# **WOMEN IN ENGINEERING**

A Statistical Update

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### **Executive Summary**

Women continue to be under-represented in the engineering profession at considerable cost to the economy. The evidence suggests that young Australia women have the capacity to study mathematics and science at school but this potential is not reflected in the choice of year 12 school subjects where young women account for much of the decline in mathematics enrolments. In school science, few young women study physics and more are inclined to study biology or chemistry. All science enrolments are falling.

Young women account for about 14% of acceptances of places in university engineering courses, a figure that has not changed very much in recent years. Commencements by women in engineering courses at all levels fell in the first half of last decade but there has been some growth since 2006. Bachelor degree commencements fell throughout most of the decade and the 2001 level was not recovered until 2009. There has been a shift in entry level commencements to sub-degree level courses. The women's' share of entry level commencements has been steady in recent years at about 14%. Women engineers have a high propensity for further studies. Their share of masters degree commencements was 18%; higher still for doctoral degree commencements at 24%.

University course completions by women fell for most of the decade and did not recover the 2001 level until 2008. Falling completions was most acute for bachelors degree which in 2010 were still lower than in 2001 level by a large margin. Taking into account all entry level courses, the womens' share of completions is about 16%. For masters degree completions the womens' share is about 18-20% and for doctorate degree completions about 22%.

In the last census there were 32,814 women with engineering qualifications but 8,385 were not in the labour force. Unemployment among women engineers who were in the labour force of 24,429 was 5.2%, almost twice the rate for men, 2.7%, at a time of engineering skill shortage. Generally, this gap prevailed irrespective of the level of qualification held. Over half of the womens' engineering labour force (57%) was born overseas compared to 39% for men.

Women engineers employed full time worked shorter hours than men but women employed part time worked longer hours than men. Men earned more than women irrespective of whether employment was full or part time. The age structure of men engineers was characteristic of a mature, aging population whereas for women it was characteristic of a young population.

The proportion of the engineering labour force employed in engineering work was less for women than for men. Qualifications and country of origin were important factors here with the shares particularly low for women born overseas.

Family responsibilities are clearly a factor in the labour force participation of women. The proportion of women employed full time falls as the number of children increases. Family responsibilities are also linked to unemployment rates with rates increasing with the number of children a women has.

In 2011, women constituted 11.0% of Engineers Australia's overall membership, but only 7.5% of the engineering team membership. Engineers Australia's women members are highly concentrated in the professional occupational category.

The are many outstanding women engineers in Australia. However, the statistics reviewed in this paper suggest that progress towards greater participation by women in engineering has stalled. The factors involved are complex and pose major challenges but they must be faced to achieve real progress.

#### 1. Introduction

In 1987, the participation of women in higher education exceeded men for the first time. Since then the gender gap has increased so that by 2010 the women's' share was 55.6%<sup>1</sup>. The success of women in education led to major changes in the Australian labour market and these changes should be the benchmark for evaluating the progress of women in engineering.

Occupational research<sup>2</sup> shows that over 81% of the engineering labour force is employed as managers, professionals and technicians and trade workers compared to 49% in the labour force as a whole. Yet the womens' share of these occupations is just 8% compared to 36% in the labour market overall. Engineering cannot claim progress in gender equity in these circumstances.

Gender equity is still a critical issue in national policy making, but attention is shifting to the economic inefficiency caused by the gender imbalance, not just in engineering but in other male dominated occupations as well. To put this into perspective, Goldman Sachs JB Were<sup>3</sup> estimated that closing the gender gaps in these occupations has the potential to add 11% per year to Australia's GDP.

Within Engineers Australia, improvements in the participation of women have been championed by the Women in Engineering National Committee. This group has produced the CREW (Career Review into Engineering Women) reports<sup>4</sup> and has been involved in conferences<sup>5</sup> and other activities<sup>6</sup> to support increased participation of women in engineering. This paper contributes to this agenda by updating statistics on the participation of women in engineering to demonstrate that little has changed over the years.

#### **Gender Participation in School Mathematics & Science** 2.

### Mathematical and scientific literacy

Enrolments of boys in school mathematics subjects has been higher than for girls in most Australian jurisdictions encouraging some to conclude that girls are not choosing mathematics because they are less able in this subject than boys. This view is unduly simplistic as will be shown later in the section. In science gender enrolments have been about even, but there appears to be a bias towards boys in the physical sciences and, in the physics sciences, towards physics<sup>7</sup>. This

<sup>&</sup>lt;sup>1</sup> See Higher Education Statistics at <u>www.deewr.gov.au</u>

<sup>&</sup>lt;sup>2</sup> Engineers Australia, The Engineering Profession in Australia; A Profile from the 2006 Population Census, September 2010, www.engineersaustralia.org.au/advocacy

Goldman Sachs J B Were, Australia's Hidden Resource: The Economic Case for Increasing Female Participation, Research Report, 26 November 2009, www.gsjbw.com

<sup>&</sup>lt;sup>4</sup> Pam Roberts and Mary Ayre, Counting the losses The Careers Review of Engineering Women: an investigation of women's retention in the Australian engineering workforce, commissioned by the National Women in Engineering Committee, Engineers Australia, February 2002, (The CREW report), and Julie Mills, Virginia Mehrtens, Elizabeth Smith and Valarie Adams, An Update on Women's Progress in the Australian Engineering Workforce, April 2008, (CREW Revisited in 2007 the year of women in engineering), www.engineersaustralia.org.au

<sup>&</sup>lt;sup>5</sup> See for example the 15<sup>th</sup> International Conference for Women Engineers and Scientists, Adelaide, 20-22 July 2011, www.engineersaustralia.org.au

See the activities reports on the Women in Engineering web page on www.engineersaustralia.org.au

DEEWR, Opening up pathways: Engagement in STEM across the Primary-Secondary school transition, June 2008, A review of the literature concerning supports and barriers to Science, Technology, Engineering and Mathematics

section considers whether these differences occur because there are differences in mathematical and scientific capacity between boys and girls.

