Skills Australia submission to the Senate Education, Employment and Workplace Relations Committees

Inquiry into the shortage of engineering and related employment skills

March 2012

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Executive Summary

Skills Australia is an independent statutory body, providing advice to the Minister for Tertiary Education, Skills, Science and Research on Australia's current, emerging and future workforce skills needs and workforce development needs.

As part of its primary function to provide advice to the Minister on Australia's workforce skills needs and workforce development needs, Skills Australia undertakes research to assess evidence from commissioned research and industry stakeholders. Skills Australia also provides recommendations on current and future skills needs to help inform decisions to encourage skills formation and drive ongoing reforms to the education and training sector.

In December 2011, Skills Australia hosted a seminar on Engineering Pathways to initiate a national dialogue between key stakeholders to discuss ways to address skills shortages in the engineering occupations. The purpose of this seminar was to:

- Provide a forum for discussion on issues of concern for the engineering industry identified by recent research, including skills shortages;
- identify opportunities for stakeholders to work together to address these issues and; and,
- suggest ways to improve the supply of engineering skills for the Australian workforce.

Several key themes emerged from the seminar that resonated with evidence from other research, some of which included the following:

- Engineers not working as engineers;
- problematic articulation between the Vocational and Education Training (VET) and Higher Education pathways;
- need to increase the supply of engineers; and,
- workforce planning and retention.

Skills Australia's response to the Senate Inquiry is informed by our consultations, research, and data analysis. Skills Australia considers that the Inquiry comes at an opportune time as our research and preliminary analysis of the consultation feedback has shown that engineering skills shortages can be a major issue for stakeholders and may have significant implications for the economy as a whole.

This submission focuses on the themes of addressing engineering supply and demand issues, workforce issues including the attraction and retention of women, skills utilisation and implications of the skills shortage to industry and the economy.

Skills Australia has made a number of recommendations in its report on *Australian Workforce Futures* (2010), some of which are reiterated in this submission. We consider these recommendations to be significant in making systemic interventions into education and graduate supply, addressing participation including the recruitment and retention of women and skills transfer issues in an ageing workforce, and investing in better articulation between industry needs and supply infrastructure to ensure that the skills needs of our economy are met into the future.

This submission specifically addresses the following Terms of reference:

(a) The implications of the shortage for infrastructure delivery in terms of economic development, cost, efficiency, safety and disputation.
Addressed in section 5.

(c) Options to address the skill shortage for engineers and related trades.
Addressed in sections 3, 4, 5 and 6.

(e) Effective strategies to develop and retain engineering talent in the private and public sectors through industry training and development, at enterprise, project and whole-of sector levels.
Addressed in sections 3, 4, and 6.

(g) Consequences of skills shortage in the construction sector to the public sector's capacity to effectively procure and manage infrastructure projects;
Addressed in sections 4 and 5.

(i) Other related matters.
Addressed in all the sections.

Introduction

Skills Australia is an independent statutory body, providing advice to the Minister for Tertiary Education, Skills, Science and Research on Australia's current, emerging and future workforce skills needs and workforce development needs.

Skills Australia's provides advice on sustaining economic growth, future skills shortages and how to raise productivity by increasing and deepening the skills of Australia's workforce (Skills Australia, 2010). Critical to achieving these objectives is improvement to the productivity of workplaces through better engagement of employees and more effective use of their skills. Increases in productivity, participation and inclusion can be achieved by ensuring our education sector has the capacity to deliver the necessary skills and through a partnership approach across government, industry and enterprises.

The importance of engineering to the Australian economy is well highlighted in research by government, non government bodies and peak industry groups (Skills Australia, Department of Education, Employment and Workplace Relations (DEEWR), the National Resources Sector Employment Taskforce (NRSET), Australian National Engineering Taskforce (ANET), and Engineers Australia (EA)), as well as by other government and non-government bodies and peak industry groups. In addition, Skills Australia's analysis of the resources sector and defence industries forecast strong employment growth in occupations relating to planning, construction, development and operations, in which engineering and related occupations play a major role (Skills Australia, 2011a).

In Australia, evidence indicates that shortages of engineers have been persistent for many years (DEEWR 2011a, 2011b; NRSET, 2010; ANET, 2010a, 2011; Engineers Australia, 2011). DEEWR skills shortage research also identifies significant shortages across many of the professional, associate and trade engineering occupations such as civil engineers, structural engineers, petroleum engineers and civil engineering draftspersons and technicians (DEEWR, 2011a). According to ANET, 'the engineering capacity shortfall has had a wide range of negative outcome across sectors with industry sources reporting financial and opportunity loss due to inability to attract and retain engineering professionals'(ANET, 2010a, p.32).

Skill shortages are most common at times of high economic growth and low unemployment. However, they can also occur in regions of high unemployment where there is a mismatch between the skills available and the skills in demand. Shah and Burke (2003) define skill shortages as existing when the "demand for workers for a particular occupation is greater than the supply of workers who are qualified, available and willing to work under existing market conditions."

There are two related concepts that often get confused when skill shortages are discussed. One is more accurately described as a 'recruitment difficulty', where a business finds it difficult to fill a specific vacancy, even though there is not an identified broader skill shortage. This may be due to the characteristics of the business or the available job, the location of the vacancy or the skill set required for the position. The second related concept is a 'skills gap' which occurs when existing staff do not have the skills required for the positions they occupy.

Some of the main causes of skill shortages are:

- Education and training shortfalls - the number of people entering education and training is less than the number required to fill available positions;
- Wastage - while people are trained in a skill, many do not work in that occupation;
- Migration - an increasingly globalised labour market means professionals such as engineers can often find employment in other countries; and

- Workforce exits – the need to replace people leaving the workforce.

Individuals' willingness to seek employment outside the skills set they acquire through training or education, while in many ways a benefit to both the labour market and individuals, can often also result in skills shortages.

1. What is engineering?

There have been many approaches to defining and quantifying the engineering labour force. As such, it is difficult to provide a single consistent definition of engineering that adequately encompasses the broad range of approaches to measuring this population.

The definition of engineering used in this paper is drawn primarily from the body of work undertaken by Engineers Australia (2010) and is described in detail in Appendix A. In summary, the Skills Australia approach attempts to match engineering related Australian and New Zealand Standard Classification of Occupation (ANZSCO) categories with specific engineering related qualifications derived from the Australian Standard Classification of Education (ASCED). This concordance has been used to create three categories of engineering occupations (management, professionals, and technicians and trades workers), and allows for more detail and consistency in the analysis of engineering supply and demand. See Appendix B for the detailed list of occupations included in each occupation category.

The broad levels of education which comprise engineering managers, professionals and technicians and trades workers are outlined in Table 1 below:

Table 1: Engineering qualifications, AQF levels and occupations

Engineering Qualification	Engineering Occupation
Bachelor Degree and Above	Professionals, Managers
Diploma/Advanced Diploma	Technicians and Trades Workers
Certificate III/IV	Technicians and Trades Workers

