80% of respondents raised this issue. During the global financial crisis the proportion fell to 72% but had risen back to 77% by 2010 and into 2011. There was a similar pattern for experiencing longer than expected recruitment periods. In the early years of the survey about two-thirds of respondents reported this experience and even after reduced economic activity in 2008 and 2009 about half of respondents still reported it. In 2011, this issue appeared to be heading back towards historical results. Two symptoms of a tight labour market are that in recent years 30% of respondents reported they could not recruit engineers at all and that the proportion that paid higher than expected salaries is on the rise. Retraining engineers with an inappropriate skill set has risen since the GFC and recently has been steady at a little under one quarter.

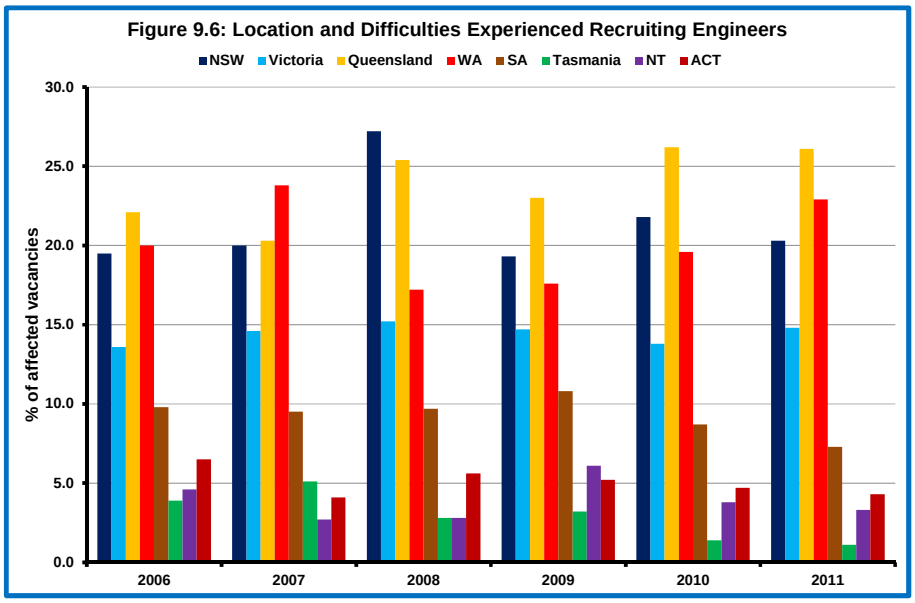


Table 9.1: Difficulties Experienced in Recruiting Engineers (% Respondents)

Difficulties	2006	2007	2008	2009	2010	2011
Could not recruit required skill set	82	80	80	72	77	76
Longer recruitment period	66	64	64	51	51	57
Could not recruit at all	46	40	40	32	29	29
Paid higher than expected salary	42	58	58	32	31	43
Recruited different skill set & retrained	18	28	28	20	24	23
Other	2	2	0	8	3	5

Table 9.2: The Consequences of Difficulties Recruiting Engineers (% Respondents)

Consequence	2006	2007	2008	2009	2010	2011
Minor irritation but no monetary issues	12	10	16	21	10	13
Moderate problems with some monetary problems	39	40	43	43	57	54
Major problems, including project delays & costs	43	42	33	28	29	28
Did not proceed with available project	6	7	8	8	4	6

For society as a whole there are costs involved with shortages of engineers as shown in Table 9.2. While around 10% of respondents (20% during the global financial crisis) described the consequences of the recruiting difficulties they experienced as minor irritations with no monetary issues, over three-quarters reported that some monetary consequences were involved. The proportion that experienced moderate problems with some monetary problems has trended upwards from 39% in 2006 to over half in 2010 and 2011. The proportion that experienced major problems that involved project delays and cost blow-outs has trended downwards from 43% in 2006 to a little under 30% in the last three years. The suggestion here is that employers are adapting to the difficulties of recruiting engineers but the proportion of respondents in both categories remains too high. A small minority of projects (6% in 2011) did not proceed.

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