The OECD's PISA comparisons aim to test students reading, mathematical and scientific literacy in terms of real-life competencies. The tests do not test the ability of students to master a specific curriculum but are used to examine the potential of students to study mathematics and science subjects. Australia has participated in the OECD's PISA comparisons since 2000. Thompson and De Bortoli noted that between 2003 and 2006, although the overall performance of Australian students in mathematics did not change, there was a significant fall in female mathematics literacy<sup>8</sup>. The 2009 PISA scores are now available and Table 1 compares the Australian outcomes to a selection of trading partners<sup>9</sup>.

	Mathe	matics	Scie	ence
Country	Men	Women	Men	Women
Australia	519	509	527	528
New Zealand	523	515	529	535
Canada	533	521	531	526
United States	497	477	509	495
Denmark	511	495	505	494
Germany	520	505	523	518
Japan	534	524	534	545
Korea	548	544	537	539
Sweden	493	495	493	497
United Kingdom	503	482	519	509
OECD Average	501	490	501	501
Russia	469	467	477	480
Brazil	394	397	407	404
Indonesia	371	372	378	387

# Table 1: How did Australian students compare internationally in PISA mathematics and science tests in 2009?

In 2009, young Australian women scored 509 in PISA tests compared to 519 for young men. This difference is important, but perhaps a more useful result is that young Australian women scored higher than the OECD averages for both genders. In science, there was no difference between young Australian men and women and both genders were well above the OECD averages. These results suggest that capacity to study mathematics and science at school may not explain the

engagement at Primary-Secondary transition, Writing team; R Tytler, J Osborne, G Williams, K Tytler, J Cripps Clark, A Tomei and H Forgasz.

<sup>&</sup>lt;sup>8</sup> See DEEWR, op cit, pp26-7

<sup>&</sup>lt;sup>9</sup> PISA statistics were sourced from the OECD on-line data base.

observed differences in enrolments and that the focus should be on other factors such as social perceptions and the learning environment.

### Year 12 mathematics and science

In 2010, there were 111,600 girls and 102,942 boys in year 12 classes at schools. The share of girls was 52%, and had moved within a narrow range of 52 to 53% since 1997. Over this time, the *increase* in retention of boys to year 12 was higher than for girls, but despite this increase, year 12 retention rates favoured girls by a large margin. In 2010, 70.8% of boys remained at school until year 12 compared to 81.3% of girls and Federal Government policies to encourage further increases are in place.

Statistics on gender participation in specific school subjects are fragmented, but enough is known to piece together an overview about whether school enrolments in mathematics and science subjects have limited the number of girls progressing to university courses in engineering.

#### **Mathematics**

Advanced mathematics was once considered a key enabling subject for engineering courses. However, Forgasz argues that advanced mathematics is generally no longer uniformly required for engineering courses as was the case in earlier years. Furthermore, students responding to competitive pressures for entry to prestigious universities "often select subjects to maximise tertiary entrance scores"<sup>10</sup> rather than to reflect their academic abilities. Students who study advanced mathematics typically also take intermediate mathematics. For these mixed reasons, both levels of year 12 mathematics need to be considered.

Barrington regularly publishes statistics on participation in year 12 mathematics for the Australian Mathematical Sciences Institute<sup>11</sup>. The latest statistics show that in 2010:

- Although the *proportion* of year 12 students studying advanced mathematics stabilised at 10.1% (compared to 14.1% in 1995), the *number* of students increased marginally to 21,233 students as year 12 retention rates increased.
- The *proportion* of year 12 students studying intermediate mathematics continued to fall and was 19.6% in 2010 (compared to 27.2% in 1995), equating to 41,447 students.
- Considered together, 29.7% of year 12 students or 62,680 studied advanced and intermediate mathematics in 2010 compared to 41.3% in 1995.

Forgasz<sup>12</sup> has examined gender shares for participation in intermediate mathematics for the period 2000 to 2004. Since students studying advanced mathematics also study intermediate mathematics, both levels are considered in her analysis. Forgasz found that:

• Fewer girls than boys studied intermediate mathematics in these years. In 2000, the share of girls was 47.3% and the ratio of boys to girls was 1.11. By 2004, the share of girls had fallen to 45.6% and the ratio of boys to girls had increased to 1.19.

<sup>&</sup>lt;sup>10</sup> Helen Forgasz, Australian year 12 "Intermediate" level mathematics enrolments 2000-2004: Trends and patterns, 2006, 29<sup>th</sup> annual conference of the Mathematics Education Research Group of Australia: Identities, Culture and Learning Spaces, Volume 1, Canberra, Australia

<sup>&</sup>lt;sup>11</sup> www.amsi.org.au

<sup>&</sup>lt;sup>12</sup> Helen Forgasz, op cit

- While the trend was for fewer students to study year 12 intermediate mathematics, the fall for girls was much higher than for boys.
- These changes were evident in all Australian jurisdiction with the exception of the ACT.
- Falling enrolments for girls were the main contributors to decreased enrolments in intermediate mathematics in jurisdictions where enrolments had fallen but increasing enrolments for boys were the main contributors where intermediate mathematics enrolments had increased.

Forgasz concluded "females are continuing to limit their career options by not pursuing (mathematics) subjects at the intermediate level." Forgasz described a negative circle in which fewer year 12 enrolments meant fewer students feeding into tertiary level mathematics courses and subsequently into teacher education programs leading to further decreases in enrolments.