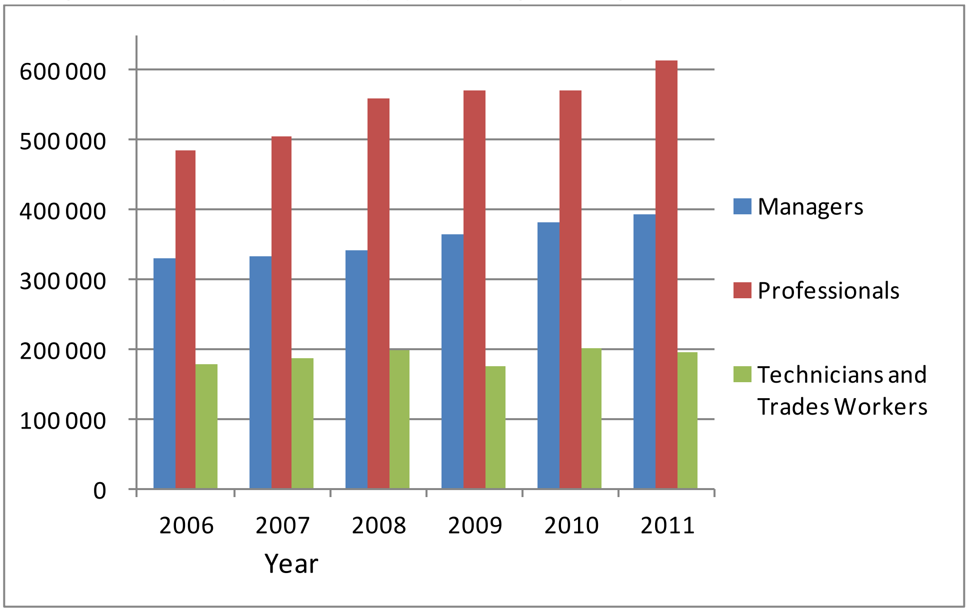
All occupations in the engineering professionals and managers groups are assumed to have a level of skill commensurate with a bachelor degree or higher qualification. Technicians and trades workers are assumed to require an engineering qualification level at certificate III/IV, diploma, or advanced diploma. There are some significant limitations to this approach and these are described in detail in subsequent chapters.

2. Labour market demand for engineers

Ideally, the analysis of the Australian engineering labour market should be undertaken using demand information that is consistently defined and classified. As has already been mentioned, there is no consistent definition in use, and data limitations are significant.

Figure 1 presents the baseline engineering workforce from 2006 to 2011. These estimates have been sourced from the ABS Labour Force Survey using ANZSCO occupation classifications, and show a steady increase in the number of persons employed as managers and professionals in selected engineering occupations from 2006 to 2011 (331 000 managers in 2006 to 393 000 in 2011, and 485 000 professionals in 2006 to 615 000 in 2011). The number of technicians and trades workers in engineering remained relatively constant throughout the same period, from 179 000 in 2006 to 195 000 in 2011. In the year following the global financial crisis (2009), engineering technicians and trades workers were the only occupational category to experience a contraction in total employment, falling 11 per cent in 2009 before increasing by a similar amount the following year.

Figure 1: Total persons employed in engineering occupations 2007 – 2011

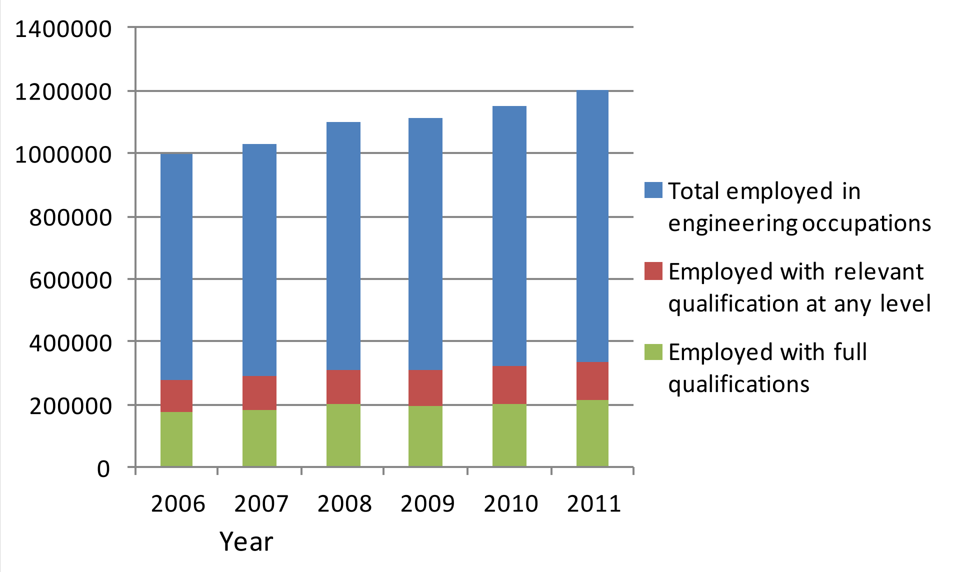


Source: ABS Labour Force Survey 2011 (6202.0), see Appendix B for selected occupations

The data presented in Figure 1 reflect the total number of persons employed in occupations that best reflect the skills that engineers possess. There is no guarantee that an occupation classification matches the job requirements expected of that classification and as a result, the total number of persons employed in these occupations is much higher than the number of persons with engineering qualifications.

Figure 2 demonstrates that even after selecting the ANZSCO occupations that best reflect the skills required of engineers, the proportion of fully qualified engineers filling these positions is low (an estimated 17.6 per cent in 2011). While these 212 000 fully qualified persons can be considered to be a good estimate of the size of the engineering labour force, this figure is likely to be an undercount of qualified engineers due to the limitations of current data sources. As mentioned previously, most data sources limit qualification collection to 'highest qualification' only. This is especially important in management occupations, where it is likely that persons with engineering qualifications may have had that qualification superseded by post graduate qualifications such as an MBA, or other further business and management studies.

Figure 2: Engineering labour force, qualification composition, 2006 to 2011[ab]



Source: Skills Australia, estimates derived from ABS Labour Force Survey, November 2011, and ABS Census of Population and Housing 2006.
a. Includes all engineering occupations (management, professional, and technicians and trades).
b. Full engineering qualifications for engineering management and professional occupations includes Bachelor degree and above in engineering related field; For technicians and trades occupations includes Certificate III/IV, Diploma or Advanced Diploma only, in engineering related field.

In addition to these fully qualified engineers, in 2011 there were an estimated 125 000 persons employed with engineering qualifications at the Advanced Diploma level and below. While many of these persons could be considered to be underqualified in these occupations, it is not possible to determine the extent of under-qualification due to the fundamental differences between occupation classification and job role.

The total number of fully qualified engineers in Australia, across all categories was approximately 177 000 in 2006 and 212 000 in 2011. From 2006 to 2011, the workforce in engineering professional occupations was estimated to have increased by 25 000, or 27 per cent, engineering management, and technicians and trades occupations increased by 17 and 10 per cent respectively. These figures are presented below in Table 2.

Table 2. Summary of fully qualified engineers, in engineering occupations, 2006 - 2016

	2006	2007	2008	2009	2010	2011	2016
Engineering management	24 000	24 000	25 000	26 000	28 000	28 000	34 000
Engineering professionals	91 000	95 000	105 000	108 000	107 000	116 000	147 000
Engineering technicians and trades	62 000	65 000	69 000	61 000	70 000	68 000	74 000
Total qualified engineers	**177 000**	**184 000**	**199 000**	**195 000**	**204 000**	**212 000**	**253 000**

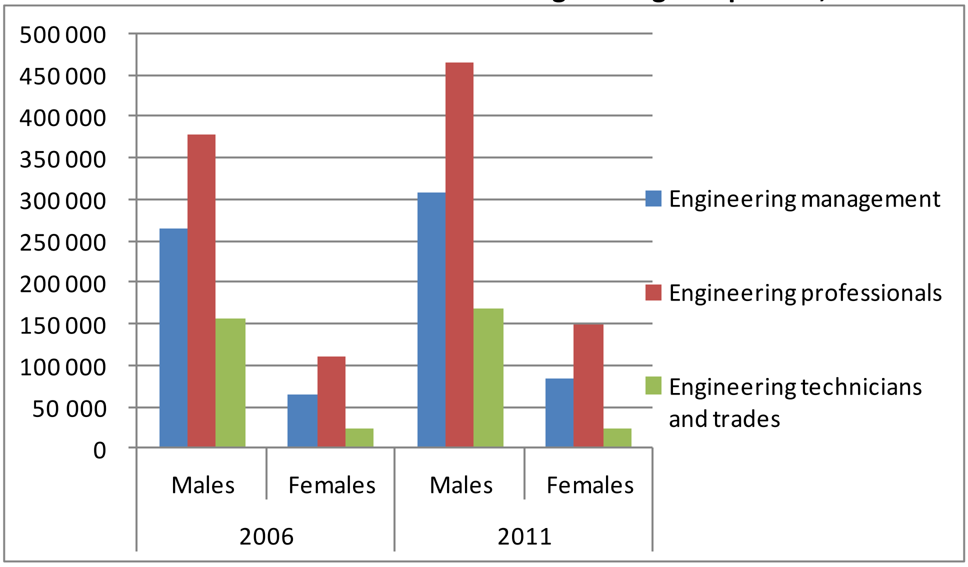
Source: Skills Australia, estimates derived from ABS Labour Force Survey, November 2011, and ABS Census of Population and Housing 2006.

Assuming growth rates over the next five years match those of the previous five years, the workforce demand for management and professional engineering is expected to increase by 37 000 people between 2011 and 2016 (from 144 000, to 181 000 persons) and technicians and trades engineers by 6 000 persons between 2011 and 2016 (from 68 000, to 74 000 persons). Over the next five years this equates to an annual increase of approximately 7 400 new engineering management and professional jobs, and 1 200 engineering new technicians and trades jobs. These estimates may be conservative given the large number of major resources, defence industry and infrastructure projects planned and commissioned to commence over the next five years.

The estimates of demand for engineers in Table 2 relate to new engineering jobs created through the expansion of the resources and construction sectors. These estimates do not account for the large number of engineers who are approaching retirement over next five to fifteen years. The annual rate of engineers reaching retirement could be as many as 4 per cent of the total engineering labour force (ANET, 2010a).

Engineering has traditionally been seen to be a male dominated profession, and this trend still holds true today. Figure 3 displays the total workforce employed in selected engineering occupations, split by gender.

Figure 3: Total Males and Females in selected engineering occupations, 2006 and 2011



Source: ABS Labour Force Survey, November 2011, cat. no. 6202.0. See Appendix B for selected occupations.

Between 2006 and 2011, females have slightly increased their share of employment within engineering occupations from 19.8 per cent to 21.5 per cent.

There are many barriers to female participation in engineering and related occupations, including limited flexibility of working hours, and traditional association of the occupation with males. Many companies employing engineers are beginning to address these barriers, and NRSET found that companies have been deploying programs designed to increase the number of females in the workforce (NRSET, 2010). These programs aim to improve workplace flexibility, provide more part-time employment opportunities, and access to childcare.

In June 2011, the Australian Mines and Minerals Association (AMMA) received Australian Government funding to lead a project to attract and retain females in the resources and related construction sectors. The Minerals Council of Australia has also been active in promoting females in the resources sector, and has recommended that in addition to improvements to workplace flexibility and part-time career opportunities, the sector should work to address the strong masculine culture through inclusive practices and innovative marketing strategies (Office for Women & MCA, 2006).

Factors driving demand for engineering skills

Resources sector

Demand for engineering skills is significant across the economy, however some sectors experience stronger demand than others. Demand for labour in the resources sector depends in part on the extent of major project construction activity and trends in production, which is also dependent on mineral exploration investment in Australia.

The Bureau of Resources and Energy Economics (BREE, 2011) releases lists of major projects in the mining industry. As of October 2011, the total value of projects listed was valued at $456.5 billion (where the value is known), including 102 advanced projects valued at $231.8 billion where final investment decisions (FID) have been made. These major projects will lead to increased demand for engineering skills.

In addition, Skills Australia has estimated potential growth in mining operations employment over this period to 2016 (Skills Australia, 2012). The findings suggest that employment growth in mining operations will increase by 89 000 persons from 2010 to 2016, with annual average growth in employment in mining operations of 7.9 per cent over this period. The largest employment growth is anticipated to be for machinery operators and drivers, followed by technicians and trades workers.

Defence

Skills Australia's (2012) analyses of skills supply for the defence industries shows that the planned expansion in Defence acquisitions comes at a time when competing demand for skills from other major projects in other industries may result in skills shortages emerging. Labour demand will also be influenced by the timing of planned procurements.

In September 2011, Skills Australia was commissioned by the Australian Government Minister for Defence materiel to develop a workforce strategy for Australia's Defence materiel supply industries. The first output under the Strategy, the Defence Industry Workforce Strategy Discussion Paper, was released on 1 February 2012. It provides a preliminary assessment of the skills outlook for the Australian defence materiel supply industries.

The Discussion Paper highlights the importance of a range of engineering professions and trades to Australia's defence materiel supply industries. Over the next decade, the supply of engineering professionals and technicians and trades workers across a range of disciplines will play a key role in determining the capacity and capability of Australian industry to compete for Defence acquisition contracts.

Skills Australia has identified some potential skills gaps in engineering professions and trades for the defence materiel supply industries. Skills gaps seem likely to include electronic, electrical, mechanical and aerospace engineers. While supply of people with mechanical engineering and aerospace qualifications is projected to increase until 2020, until the mid 2010s there may be a decline in the number of electrical and electronic graduates.

Many of the jobs in the defence materiel supply industries are highly skilled, often requiring advanced qualifications and extensive workplace experience. These types of specialist skills are frequently subject to significant competition between employers.

The defence materiel and supply industries will also face substantial competition for these skills from other industries, including the rapidly growing resources sector. Skills Australia will conduct further analysis of these potential skills gaps in the lead up to its final report.

National Broadband Network

In April 2009 the Australian Government announced the establishment of a new company to build and operate a new super fast NBN. The Government noted that the NBN will:

- Connect 90 per cent of all Australian homes, schools and workplaces with broadband services with speeds up to 100 megabits per second 100 times faster than those currently used by many households and businesses.
- Connect all other premises in Australia with next generation wireless and satellite technologies that will deliver broadband speeds of 12 megabits per second.
- Directly support up to 25 000 local jobs every year over the 8 year life of the project.

At the time the NBN was announced, the preliminary estimate was that the enhanced network would cost up to $43 billion, based on advice from specialist technical advisers (Conroy, 2011).

Other infrastructure projects

In its most recent report on Australia's economy, the OECD stated that Australia has an infrastructure deficit, partially due to underinvestment in the 1980s and 1990s (OECD, 2010).

The OECD said that there are substantial needs in many areas:

- Growth in mineral exports predominantly to China has put substantial strains on key port infrastructure and exposed gaps in rail infrastructure. The demand for freight is expected to double between 2000 and 2020 and needs to be addressed (BTRE 2006 cited in OECD 2010, p. 92).
- Rapid growth and population ageing over the coming decades call for a reappraisal of urban infrastructure requirements. In 2006, over three-quarters of the population was living in cities of over 100 000 people, which produced roughly 80 per cent of GDP (IA, 2010a cited in OECD 2010). The OECD observed that this gives rise to congestion. Congestion costs estimated at some $13 billion (1½ per cent of GDP) for 2010 could exceed $20 billion in constant prices by 2020 with unchanged policies (BTRE 2007 cited in OECD 2010, p. 92).
- Water supplies to large cities are insufficient given the prices currently charged, leading to chronic restrictions. These difficulties are only partially attributable to climate change (OECD, 2008). A high proportion of the electricity infrastructure was installed in the 1960s and now needs replacement. There is also a substantial population and industry shift towards regions where mining industry is expanding and new infrastructure is required. Capital investment in water, energy and transport industries, which was low in the 1980s and 1990s, has nonetheless increased since 2000 (OECD 2010, p. 92).
- Environmental concerns about scaling back greenhouse emissions demand substantial capital investment in energy and rural water management (OECD 2008 cited in OECD 2010, p. 93).