### Science

Ainley, Kos and Nicholas<sup>13</sup> examined the participation of year 12 students in a range of science and mathematics subjects<sup>14</sup>. Gender statistics on the participation in three science subjects was obtained from the Longitudinal Survey of Australian Youth for 2001 and for the period 2004-06. Pieced together with overall trends, this information shows:

- The overall trend for year 12 students studying physics has been downwards since the 1970s and it is not yet clear whether this decline has been arrested. In 1976, 27.5% of year 12 students studied physics. By 2007 this share had fallen to 14.6%. Gender statistics were only available for limited periods; in 2001 (proportion studying physics 16.5%) and 2004-06 (proportion studying physics an average 15.4%).
- More boys than girls studied year 12 physics. In 2001 the shares were 25.4% for boys and only 9.2% for girls. Between 2004-06, both shares were lower; the share of boys was 23.0% and the share of girls fell to 8.1%.
- The trend for year 12 students studying chemistry was similar to physics, but the decline was less. In 1976, 28.6% of year 12 students studied chemistry, falling to 18.0% in 2007.
- The gender gap in chemistry was much smaller than in physics. In 2001, 19.8% of boys studied chemistry compared to 16.3% of girls. Between 2004-04, these shares fell to 18.9% for boys and 17.1% for girls.
- Participation in year 12 biology fell from 55.3% in 1976 to 24.7% in 2007. In 2001, 25.4% of year 12 studied biology and the average between 2004-06 was 25.1%
- More girls than boys studied year 12 biology. In 2001, 18.3% of boys studied biology compared to 31.6% of girls. By 2004-06, both shares had increased; to 19.3% for boys and to 32.5% for girls.

Taking multiple science courses in year 12 is regarded as an indicator of students' academic orientation and can influence future academic and career choices. Ainley, Kos and Nicholas showed from the longitudinal statistics mentioned above that the most common combination of science subjects was physics and chemistry, but the proportions of year 12 students taking this combination fell from 11.4% in 1998 to 9.7% in 2001 and 8.6% in 2004-06. Corresponding statistics for the combination of chemistry and biology were 6.7% in 1998, 6.3% in 2001 and 6.2%

<sup>&</sup>lt;sup>13</sup> John Ainley, Julie Kos and Marina Nicholas, Participation in Science, Mathematics and Technology in Australian Education, ACER Research Monograph No 63, August 2008, <u>www.acer.edu.au</u>

<sup>&</sup>lt;sup>14</sup> Engineers Australia, The Engineering Profession; A Statistical Overview 2011, p29, <u>www.engineersaustralia.org.au</u>

in 2004-06. The pairing of physics and biology showed even lower figures; 2.4% in 1998, 1.9% in 2001 and 1.5% in 2004-06. Although specific gender statistics are not available for combinations of year 12 subjects, the statistics discussed here are governed by the gender shares outlined in the dot points above.

### Summary

The PISA results suggest that the mathematical and scientific literacy of Australian girls is strong compared to other countries. However, this capacity does not translate into participation in advanced and intermediate mathematics and science. In mathematics, falling participation is much stronger for girls than boys. In science, more boys than girls are attracted to the physical sciences and within them boys towards physics and girls towards chemistry. These statistics are a matter of general concern for Australia and for engineering in particular. Medium to long term policies are required to address this situation. In the short term, the number of girls studying engineering enabling subjects is well above the numbers enrolling in engineering courses suggesting that engineering is not competing with alternatives as well as it might.

### 3. Transition from School to University

The statistics discussed in this section relate to Tertiary Entrance Centre activities. Since about 2005 interest in engineering, as measured by the applications for university places, have increased faster than in non-engineering disciplines. However, growth in acceptances of engineering places has been much slower. This is the background against which the two years of available gender specific statistics shown in Figure 1 should be evaluated. These statistics relate to applications from, offers made to and acceptances from current year 12 graduates and do not include mature age students and students who deferred in earlier years.



On average about 2,000 girls applied for places in university engineering courses compared to over 13,500 boys. The statistics suggest that universities "over-offered" places to girls but these additional offers were not taken up. In 2010, acceptances of places by girls were 1,695 or 14.2% of all acceptances.

Engineering courses have attracted more students with relatively high TES scores than other disciplines. In 2010, 41.1% of engineering acceptances had TES scores of 90 and higher compared to 26.8% of non-engineering acceptances. Similarly, 30.1% of engineering acceptances had TES scores between 80 and 90 compared to 25.2% of non-engineering acceptances. Conversely, for TES scores below 70, the proportion of engineering acceptances was consistently lower than for non-engineering acceptances. However, the bulk of this outcome was drawn from boys when the majority of high scores were achieved by girls.

In 2010, 10,064 boys with TES scores over 90 accepted offers of places in universities compared to 2,396 girls. Engineering attracted 2,396 or 23.8% of the boys but just 569 or 4.6% of the girls. In comparison, 1,978 girls with TES scores over 90 accepted places in science degrees.

### 4. University Commencements

This section examines commencements by women in university engineering courses from two perspectives; first, the commencements in courses of all levels, from doctorates to undergraduate certificates; and second, commencements in entry level qualifications in engineering. The statistics for courses of all levels are the more reliable, but provide only limited insights into how women enter engineering studies. The second set of statistics is necessary to examine the number of women commencing three year, four year or double degree courses in engineering and the specialisations they are attracted to. The reliability of these statistics is effected by some double counting, particularly in the case of double degrees; at times, the engineering component only is counted, at times the non-engineering component is counted and on other occasions both are counted. The main problem is reconciling the two sets of statistics. In general, the trends in both sets are considered to be reliable when used together and this is how they are employed here.

We begin with Table 2 which shows the trends in commencements by "domestic" women in engineering and related technologies courses of all levels during the past decade. "Domestic" is the descriptor used by DEEWR for individuals who are Australian citizens or who hold a permanent residency visa. "Overseas" students are not citizens or permanent residents and must apply for, and be granted, a student visa to study in Australia. It is rare for an overseas student to become a domestic student during the course of their studies. Similarly, to become part of the engineering team, overseas students must first complete their engineering courses and then apply for, and be granted, either a permanent residency visa or a temporary 457 visa.

Table 2 shows that female engineering course commencements fell over the first half of the decade with the fall being particularly severe for entry level courses (bachelors degrees and associate degrees and diplomas combined) which fell from 1,652 in 2001 to 1,299 in 2005. During the second half of the decade womens' commencements grew relatively quickly and by 2007 had recovered the ground lost in the earlier years. By 2010, entry level commencements had increased to 1,971, an increase of 19.3% on the 2001 intake, and overall course commencements had increased to 2,896, an increase of 31.6% on the 2001 commencements.