The OECD noted that Infrastructure Australia (IA) was established to better coordinate infrastructure spending and advise the government on infrastructure policy. One of IA's first tasks was to conduct an audit to steer public and private investment. The audit spotlighted requirements in seven sectors: broadband internet, ports, the rail freight network, urban transport, the energy market, water supply and infrastructure for Indigenous communities (IA 2008 cited in OECD 2010).

In these sectors, nine priority projects and an additional list of 28 other projects, accounting for aggregate investment in excess of $60 billion, were identified (IA 2009). Of these, seven priority projects were selected as part of the 2009-10 Budget. Further, the 2010-11 Australian Government Budget increased railway investment to 0.3-0.4 per cent of GDP a year between 2008-09 and 2013-14, representing a doubling of those of the six previous years (OECD 2010, p. 97).

3. Labour market supply of engineers

The supply of skilled labour to Australian industries is sourced from a number of areas, including higher education, VET, migration, and underutilised labour.

Higher education

DEEWR higher education data (2011b) shows a steady increase in domestic students for engineering places at Bachelor level and above in universities between 2001 and 2010 (Table 3). During this period, overall domestic commencement figures in engineering have risen by 19.5 per cent from 13 502 in 2001 to 16 131 in 2010. Over the same period there was minimal change in the proportion of males and females commencing engineering studies, with males increasing student share from 84.3 per cent in 2001 to 84.6 per cent in 2010 (females share decreased from 15.7 per cent to 15.4 per cent).

Table 3: Commencements and completions for domestic engineering students, Bachelor degree and above, by gender[a,b]

	Commencements			Completions		
Year	Male	Female	Total	Male	Female	Total
2001	11 381	2 121	13 502	6 298	1 282	7 580
2002	11 186	2 052	13 238	6 000	1 208	7 208
2003	11 167	1 965	13 132	6 177	1 273	7 450
2004	11 008	1 910	12 918	6 304	1 312	7 616
2005	11 025	1 774	12 799	6 044	1 225	7 269
2006	11 090	1 923	13 013	6 357	1 249	7 606
2007	11 699	2 075	13 774	6 302	1 238	7 540
2008	11 998	2 226	14 224	6 645	1 282	7 927
2009	13 085	2 401	15 486	6 718	1 279	7 997
2010	13 649	2 482	16 131	7 107	1 414	8 521

Source: DEEWR (2011c) higher education statistics, unpublished data from Higher Education Data Cube (uCube).
a. Commencements cannot be directly compared to completions for determination of retention and attrition.
b. The field of 'engineering and related technologies' includes a small number of students enrolled in geomatic engineering and surveying, which are not usually regarded as part of engineering.

The number of domestic students completing Bachelor or above qualifications in engineering increased by 12.4 per cent over the same period, from 7 580 in 2001 to 8 521 in 2010 (except for dips between 2004 and 2008). As with commencements, domestic male students increased their share of completions slightly from 83.1 per cent of all completions in 2001 to 83.4 per cent in 2010 (females share decreased from 16.9 per cent to 16.6 per cent).

An engineering degree in Australia has become an increasingly popular choice for international students. As can be seen from Table 4 below, international commencing student numbers have increased by 83.4 per cent since 2001, from 5 281 students in 2001 to 9 687 in 2010. Interestingly, in contrast to the domestic student population, the share of males commencing an engineering degree has decreased from 83.3 per cent in 2001 to 80.1 per cent in 2010 (females increased share from 16.7 per cent to 19.3 per cent).

Table 4: Commencements and completions for international engineering students, Bachelor degree and above, by gender[a,b]

	Commencements			Completions		
Year	Male	Female	Total	Male	Female	Total
2001	4 400	881	5 281	2 269	518	2 787
2002	5 175	1 034	6 209	2 545	576	3 121
2003	6 472	1 208	7 680	3 306	712	4 018
2004	6 163	1 213	7 376	3 710	809	4 519
2005	5 900	1 257	7 157	4 224	939	5 163
2006	5 793	1 216	7 009	3 965	833	4 798
2007	6 342	1 393	7 735	3 922	867	4 789
2008	6 591	1 543	8 134	4 223	1 074	5 297
2009	7 996	1 790	9 786	4 471	1 018	5 489
2010	7 820	1 867	9 687	5 102	1 198	6 300

Source: DEEWR (2011c) higher education statistics, unpublished data from Higher Education Data Cube (uCube).
a. Commencements cannot be directly compared to completions for determination of retention and attrition.
b. The field of 'engineering and related technologies' includes a small number of students enrolled in geomatic engineering and surveying, which are not usually regarded as part of engineering.

International students completing a Bachelor degree or above in engineering increased by 126 per cent over the same period, from 2 787 in 2001 to 6 300 in 2010. The share of female international students also increased slightly from 2001 to 2010, rising from 18.6 per cent to 19 per cent from 2001 to 2010 (share of male student completions declined from 81.4 per cent to 81 per cent).

This data indicates that the overall supply of graduate engineers (from both domestic and international students) increased considerably in the last decade, and international student completions are responsible for the majority of the increase in graduate supply (approximately 43 per cent of graduates in 2010 were international students, compared to 27 per cent in 2001).

It is likely that supply of engineers will need to be augmented for a number of reasons. The conservative estimate provided earlier in this paper of 7 400 new engineering management and professional jobs annually over the next five years is very close to the recent number of domestic engineering student completions (8 521 in 2010). Any shortfall in employment of domestic graduate students could be augmented through adjustments to the international student visa program.

The tight supply of engineers graduating with a Bachelor degree and above, may in part explain why employers have recruitment issues - there is not a large pool of candidates to select from. Despite the inherent difficulties in comparing commencements with completions data, it is apparent that a large gap exists between students commencing study in engineering and completing the degree throughout the last decade.

There is a lack of detailed data to determine whether this gap is due to students transferring to another engineering discipline or commence a different degree altogether. It is also possible that transfers to other educational institutions exaggerate the number of commencing students in the nationally aggregated data. This is because students who transfer to another education institution are counted as commencing students in that institution even though they may be studying in the third year of the degree program.

Several reports have examined the reasons students do not complete an engineering degree (Marks, 2007; ALTC, 2011), and it has been proposed that engineering students leave engineering courses for reasons to do with lack of commitment and passion for engineering; lack of academic progress and because the course does not meet their expectation.

Solutions for improving the number of engineering student completions have been proposed by the Australian National Engineering Taskforce (King et. al. 2011), which argued that engineering commencements and completions could be improved through improved pathways from Vocation Education and Training qualifications into the higher education sector. Skills Australia (2011) has previously argued that Australia lacks sufficient career advisory services available to individuals of all ages. This may also be having an impact in attracting prospective students into engineering.

Skills Australia's projections: Higher education engineering courses

Skill Australia has prepared projections of commencements and completions in higher education in courses related to engineering.

The number of commencing students in Bachelors or Vocational Education and Training engineering courses over the period of 2011-2020 has been calculated based on the historical nine-year growth rate, with an assumption that the annual growth experienced from 2001 to 2010 will continue at a constant rate from 2011 to 2020. The number of students completing these courses over this period of time has been calculated based on the historical average four-year completion rate, and assumes that students will undertake their studies for four years.

The Bradley Review (2008) examined Australia's higher education system and recommended that a new student demand-driven entitlement system could increase the number of student enrolments generally in various courses. Taking it further, this suggests that enrolments in engineering courses may increase if engineering occupations are considered to be in demand and financially rewarding. These projections have not accounted for constraints in capacity or capability of education providers to accommodate continuous growth in student enrolments in engineering, and should be regarded as broadly indicative of possible student demand.

Table 5 shows that the total number of projected commencements in engineering courses could increase by 93.4 per cent from 28 715 in 2010 to 55 545 in 2020, with annual average growth in engineering commencements of 6.2 per cent over this period. International student share of commencements is projected to decrease from 37 per cent to 31.9 per cent.

Table 5: Total number of projected commencements and completions in engineering courses, 2011-2020[a]

	Commencements			Completions		
Year	Domestic	International	Total	Domestic	International	Total
2010	18 078	10 637	28 715	8 981	6 656	15 637
2015	28 450	13 636	42 086	13 972	6 784	20 757
2020	37 827	17 718	55 545	20 472	9 576	30 047

Source: Estimates derived from DEEWR (2011d), *Students, Selected Higher Education Statistics*.
a. Includes all domestic and international students in an engineering related field, at diploma level and above.

Completions in engineering courses are projected to increase by 92.2 per cent from 15 637 in 2011 to 30 047 in 2020, with annual average growth of 6.7 per cent over this period. International student share of completions is expected to decrease from 43 per cent in 2010 to 31.9 per cent in 2020.

More detailed projections relating to specific engineering related courses can be found in Appendix C.

Vocational education and training

The National Centre for Vocational Education Research's (NCVER) data on completion and attrition rates for engineering students provides an indication of the number of students in the vocational education and training sector (NCVER, 2011). VET engineering and related technologies total commencements between 2005 and 2010 increased by 21 per cent (141 471 to 171 354). The vast majority of these commencements were at Certificate III level, other key findings are:

- Advanced Diploma commencements decreased by 26 per cent (6 140 to 4 573)
- Diploma commencements decreased by 12 per cent (6 703 to 5 878)
- Certificate IV commencements increased by 79 per cent (9 852 to 17 637)

VET engineering and related technologies total completions between 2005 and 2009 increased by 44% (41 677 to 60 121), other key findings are:

- Advanced Diploma completions decreased by 12 per cent (1 460 to 1 292)
- Diploma completions decreased by 4 per cent (2 030 to 1 941)
- Certificate IV completions increased by 83 per cent (2 063 to 3 777)

As discussed above, VET sector commencements in Advanced Diploma and Diploma qualifications have decreased by 26 per cent and 12 per cent respectively. The reason for this decline is unclear but could be related to lack of accreditation since only two of the many VET providers delivering Advanced Diploma qualifications are currently accredited by Engineers Australia (ANET, 2011, p. 11).

Though enrolment in VET Diplomas has declined some VET Providers such as Chisholm Institute have switched some of their provision to higher education qualifications at similar AQF Levels such as the Associate Degree. This can be more attractive to students as it provides an easier articulation pathway into Bachelor and higher programs. It also seems a more attractive qualification to some employers. One theme that was suggested at the Skills Australia seminar on engineering pathways was that the VET Diploma was more about broadening the base and range of student skills and competencies but the Associate Degree was more concerned with "skills deepening"; that is giving the student more in depth theoretical knowledge. Accreditation with Engineers Australia ensures that institutions are meeting national and international benchmarks and provides graduates with Engineers Australia membership at the relevant career grade.

King et.al. (2011, p. 21) note, a number of VET engineering Advanced Diplomas have been developed, however, not all not are currently being offered by VET providers.

While analysing VET completion rates in Australia is difficult because individual students cannot be tracked, Skills Australia (2011c) argues that qualification completion rates in the VET sector are unacceptably low. Improving completion rates in VET could help meet industry demand and allow more students to progress to higher level engineering qualifications.

Supply from migration

Migration provides an important supply of skilled and semi-skilled labour into the Australian labour market. Some of our stakeholders such as Engineers Australia argue that skilled migration has been the Australian Government's main response to skills shortages in the engineering sector. The Skilled Occupations List (SOL) produced by Skills Australia is used by the Department of Immigration and Citizenship (DIAC) to govern independent skilled permanent migration. Most engineering occupations are currently on the skilled occupations list.

There are two principal streams of skilled migration, temporary migration mostly through the use of the subclass 457 visa and permanent migration generally through the General Skilled Migration (GSM) program. Evidence suggests that migration supply is linked to domestic economic conditions, with increased migration during periods of increased labour demand (Cully 2009).

As part of the 2011-12 Budget, the Australian Government announced a range of new migration arrangements including the introduction of Enterprise Migration Agreements (EMAs) and Regional Migration Agreements (RMAs).

Significant numbers of subclass 457 visa grants have historically been made to civil engineering professionals, industrial, mechanical and production engineers, other engineering professionals, and geologists and geophysicists. Table 6 below shows a breakdown of skilled migration both permanent and temporary by visa category. A full break down of these statistics is presented in Appendix D.

Table 6: Skilled migration of engineering managers, professionals and technicians and tradespeople by visa category

Visa Stream[a]	2006-07	2007-08	2008-09	2009-10	2010-11
General Skilled Migration	12145	11942	10855	12182	9558
457 Temporary business visa	17890	22540	19620	15812	23381
Employer sponsored visa	2176	3003	4322	4355	5224

Source: Department of Immigration and Citizenship data.

a. Includes Engineering managers, Engineering professionals and engineering technicians and trades.

DIAC's Continuous Survey of Australia's Migrants (CSAM) has provided an improved understanding of the labour market outcomes of recent migrants (see Table 7). The unemployment rate of all independent skilled migrants was 8.7 per cent (a figure above the 5.4 per cent national unemployment rate at the time of the survey) and their participation rate was 97 per cent (CSAM, 2011).

Table 7: Employment outcomes of Australian migrants, skilled independents, 2010 survey

	Unemployment Rate	Participation Rate*	In Nominated Occupation	In Skilled Work (FT)
Engineering managers[a]	0%	100%	35%	95%
Engineering professionals[b]	9%	98%	44%	68%
Engineering technicians and trades[c]	3%	98%	37%	91%
Total Engineers	**8%**	**98%**	**43%**	**73%**
Total Migrants	**9%**	**97%**	**-**	**63%**
Total Australian Population (aged 15+)	**5%**	**66%**	**-**	**25%**

Source: Department of Immigration and Citizenship, Continuous Survey of Adult Migrants 2011.

* The labour force participation rate can be defined as the percentage of the working age population who are in the workforce. Thus, the labour force participation rate is affected by the size of the labour force as well as the working age population. People are considered in the workforce if they are either working or actively seeking work.

a. Engineering managers includes; Engineering Managers.

b. Engineering professionals includes; Civil engineering professionals; Industrial, mechanical and production engineers, Other engineering professionals.

c. Engineering technicians and trades workers includes; Building and engineering technicians; Civil engineering draftspersons and technicians; Electrical engineering draftspersons and technicians; Electronic engineering draftspersons and technicians; Mechanical engineering draftspersons and technicians; Aircraft maintenance engineers; Toolmakers and engineering patternmakers.

CSAM data does not provide us with enough data to explain the underlying reasons for these results. However, anecdotal evidence suggests that qualified engineers who come through the GSM program may have difficulty obtaining employment in their profession. There is some suggestion that employers prefer not to employ qualified engineers who complete their education overseas, complaining that few meet Australian employment market needs and lack adequate English language skills. The evidence from CSAM data (Table 7) shows that engineering professionals have a higher rate of unemployment than total engineers, as well as the general Australian unemployment rate.

Match between engineering qualifications and jobs

The number of qualified engineers employed in engineering occupations is smaller than the total engineering labour force, and policy designed to improve the number of qualified engineers should consider how many persons with a qualification end up working in a capacity that uses those skills.

Table 8 below shows that of the total 168 632 persons aged 15 to 64 with a Bachelor degree and above in an engineering related field, 93 263 (or 55.3 per cent) were employed in an occupation that could directly utilise those skills. Of the 880 375 persons aged 15 to 64 with a Diploma/Advanced Diploma, or Cert III/IV in an engineering field, only 125 117 (or 14.2 per cent) were employed in an occupation directly utilising those skills.