Course level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctorate	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
Assoc 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
All commencements	2207	2125	2019	1936	1876	2041	2264	2380	2635	2896

Table 2: Commencements of engineering and related technologies courses by domestic women

Source: Statistics provided by DEEWR



Figure 2 illustrates the trends in the womens' shares of commencements in selected course levels. In 2010, the women's' share of total commencements was 15.8%, only slightly higher than in 2001 (15.7%). The trend line was u-shaped with a low point of 13.8% in 2005. There was a similar trend for entry level courses (bachelors degrees, associate degrees and diplomas), but in this case an initial increase in commencements petered out into a static situation from 2007 onwards. The result was a fall in the women's' share of entry level commencements, from 15.0% in 2001 to 13.9% in 2010.

Women graduates have a high propensity to further their studies. The women's' share of doctoral course commencements has consistently been above the entry level courses share although the numbers involved are relatively small. In 2001 there were 128 women engineers commencing doctoral courses, a share of 24.0%; by 2010, there were 164, a share of 24.1%. As Figure 2 shows, the women's doctoral commencements share fell in line with the general decline in commencements, but the margin between the doctoral and entry level trends was maintained.

The share of women commencements in master and other postgraduate courses has also been higher than for entry level courses. In 2001, 398 women commenced courses at this level, 18.0% of all commencements. Numbers gradually increased to a peak of 546 in 2010 although the share peaked at 19.7 in 2008.

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
Three yea	hree year degree												
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		
Four year	degree												
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		
Double de	gree	-						-		-			
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		

Table 3: The pattern of engineering degree specialisations commenced by domestic women

Table 3 looks at commencements in bachelors degrees in more detail. AQF diplomas and advanced diplomas were not included in this Table because the numbers involved were too small to usefully disaggregate. The Table includes separate panels for womens' commencements in three year, four year and double degrees. The specialisations shown are the four digit level of the Australian Standard Classification of Education (ASCED). A further degree of disaggregation that spells out many familiar specialisations is possible, but is not supported by the quality of the statistics. The issue relates to way universities fill in their statistical returns to DEEWR. Courses

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that in some years are coded as mechanical engineering are coded as "other" in other years. The result is inconsistent trend information; the only way to resolve the situation is to avoid further disaggregation.

Figure 3 shows the proportions of women and men commencing three year, four year and double degree bachelor courses in engineering in 2001 and in 2010.



In 2001, 12.5% of women commenced three year bachelors degrees compared to 15.0% of men. Over the decade both shares fell, but the fall was higher for men (from 15.0% to 8.9%) than for women (from 12.5% to 10.7%). The share of men who commenced double degrees was relatively stable, changing only marginally from 25.6% to 26.4%. However, proportionally more women commenced double degrees in 2001 (32.4%) and over the decade even more preferred this format increasing the share to 35.6% in 2010. For both genders well over half of all commencements were in four year degrees.

Figure 4 shows the trends in the womens' shares of bachelors degrees commencements. These trends illustrate how growth in women commencements over time compares to the overall growth in engineering commencements.

During the four years to 2004, the women's' share of three year bachelors degree commencements averaged 12.0%. This increased to an average of 18.5% over the following four years before settling at a lower plateau of 16.3% during 2009 and 2010.

In 2001, women commencing four year bachelors were 14.2% of four year commencements. Under the influence of a strong downtrend this share fell to a low of 9.9% in 2005. It has since recovered to 12.3% in 2010 but the recovery was much slower than the earlier decline.

The women's' share of commencements in double degrees has been much higher than commencements in four year degree and averaged 18.5% for all but three years of the past decade. The exception was 2004 to 2006, inclusive, when the share averaged 16.3%, still well above the four year degree share.



In three year bachelors courses, several specialisations had numbers too small to provide meaningful information. However, four specialisations showed relatively consistent commencements levels; process and resource engineering (including chemical, mining and materials) averaged 22 commencements with 41 in 2010; electrical and electronic engineering averaged 34 commencements with 18 in 2010; aerospace engineering averaged 45 commencements with 52 in 2010 and "other" engineering (including environmental, biomedical and other) averaged 27 commencements with 21 in 2010. At the beginning of the decade, few women commenced manufacturing engineering, but steady growth saw numbers increase to 54 by 2010.

Women commencements in four year bachelors degrees are more widely spread. On average there were 181 commencements in engineering and related technologies courses not further defined which can be thought of as general engineering courses. Commencements showed some growth in the last three years with 262 in 2010. There were on average 117 commencements in process and resource engineering with 2010 commencements of 125. Mechanical and industrial engineering commencements averaged 53 with some growth in recent years resulting in 67 in 2010. Civil engineering commencements averaged 127 over the decade but with solid growth over the last three years and 168 commencements in 2010. There were on average fewer commencements in four year aerospace degree than in three year degrees with an average of 28 and 30 commencements in 2010. Commencements in "other" engineering averaged 180 with large increases recorded over the last four years so that 2010 commencements were 240. Commencements in electrical and electronic engineering collapsed from 178 in 2001 to 49 in 2008. The last two years showed a minor recovery to 75 commencements in 2010. In 2010, over half of all commencements were in the "general" or "other" specialisations.

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There was a similar pattern in double degree commencements. Engineering and related technologies not further defined averaged 175 over the decade and showed solid growth over the last four years to be 273 in 2010. The "other" specialisation averaged 106 commencements. The two categories combined accounted for 55% of double degree commencements in 2010. Of the remaining specialisations, the highest number of average commencements was in process and resource engineering with 81 and some growth to 90 in 2010. There were on average 36 commencements in mechanical engineering and 58 in civil engineering. The latter experienced some growth during the last two years and there were 78 commencements in 2010. Commencement in double degrees in electrical and electronic engineering collapsed from 115 in 2001 to 26 in 2008. In the last two years commencements in this specialisation averaged 36.

## 5. University Completions

This sections examines course outcomes. As in the previous section the more reliable statistics are the aggregates for course completions in engineering and related technologies shown in Table 4. The key trends in this Table are illustrated in Figure 5.

In 2001, there were 1,299 course completions by women in engineering and related technologies; 79.4% were at entry level and the remainder were postgraduate courses. Reflecting declining course commencements in the first half of the decade, completions were more-or-less static through to 2007. In 2008 and 2009 completions were marginally above 2001 levels, but it was not until 2010 that there was evidence of obvious growth.

Level	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
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

Table 4: Completions of engineering and related technologies courses by women

Source: Statistics provided by DEEWR

The main influence on the trend was the completion of entry level courses. In 2001 there were 1,027 completions of bachelors degree, together with a handful of associate degrees and advanced diplomas, accounting for 79.4% of women's' completions and 16.6% of all entry level completions. Entry level completions by women fell steadily to a low of 867 (855 degrees and 12 advanced diplomas) in 2007. There followed three years of increasing completions but the 2010 figure of 952 (917 degrees and 35 advanced diplomas) remained well below the 2001 outcome. The influence of these changes is clearly discernible in the declining trend in the women's' share of entry level completions shown in Figure 5 which by 2010 had fallen to 14.4%.

Women postgraduate completion numbers have been comparatively small but none-the-less represent higher shares of engineering completions compared to entry level courses. There were 63 doctoral completions in 2001, 19.4% of all engineering doctoral completions, increasing to 104

or 21.9% of doctoral completions in 2010. Figure 5 shows that the trend here has been generally upwards. There were 200 completions of masters degrees and other postgraduate qualifications in 2001, a women's' share of 16.8%. This increased to 359 or 20.0% of completions by both genders in 2010. Again Figure 5 shows that the women's' share here has generally trended upwards.





In broad terms the mix of three year degrees, four year degrees and double degrees completed by women mirrors the commencement shares described in Figure 3. Figure 6 illustrates the trends over the past decade.

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The women's share of three year degree completions was 15.6% in 2001 and increased to 24.4% by 2010. The share of four year degree completions fell from 16.9% in 2001 to 12.9% in 2010 while the share of double degree completions also fell from 17.8% in 2001 to 16.0% in 2010.

Table 5 is the completions counterpart to the detailed commencements in Table 3. As well as the caveats mentioned an additional complication is that occasionally universities do not include course duration when reporting completions to DEEWR. This occurred in 2005 and to deal with the problem, it was concluded that the completions in question were most likely four year degree completions based on a more detailed examination of the relevant institution's statistics.

ASCED	Specialisation	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Three y	opecialisation	2001	2002	2000	2004	2000	2000	2007	2000	2005	2010
0300	Engineering & Related Technologies	18	4	12	7	15	3	7	1	4	~10
0301	Manufacturing Engineering & Technology	2		5	4	13	10	8	23	20	44
0303	Process & Pesource Engineering	18	20	1/	10	<10	31	12	20	10	<10
0305	Automotive Engineering & Technology	0		0	0	0	0	0		10	0
0307	Mechanical & Industrial Engineering & Technology	3	3	2	1	2	2	1	1	0	0
0307	Civil Engineering & Technology	0	2	4	0	4	12	0	<10	0	0
0303	Geometic Engineering	10	24	16	17	12	14	0	12	11	<10
0313	Electrical & Electronic Engineering & Technology	12	0	6	18	52	41	3/	24	20	21
0315	Aerospace Engineering & Technology	14	22	10	23	28	20	34	30	25	25
0313	Maritimo Engineering & Technology	14	1	19	23	20	29	0	39	23	23
0317	Other Engineering & Technology	20	12	10	0	7	14	5	0	7	11
0399		20	101	00	0 00	120	14	100	9	116	110
	Total	90	101	00	00	129	150	109	130	110	119
Four yea	ar degree										
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
Double (	degree										
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

The trend in completions of three year degrees by women comprised three phases; over the first four years completions averaged 94 per year, followed by two years of heightened activity averaging 147 per year and then four years averaging 117 completions per year. Two familiar specialisations, mechanical and production and civil engineering had fewer than ten graduates in

most years, with zero in many years. The exception was 12 civil engineering graduates in 2006. The most consistent completions were in aerospace engineering which averaged 26 completions per year and process and resource engineering which averaged 14 per year but falling during the last two years. The two categories "nfd" and "other" showed falling numbers of completions; the former being 18 in 2001 and falling to less than ten in 2010 and the latter with 20 completions in 2001, falling to 11 in 2010. On the other hand, completions in manufacturing engineering increased from 2 in 2001 to 44 in 2010. Completions in electrical and electronic engineering increased from 12 in 2001 to 52 in 2005, before settling at a lower level over the remaining years.

Completion of four year degrees in engineering by women fell from 691 in 2001 to 544 in 2010, with average completions of 590 per year. Completions in the "other" category were consistently high and averaged 131 per year. There were increasing numbers completing in the "nfd" category, increasing from 9 in 2001 to 55 in 2010. Three specialisations, manufacturing, automotive and maritime engineering, had occasional graduates. The largest group of graduates was in process and resource engineering with an average 118 completions per year. The next largest group was civil engineering with an average of 102 completions per year, also falling to 94 in 2010. There were on average 51 completions per year in mechanical and industrial engineering and 21 per year in aerospace engineering. Completions in electrical and electronic engineering reflected the collapse in commencements noted above. In 2001 there were 140 completions but by 2010 there were only 49.

Completion of double degrees by women was consistently close to the average of 251 per year. Over 120 of these fell into the "nfd" or "other" categories. There were small numbers completing double degrees in manufacturing and aerospace engineering and none in automotive or maritime engineering. The largest group of graduates was in process and resource engineering with an average of 45 per year, falling to 36 in 2010. Completions in mechanical and industrial engineering averaged 21 per year. Once again reflecting the trends in commencements, completions of double degrees in electrical and electronic engineering fell from 56 in 2001 to 17 in 2010.

The consistent theme in Table 6 is the high levels of completions in process and resource engineering. This specialisation includes chemical, mining and materials engineering and may reflect the subject choices by year 12 girls.