Table 8: Utilisation of engineering qualifications in the Australian labour market, Census 2006

Qualification	Total labour force, aged 15 - 64	Persons employed in engineering occupation	Per cent utilisation
Bachelor degree and above in engineering	168 632	93 263[a]	55.3
Diploma, Advanced Diploma or Cert III/IV in engineering	880 375	125 117[b]	14.2

Source: ABS Census of Population and Housing, 2006. Results from ABS table builder.
a. Includes persons with Bachelor degree and above in engineering field, employed in professional and managerial engineering related occupations.
b. Includes persons with Diploma, Advanced Diploma or Cert III/IV in engineering field working 'above skill level' i.e. working in technicians and trades, as well as professional and managerial engineering related occupations.

The broad range of expertise that is gained from an engineering qualification can be applied to a majority of professional occupations and many persons with an engineering qualification may have found rewarding employment in occupations outside of engineering. Some graduates begin careers in traditional engineering occupations and then move into non-traditional occupations later in their career. A proportion of engineering graduates also respond to normal labour market incentives and work in occupations where it is unlikely they will practise engineering. Anecdotal evidence, for example, indicates that these graduates are often targeted by comparatively higher paying financial and insurance sectors which value their analytical education as a foundation for these careers. Creating further opportunities for engineering graduates could improve the likelihood of completing students pursuing a career in engineering.

4. Skill shortages or recruitment difficulty?

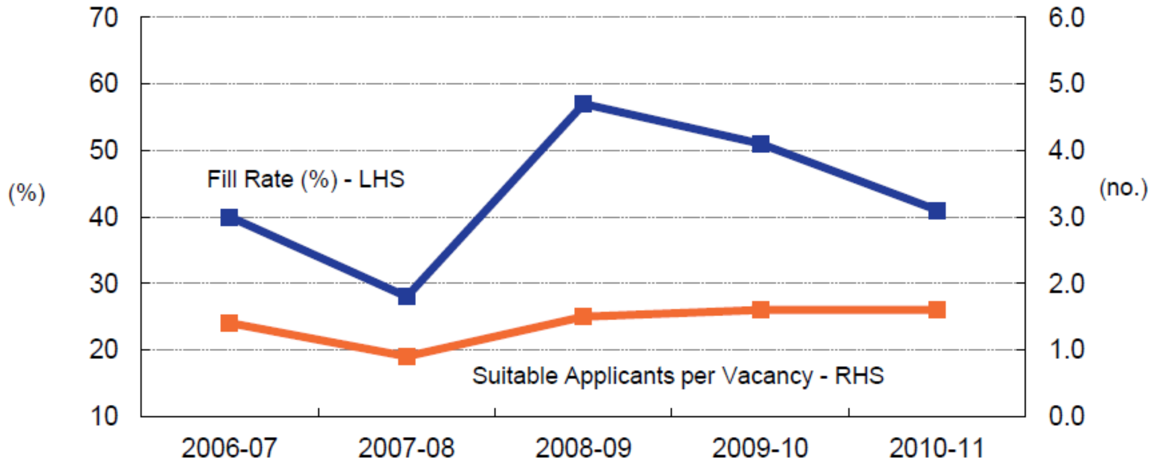
Recent research undertaken by DEEWR and Skills Australia indicates that shortages are relatively widespread for engineering professional and para-professional occupations (see Appendices C and D; Skills Australia, 2011d). These shortages are largely driven by high levels of activity in the resources and infrastructure construction sectors. Skills Australia research (2011a, p: 22-25) has found that nationally, shortages of engineers are similar to those seen before the onset of the global financial crisis and increased demand has been evident since late 2009.

Appendix E highlights the engineering occupations that are in shortage across the professional, para-professional and trade levels. It shows that there are widespread shortages across engineering, with only 3 of the occupations surveyed not experiencing shortages. Of significance are the lengths of time some of these occupations have been in shortage, for example, civil engineers were in shortage for 9 of the 10 years prior to 2011 (DEEWR, 2011a; 2011b).

With continuing strong demand for engineers across the economy, employers are experiencing difficulty recruiting in most professional engineering specialisations. Skills Australia research has found that skills shortages are currently evident for around 80 per cent of surveyed engineering professions, including both civil and electrical engineers which are key skills for the resources sector (Skills Australia, 2011a, p.25). Deloitte Access Economics research found that there are projected shortages for professionally qualified staff in engineering related occupations such as mining, mechanical, civic, petroleum, chemical and electrical (Deloitte, 2011). Furthermore, DEEWR research highlights that the labour market for engineering professionals tightened over 2010-11, with the proportion of professional engineering vacancies filled being the lowest of any occupational cluster assessed (DEEWR, 2011a, p.26).

"Overall, research indicated that employers continue to experience difficulty recruiting in most professional engineering specialisations, with the proportion of engineering vacancies filled in 2010-11 the lowest of any occupational cluster assessed by DEEWR (41 per cent compared with 60 per cent for all professions). The number of suitable applicants per vacancy, though, was close to the average across all professions suggesting there is a disparity in the response to advertising. Figure 4 below presents the proportion of vacancies to the number of suitable applicants per vacancies for engineering professionals" (DEEWR, 2011a, p.26).

Figure 4: Proportion of vacancies filled and number of suitable applicants per vacancy, engineering professionals, 2006-07 to 2010-11



Source: DEEWR Survey of Employers who have Recently Advertised results

What is noteworthy is that even though shortages persist for the majority of engineering occupations, there are sometimes significant numbers of qualified but unsuitable applicants for positions. These applicants include new graduates who are considered by employers to be unsuitable because they lack a minimum level of experience, as well as experienced candidates who do not meet employers' needs for communication skills or specialist technical skills.

The majority of employers surveyed were seeking to recruit staff who had at least five to ten years experience. Candidates who lacked this level of experience were generally considered to be unsuitable. DEEWR skills shortage research (2011a, p. 28) further noted that:

- Unsuitable chemical engineering candidates often lacked experience in specialised areas such as water treatment, minerals processing plant design and odour control processing;
- Employers of mining engineers often required candidates to have experience in their specific sector of the resources industry.
- Some employers reported being unable to fill vacancies due to candidates lacking the level of qualification required.
- The majority of employers required engineers to have local experience and, as a result, many international and interstate candidates were often considered to be unsuitable.

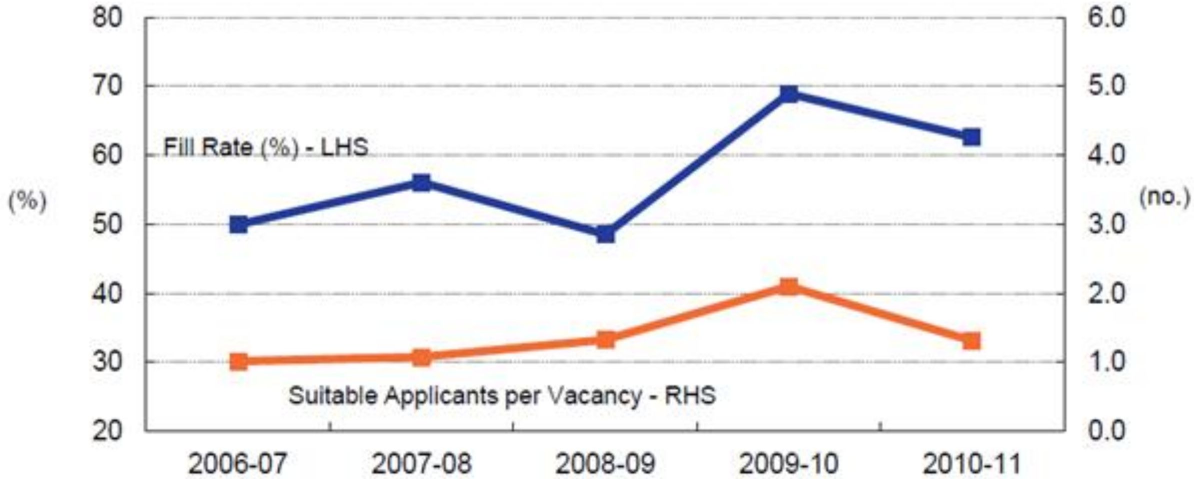
There are also acute shortages of para-professional (or technician and trades) engineers. Watson and McIntyre (2011) note there are currently insufficient graduates with para-professional qualifications to meet employer demand for people with technical skills in engineering-related occupations. This will be further exacerbated by the fact that engineering and related technologies commencements and completions at the para-professional level are declining (see below). There are a number of factors contributing to shortages in engineering. These are discussed below.