## 6. The Womens' Engineering Labour Force

### What is included in the statistics?

This section examines the structure of the women's engineering labour force using 2006 census statistics. These statistics are now quite out of date, but never-the-less highlights some important characteristics and structural features of women in engineering labour force. The statistics are also important as the benchmarks for the 2011 census statistics expected to be available later in the year.

The definitions used are conventional economic definitions of labour force status applied to the segment of the population with engineering qualifications recognised by Engineers Australia. This group is called the engineering population. The engineering labour force comprises the engineering population that is employed, whether full time, part time or away from work, or unemployed, but actively seeking employment. Not everyone in the engineering population is in

the labour force; some are retired and others are not in the labour force by choice or circumstance; this group is usually described as not in the labour force, or NLF.

The qualifications for professional engineers and engineering technologists are clear-cut. At least a three year accredited degree is required and nearly every engineering degree course in Australia is accredited by Engineers Australia. Statistics relating to these qualifications are readily available in the census data-bases but the ABS does not distinguish between bachelors degrees of different durations<sup>15</sup>. This means that the statistics combine professional engineers and technologists.

Engineers Australia requires that engineering associates hold an associate degree or an AQF advanced diploma in engineering and meet stipulated competencies. Under a recent revision bachelors degrees in engineering are either level 7 or 8 under the Australian Qualification Framework (AQF) depending on whether they are three year or four year honours programs. Postgraduate qualifications are ranked at higher levels. Associate degrees and AQF diplomas are rated AQF level 6. Statistics for associate degrees and advanced diplomas can be separately distinguished but some AQF level 6 qualifications are embedded in statistics for other diplomas, many of which are AQF 5 or lower. In this paper, statistics include all diploma qualifications in engineering. Further work to separate diploma qualifications will be undertaken in conjunction with analysis of the 2011 census outcomes later in the year.

A final issue is that the ABS codes individuals to the field of their highest qualifications. So, if an individual's highest qualification is a masters degree in engineering, that person is coded as an engineer irrespective of the job performed. On the other hand, if an individual's highest qualification is a masters degree in business administration, that person is coded as a business professional irrespective of whether their main job is in engineering or in business. In other words, to the extent that individuals whose main work is engineering have post graduate certificates, diplomas or degrees in a field other than engineering, the size of the engineering population is understated. There are no easy adjustments that can be made to compensate for this problem.

#### Engineering and labour force status

Table 6 shows the labour force status of the engineering population by qualification. There were 32,814 women in the engineering population. The women's engineering labour force was 24,429, giving a labour force participation rate of 74.4% compared to 82.5% for men. Women were 10.7% of Australia's engineering population and 9.8% of the engineering labour force.

The proportion of women employed full time was 73.3% compared to 88.9% for men<sup>16</sup>. Conversely, 26.7% of women were employed part time compared to 11.1% of men. Despite this part time men outnumbered part time women by four to one suggesting there were significant opportunities for part time work.

The unemployment rate for women engineers was 5.2%, over twice the rate for men (2.4%). Figure 7 shows that the lowest unemployment rate for women was 3.9% for women with doctoral degrees. In respect to all other qualifications the overall conclusion applied. Although there were just 1,263 unemployed women engineers, the unemployment rate was inconsistent with skill shortages.

<sup>&</sup>lt;sup>15</sup> For the ABS a bachelors degree has duration of study between three and six years

<sup>&</sup>lt;sup>16</sup> These shares assume that individuals away from work are distributed in the same way as those present.

Labour force	Doctoral	Masters	Other	Bachelor	Associate degree	Engineering	Other	Extended
status	degree	degree	postgraduate	degree	& Advanced dip	team	diplomas	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
		-						-
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
		-						-
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

Table 6: The Australian Engineering Labour Force and Population in the 2006 Census

Source: Compiled using the ABS 2006 Population Census TableBuilder



### **Country of origin**

Skilled migration has been an important feature in Australia's history and engineering in particular is highly dependent on the flow of overseas engineers in the country. The statistics covered in this section deal with women engineers born in Australia and born overseas. "Born overseas" is a broader concept than skilled migrant. The latter term encapsulates individuals born, raised and trained overseas who migrate to Australia. Born overseas includes this group but also includes the children of earlier generations of migrants who may have grown to maturity and have been trained in Australia as well as overseas students who were educated in and subsequently remained in Australia. Since detailed statistics on migrant engineers are unavailable it has become common to use born overseas as a surrogate.

Table 7 shows the labour market status of Australian and overseas born women in the engineering labour force. For the engineering labour force as a whole, 55.1% were Australian born and 44.9% were born overseas. More women than men were born overseas; 13,905 or 56.9% women were born overseas and 10,524 or 43.1% were born in Australia while 98,181 or 43.6% of men were born overseas and 127,177 or 56.4% of men were born in Australia. Since the census, aggregate labour force statistics for 2010 indicate that recent high levels of skilled migration has increased the overseas born share of the engineering labour force to over 50%<sup>17</sup>.

Labour force	Au	stralian be	orn	Ov	verseas bo	orn	Engineering team			
status	Men	Women	Total	Men	Women	Total	Men	Women	Total	
Employed FT	107238	6952	114190	78974	9054	88028	186212	16006	202218	
Employed PT	11888	2628	14516	11422	3211	14633	23310	5839	29149	
Employed away	5821	679	6500	3912	642	4554	9733	1321	11054	
Total Employed	124947	10259	135206	94308	12907	107215	219255	23166	242421	
Unemployed FT	1770	148	1918	2818	547	3365	4588	695	5283	
Unemployed PT	460	117	577	1055	451	1506	1515	568	2083	
<b>Total Unemployed</b>	2230	265	2495	3873	998	4871	6103	1263	7366	
Labour Force	127177	10524	137701	98181	13905	112086	225358	24429	249787	

Table 7: The Australian and overseas born components of the extended engineering labour force

Country of origin is a significant factor in gender differences in unemployment rates. In the Australian born component of the engineering labour market, the unemployment rate for men was 1.7% and for women 2.5%. This compares to 3.9% and 7.2% respectively for overseas born men and women. Although the rate for Australia born women is higher than for men, both rates are well within the range that economists regard as "frictional" unemployment<sup>18</sup>. However, two thirds of all unemployed engineers were overseas born and the high rates at a time of skill shortages suggest issues related to integration and acceptance.