Engineering trades

In the case of the engineering trades the labour market tightened considerably over 2010-11, driven in part by expansion in the resources sector. It is notable too, that it is common for employers to consider applicants to be unsuitable even though they hold formal qualifications, if they lack specific work experience or skills. This potentially reduces the ability of workers to move easily between employers in different industry sectors. For example, workers with experience primarily in the manufacturing sector may experience difficulty gaining employment in the resources sector.

Figure 6 shows the proportion of vacancies to the number of suitable applicants per vacancies for engineering professionals.

Figure 6: Proportion of vacancies filled and number of suitable applicants per vacancy, engineering trades, 2006-07 to 2010-11



Source: DEEWR Survey of Employers who have Recently Advertised results.

Surveyed employers were generally seeking to recruit workers with formal qualifications, however as the DEEWR skills shortage research indicates (DEEWR, 2011a), some were willing to employ applicants without qualifications who could demonstrate a sufficient level of trade skills.

- Some employers reported being unable to fill vacancies which required a broad range of trade skills or wide ranging experience.
- More often, however, employers considered applicants to be unsuitable because they lacked work experience or skill sets specific to their business. For example, employers in the resources sector frequently sought tradespeople with experience in the maintenance and repair of heavy vehicles and processing equipment, while employers of welders often reported difficulty attracting applicants with high end trade skills and with experience in specific welding techniques or working with particular materials (p. 61).
- It was not uncommon for employers to consider applicants to be unsuitable even though they held formal qualifications, if they lacked such specific work experience or skills.
- Although employment in the mining industry accounts for a relatively small proportion of the total workforce, employer comments suggest that, because of the higher wages available, this sector is able to attract skilled workers from other industries and is contributing to wages growth, particularly in regional areas (p. 61).

Consultations with stakeholders suggest that there also exists a skills gap where people employed do not have all the skills needed to perform the tasks required by the employer. Factors that can lead to skills gaps include:

- Technologies being introduced, the very newness of which means that initially few are familiar with them or their applications;
- Employers, being unable to find skilled applicants, recruiting workers who need further training and/or experience to meet the firm's skill needs for the occupation;
- New employees who are still adjusting to a new company.

Skills Australia notes that the issue is not just one of increasing skills supply, but also one of how employers maximise the benefits or utilise skills more effectively. For instance, if this does not occur the lack of experienced engineers will lead to the deterioration of existing infrastructure, as well as a decline in the number of significant new public developments (IA, 2011)

Recruitment and retention of engineers

The competitive market for engineers is reflected in the attraction and retention difficulties faced by employers across the various sectors (ANET, 2011; 2010a; 2010b; Engineers Australia, 2011). Employers not only compete in the global market for staff (due to a skills shortage internationally), other factors also impede the successful attraction and retention of existing and new employees. These include poaching by other firms, employees seeking work life balance and moving to other occupations or organisations for greater remuneration. Skills Australia's consultations have shown that female engineers tend to value flexible working conditions and tend to leave for reasons connected with the workplace culture (with discrimination, sexual harassment), family responsibilities, travel and study. International studies have also identified similar problems with women in the engineering workforce which dictates their retention rate in the workforce.

An Association of Professional Engineers, Scientists and Managers (APESMA) survey (2010) found that the workplace culture requires some scrutiny. According to the survey, 60 per cent of respondents working part time believed that this had affected their career opportunities and one third felt that they were unnecessarily refused access to training. Most noted a lack of access to senior positions, pay gaps between male and female engineers and issues with work life balance.

Approximately one quarter of respondents planned to leave the sector because of work life imbalance or a need to change for career advancement (APESMA, 2010). The Institute of Professional Engineers

New Zealand (2011) has also identified that work/life balance, career breaks and support affect the retention of women in engineering.

Addressing systemic workplace issues is a key to attracting and retaining female engineers in the organisation.

5. Economic consequences of engineering skills shortage

Skills Australia recognises that prolonged shortfalls in engineering capacity could hold back investment and productivity growth. While these issues would be most apparent in the resources sector, they could also impact upon the effectiveness of other sectors such as road, rail, manufacturing, construction and infrastructure development.

ANET (2010a, p.14) noted that the shortage of skilled engineers has specific workplace consequences for individual engineers and the profession as a whole. Anecdotal evidence suggests that many employers, faced with financial imperatives, structure work around capacity constraints rather than seeking to build capacity among the existing and stretched workforce. For instance, lack of workplace capacity leads to reliance on contractors and external expertise in larger organisations, including public sector infrastructure providers. This reliance is to the detriment of generalist workforce training; contractors develop specialist expertise rather than generalist engineering capacity, with knock-on effects to professional standards and structures.

The engineers' survey undertaken by ANET (2010b) identified a range of broader impacts of the underutilisation of their skills and capabilities in the workplace and organisation. For instance:

- **34.3%** identified an impact on efficiency and effectiveness
- **25%** identified an impact on productivity
- **17.1%** identified a loss of organisational capability
- **11%** identified an impact on cost and project delays
- **8.6%** identified a loss of morale or demotivation as a result.

One of the comments referred to the loss of knowledge and capability in the organisation as a result of the skills shortage:

> *As a government department, we moved from having a large in-house engineering workforce, to outsourcing most functions. We are now largely an administrative/management agency. However with that outsourcing we lost a lot of institutional knowledge and capability. We struggle to remain an informed client and are desperately trying to build technical expertise in key areas that cannot be met through the private sector. The current situation is inadequate to meet current demands, let alone provide a sustainable model to meet future demands. The organisation has not successfully tackled the issue of attraction and retention of engineers and allied technical personnel.* (ANET, 2010b, p.4)

It is evident that both employers and engineering employees share the effects of the skills crisis on their work, with employers highlighting the difficulty in finding qualified staff and engineers commenting on the quality and safety aspects of a loss of capacity at their workplaces (ANET, 2011; 2010a; 2010b).

6. Effective strategies to develop and retain engineering talent in Organisations

This submission has highlighted key issues of concern to the engineering workforce. As discussed previously, the resources, building and construction booms have drawn engineering expertise away from specific sectors. The large growth across the Australian economy has increased the number of engineers required by industry, however the supply of engineers from education institutions has not increased to meet this demand.

This is a complex issue and the low supply of engineers from University and the VET sectors could be a result of the general decline in the delivery of science, engineering, technology, and mathematics subjects at primary and secondary school, resulting in low numbers at the tertiary level (Angus, Only, & Ainley, 2007).

Recently in December 2011, Skills Australia hosted a seminar on Engineering Pathways to initiate a national dialogue between key stakeholders to discuss ways to address skills shortages in the engineering occupations.

The purpose of this seminar was to:

- provide a forum for discussion on issues of concern for the engineering industry identified by recent research, including skills shortages;
- identify opportunities for stakeholders to work together to address these issues and;
- suggest ways to improve the supply of engineering skills for the Australian workforce.