Another important difference between Australian born and overseas born women relates to qualifications held. The proportion of overseas born women with doctoral degrees was 3.8%, twice as high as the 1.9% for Australian born women and higher than the 2.6% for the engineering

<sup>&</sup>lt;sup>17</sup> Engineers Australia, The Engineering Labour Force, 2001 to 2010, <u>www.engineersaustralia.org.au</u>

<sup>&</sup>lt;sup>18</sup> Frictional unemployment is the short intervals of unemployment experienced when individuals shift from one job to another.

labour market overall. Similarly, overseas born women the share was 15.4% compared to 4.6% for Australian born women.





### Hours worked

Hours worked by the engineering labour force employed full time and part time are compared in Figures 8 and 9 respectively. For this purpose full time employment is 35 or more hours worked per week and part time employment is less than 35 hours per week.

In full time employment, more women engineers than men were employed less than 40 hours per week. Conversely, more men than women were employed more than 40 hours per week. There was a particularly large gender difference for the longest hours worked category with 33.6% of men compared to 19.7% of women working 49 hours or more per week.

In respect to part time work, the three groupings of hours shown crudely approximate to one to two days, two to three days and more than three days. The share of women working part time was distinctly higher in the first two groupings and lower in the third.

#### Income Earned

In both full time and part time employment, men employed in the engineering labour force earn more than women. Figures 10 and 11 compare the income distributions for men and women engineers working full time and part time respectively. Proportionately more full time employed women engineers than men are in weekly income brackets of \$1,299 or less. Conversely proportionately more men than women are in weekly income brackets over \$1,300 per week. The gender differential progressively increases in the three brackets above this income so that in the highest bracket, \$2,000 or more, the proportion of men is almost 2½ times that of women.



In part time employment, the proportion of women exceeds the proportion of men for weekly income brackets below \$800 per week. Conversely, the proportion of men exceeds that of women for weekly income brackets \$800 or more per week. As was the case in full time employment, the gender differential in favour of men increases in successive income brackets. Over 10% of men employed part time are in the highest income bracket, \$2,000 per week or more, about four times the proportion of women.



### Age Structure

The women's engineering labour force has a relatively young structure compared to men. The important differences for men and women employed full time and part time are illustrated in Figures 12 and 13 respectively.



The largest age group for full time employed men was 40 to 44 years with 15.5%. The two younger and older age groups are very similar in size and the structure has the appearance of a mature age structure. Beyond age 55 years the sizes of cohorts fall quickly and only 1.6% of full time

employed men are aged 65 years or more. For women employed full time the largest age group was 25 to 29 years with 22.4%. The age structure has the appearance of a young group with successively older age groups becoming smaller. Over age 50, the size of successive age groups reduces very quickly and there are only 1.3% of full time employed women aged over 60 years.



With the exception of the 25 to 29 years age group, the proportion of men employed part time is very similar in size through to age 54 years. There were 11.3% part time employed men aged 25 to 29 year, possibly reflecting part time work in conjunction with further studies. From age 55 years onwards the prevalence of part time work increases as men ease their way out of the full time work force with part time work.

Over two-thirds of women employed part time are aged between 25 and 44 years. The proportions in age groups 45 years on fall rapidly and display an altogether different pattern to that for men.

### **Employed in Engineering**

In the modern labour market, engineering qualifications are valued in many occupations and individuals can exercise occupational choice. In other words, there is not a one-to-one match between engineering qualifications and working as an engineer. Research reported elsewhere<sup>19</sup> shows that in practice individuals with engineering qualifications are employed in nearly every occupation in the ABS classification system, many with no connection to engineering.

This research applied several criteria (appropriate formal qualifications, level of work undertaken and degree of attachment to engineering) to a systematic scrutiny of the 458 four digit occupations in the ABS occupational code. Only 51 were identified as engineering occupations. While there is

<sup>&</sup>lt;sup>19</sup> Engineers Australia, The Engineering Profession in Australia, a Profile from the 2006 Population Census, September 2010, <u>www.engineersaustralia.org.au</u>

room at the margin to debate the final selection of occupations, sensitivity analysis has shown that including or excluding marginal occupations made little difference to the results.

Country of origin	Bor	n in Austr	alia	Bo	orn overse	as	Total			
Labour market status	Men	Women	Total	Men	Women	Total	Men	Women	Total	
Engineering labour force	94920	8502	103422	84528	12665	97193	179448	21167	200615	
Employed in engineering	65976	4972	70948	46310	6310 5000		112286	9972	122258	
% Employed in engineering	69.5	58.5	68.6	54.8	39.5	52.8	62.6	47.1	60.9	
Extended engineering labour force	127177	10524	137701	98181	13905	112086	225358	24429	249787	
Employed in engineering	80830	5475	86307	51307	5210	56515	132137	10685	142822	
% Employed in engineering	63.6	52.0	62.7	52.3	37.5	50.4	58.6	43.7	57.2	

Table 8: The engineering labour force employed in engineering

Source: Estimated using ABS, 2006 Population Census TableBuilder

Section 6 showed that 23,165 of the women's engineering labour force of 24,429 were employed and 1,264 were unemployed. However, Table 8 shows that only 10,685 women were employed in an engineering occupation; the remaining 12,480 were employed in non-engineering occupations. In other words, only 43.7% of the women's engineering labour force was employed in engineering. In contrast, the comparable share for men was 58.6%.

As well as gender, country of origin was also an important differentiating factor in the proportion of the engineering labour force employed in engineering. In the Australian born component, 63.6% of men and 52.0% of women were employed in engineering. For the overseas born component, the proportions employed in engineering are substantially lower; 52.3% for men and 37.5% for women.

Since the 2006 census was conducted, the Australian government has substantially changed skilled migration policies. As well as being geared to a new skilled occupation list (SOL), employers have been encouraged to sponsor both permanent and temporary visa applicants into engineering jobs on condition that migrants are employed in engineering. In the case of permanent visas, employer sponsored (and State and Territory sponsored) applicants are given priority in the assessment queue; independent applicants may qualify for any places left in annual target allocations. In the case of temporary visas, employers are being encouraged to, in effect; treat this method of entry as a probationary mechanism and to sponsor satisfactory temporary workers for permanent visas. The common theme in these arrangements is they encourage employment in engineering occupations.

#### **Family Responsibilities**

It has been argued that family responsibilities are a barrier to full participation by women in the engineering labour force and in employment in engineering<sup>20</sup>. Family responsibilities can take many forms, some of which are not amenable to measurement. A surrogate often used is the number of children. Table 9 looks at the women's engineering labour force with a focus on children.

<sup>&</sup>lt;sup>20</sup> See for example the CREW reports and Melissa Marinelli and Martina Calais, Painting the picture-An Update on Women in engineering Statistics in Australia, ICWES 15, 2011

Labour force	Number of children								
status	None	One	Two	Three	More than 3	Not stated	Total		
Employed FT	9149	2581	3058	756	213	248	16005		
Employed PT	1735	1250	1948	666	172	67	5838		
Employed away	479	339	339	99	31	35	1322		
Total employed	11363	4170	5345	1521	416	350	23165		
Unemployed seeking FT	376	138	122	35	8	15	694		
Unemployed seeking PT	229	119	170	32	12	3	565		
Total unemployed	605	257	292	67	20	18	1259		
Labour force	11968	4427	5637	1588	436	368	24424		

Table 9: Labour force status and children, women engineering labour force

Source: ABS, 2006 Population Census Tablebuilder

Just under half (49.0%) of the women's engineering labour force had no children. This group had a labour force participation rate of 86.1% compared to 82.7% for men. The proportion employed full time was 84.1% compared to 88.9% for men.

The other half of the women's engineering labour force had at least one child; 18.1% had one child; 23.1% had two children; 6.5% had three children and 1.8% had more than three children. As the number of children increased, labour force participation fell; for women with one child, the participation rate was 69.6%; for two children it was 67.5%; for three children it was 59.7% and for more than three children it was 43.2%.

The proportion of full time employment also fell with the number of children, plateauing out at three children. For women with one child, 67.4% were employed full time; for two children, 61.1% were employed full time and for three children 53.2%. The proportion of full time employment for more than three children was 55.3%.

The number of children also appears to be a factor in the proportion of the womens' engineering labour force employed in engineering work. Overall, this proportion was 43.7%, however, for women with no children it was 53.5%, for women with one child it was 37.5%, for women with two children it was 34.1%, for three children it was 28.7% and for more than three children it was 20.9%.

If these results are repeated in the 2011 census, there would be irrefutable evidence that family responsibilities reduce the participation of women in engineering work.

### 7. Membership of Engineers Australia

Table 10 is a summary of Engineers Australia's membership over the past decade. At 30 June 2002, there were 5,528 women members or 8.0%. By 30 June 2011, the number of women members had increased to 10,631 or 11.0%.

Year ending	Gen	eral mem	bers	Stud	lent mem	bers	All members				
30 June	Men Women Total		Men	Women	Total	Men	Women	Total			
2002	48591	2422	51013	14987	3106	18093	63578	5528	69106		
2003	48537	2641	51178	18105	3659	21764	66642	6300	72942		
2004	48565	2861	51426	20522	4044	24566	69087	6905	75992		
2005	48827	3115	51942	22494	4340	26834	71321	7455	78776		
2006	48701	3314	52015	23979	4557	28536	72680	7871	80551		
2007	49129	3496	52625	25704	4745	30449	74833	8241	83074		
2008	49968	3712	53680	26827	5019	31846	76795	8731	85526		
2009	51197	3938	55135	28096	5198	33294	79293	9136	88429		
2010	52817	4155	56972	30274	5744	36018	83091	9899	92990		
2011	53953	4386	58339	32466	6245	38711	86419	10631	97050		

Table 10: Engineers Australia total membership, 2002 to 2011

The structure of members who were part of the engineering team is summarised in Table 11. The Table includes all members' grades, the three occupational groups and membership categories outside the occupational groups.

Table 11: The structure of Engineers Australia's women membership

Year ending		Profe	ssional			Technologist				Asso	ciates		Other Members				All
30 June	Fellow	Member	Graduate	Total	Fellow	Member	Graduate	Total	Fellow	Member	Graduate	Total	Hon Fellow	Companion	Affiliate	Total	Members
2002	42	807	1447	2296	0	2	20	22	2	20	51	73	2	8	21	31	2422
2003	43	921	1547	2511	0	2	21	23	2	18	46	66	2	7	32	41	2641
2004	46	1057	1627	2730	0	4	18	22	2	21	42	65	3	7	34	44	2861
2005	50	1170	1772	2992	0	7	16	23	2	19	40	61	3	6	30	39	3115
2006	54	1265	1871	3190	0	9	16	25	2	19	42	63	3	5	28	36	3314
2007	58	1387	1928	3373	0	9	15	24	2	23	40	65	3	5	26	34	3496
2008	65	1603	1930	3598	0	8	11	19	2	28	34	64	3	6	22	31	3712
2009	68	1826	1932	3826	0	13	10	23	2	27	33	62	3	6	18	27	3938
2010	76	2042	1918	4036	0	15	11	26	1	34	27	62	3	5	23	31	4155
2011	100	2274	1892	4266	0	16	13	29	1	34	25	60	3	5	23	31	4386

At 30 June 2002, there were 2,422 women engineering team members of Engineers Australia, 4.7% of overall membership. By 2011, women engineering team members had increased to 4,386 or 7.5%.

Womens' membership is concentrated in the professional occupational category with much smaller representations of technologists and associates compared to men. Although the number of professional fellows remains low, it has more than doubled over the decade. The number of full Members has increased from 807 in 2002 to 2,274 in 2011, an increase of 182%. The number of graduate members has increased from 1,447 to 1,892, an increase of 31%.