There was strong agreement amongst the stakeholders that there is a need to attract more people into engineering studies and to consider ways to make engineering more attractive to prospective students, in both VET and higher education. The "value proposition" for working in engineering occupations needs to be clearly articulated and more widely understood. The outcome of the seminar is presented in Appendix F.

Participants agreed it had been productive to bring the key stakeholders together and there should be ongoing discussion. Skills Australia recommends the Industry Skills Councils, the Australian Council of Engineering Deans, the Australian National Engineering Taskforce (ANET) and Engineers Australia take the identified issues forward.

The following section highlights the challenges that were of concern to stakeholders.

Education and training strategies

The first challenge is addressing the low levels of supply to the engineering workforce through education and training. Most key stakeholders in the sector accept that Australia's engineering skills shortage reflects a problem area in engineering higher education, with insufficient graduates to meet industry needs; a demand-driven system may not solve this problem. Australia cannot rely on student preferences alone to ensure the flow of engineering graduates that industry requires, given that in many cases the problem stems back to undersupply of likely candidates from secondary and even primary level education (ANET, 2010a; Engineers Australia, 2011).

Policy makers should explore the relationship between the responsiveness of the tertiary and the VET sector and participation in mathematics and science subjects in the secondary and primary school systems. Increasing education and training opportunities through the following:

Schooling

The number of young people studying science, technology, engineering and mathematics at school has a direct impact on the nature of their studies post school and potential career paths. This issue has been a matter of concern in Australia for some years and was the subject of discussion in the earlier Australian Government Audit of Science, Engineering and Technology Skills and more recently through the Chief Scientist's review of the health of Australian science, which is scheduled to be published in early 2012. The issue has also been addressed through the South Australian Government's science, technology, engineering and mathematics skills strategy for South Australia (DFEEST, 2010).

Higher Education

The number of enrolments in engineering education is dependent on the number of qualified applicants and the proportion of these who are motivated towards engineering. School leavers need to be encouraged to choose engineering education options. Our consultations indicate that industry must be involved in promoting all the available education and career pathways within the engineering profession to students, including the consequences of not choosing to do maths and sciences in year 12 which limits any future aspiration to work in an engineering related occupation.

In an environment where unit offerings within engineering schools have been driven by student demand, there has also been ongoing concern, particularly from industry, that some disciplines of engineering are in danger of disappearing because of small student numbers. The issue of maintaining specialist areas of study, critical to Australia's economy, regardless of student numbers must be addressed.

There is also a lag problem when pricing and labour market signals act as the key influencer of student choices. Fluctuations in the economy, combined with the length of a standard degree mean that it may take three to four years before graduate supply will begin to react to labour market signals. (Engineers Australia, 2011)

VET

Engineering para professions, technicians and tradespeople trained through VET form a significant proportion of the engineering supply. Similar to the university system, the vocational education system needs to increase graduation numbers in order to meet industry needs. The problems of attracting students to study engineering are equally valid for both the university and vocational education system.

Engineering pathways across the Tertiary sector

There are significant benefits to creating clear pathways between vocational and higher education where students can maintain lifelong learning by jumping in and out of education between vocational and university provided training. Ensuring different and clear articulation pathways into engineering at university may be a way of increasing the supply of engineers (ALTC, 2011; ANET, 2010a; Skills Australia, 2011b). Given that skill shortages are being experienced in engineering at both the trade, associate, technologist and professional level, training options need to be maintained and maximised at both the vocational and university level.

The move towards greater integration between tertiary sectors is already evident, and engineering is no exception. King *et. al.* (2011, p.i) report that several universities have developed Associate Degrees, foundation programs, and higher education Diplomas as well as offering credit for prior VET learning to support pathways into engineering degrees. Likewise, a number of VET institutes are offering Associate Degrees in engineering.

However a number of issues with engineering pathways and the transfer of students between sectors remain. These include:

- Fewer students transfer from VET to Higher Education in engineering than in other fields. Research suggests that this is because automatic entry for VET graduates to engineering qualifications is not offered by any university. Due to the high degree of diversity in VET qualifications, consideration of entry and credit is on a case-by-case basis (Watson and Macintyre, 2011, p.61).
- Students who are admitted on the basis of prior VET study often require additional support to make a successful transition to the higher education environment (ANET, 2011, p.9).
- Students who have achieved VET Diplomas and Advanced Diplomas are under-represented at elite universities (King et al, 2011, p.4).
- The number of students completing an Advanced Diploma in engineering is relatively small. This means that there are a smaller number of students eligible for articulation into higher education courses.
- Mismatches and gaps exist between the content of VET qualifications and engineering degree programs (ANET, 2011, p.11).
- Articulation is especially difficult for students who do not have a sound background in mathematics and fundamental sciences (ANET, 2011, p.9).
- Growth in Diploma, Advanced Diploma and Associate Degree courses offered by universities may be reducing enrolments in VET engineering courses, although in recent years there has been overall growth in VET higher level qualifications (King et al, 2011, p.i). However announcements by the former Minister for Tertiary Education, Skills, Jobs and Workplace Relations, Chris Evans, state that public universities will be subject to allocations limiting the numbers of courses delivered below bachelor degree level (Sen Chris Evans, 2011).

Migration

Skills Australia considers that utilising the large number of overseas students to meet any shortfall in domestic supply of engineering graduates is an important strategy to address the short and long term skills crisis, on the understanding that recruitment of international students and employees should not replace investments in local skills development and in the development of the profession in Australia.

Role of Industry: strategies to address skill gaps in critical skills

International evidence reveals that an increased effort and government investment in education and training does not by itself deliver productivity returns (Skills Australia, 2010). To ensure potential productivity growth is more fully realised will require a fundamental change and new tools to equip enterprises to more effectively use the skills, expertise and talent of their existing employees. Skills Australia's analysis (2010; 2011b) found that many employers and employees consider they are not making adequate use of existing skills. Improved productivity through better and more strategic use of skills in the workplace benefits both individual enterprises and the entire community.

One way to encourage the more effective use of existing skills is through stronger partnerships between education and training providers and industry. Skills Australia is aware of many excellent examples, especially where firms are innovating or restructuring, where training providers have worked with enterprises to conduct skills audits of their staff and to identify gaps. Together these providers and enterprises have considered how the work could be re-organised and jobs designed—potentially with better career paths—to make the best use of existing and future skills. A corollary is that employee satisfaction levels and engagement increases when enterprises make better use of their employees' skills. This in turn contributes to increased productivity and higher retention rates.

Attraction and retention

The research presented in this paper has revealed that the majority of employers of engineering staff view experience as the most important criteria in recruitment. This severely limits the opportunities available to recent engineering graduates and can lead them to seek employment in occupations other than engineering

Engineering is seen as a male dominated profession and not many women tend to study engineering at the higher education level. If they do, studies suggest that women are more likely to leave the profession than men. Therefore, attracting and retaining more women to engineering is not only a practical strategy, but it also challenges workplaces to examine their work culture and practices if they are serious about utilising this hitherto untapped source of labour.

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Engineering methodology and definition

There have been many approaches to defining and quantifying the engineering labour force. As such, it is difficult to provide a single consistent definition of engineering that adequately encompasses the broad range of approaches to measuring this population.

There are, however, three broad categories of definition that have been developed in order to answer the primary engineering labour force related questions of interest to researchers and policy makers. These questions are; the demand for persons with engineering related skills and qualifications; the supply of persons in (and entering) the labour force with engineering related skills and qualifications; and the extent that persons with engineering related skills and qualifications are employed in engineering roles in the labour force.

According to Australian Bureau of Statistics, Australian and New Zealand Standard Classification of Occupations (ANZSCO), engineering professionals are persons "who design, plan and organise the testing, construction, installation and maintenance of structures, machines and their components, and production systems and plants, and plan production schedules and work procedures" (ABS, 2006, p.7). The types of activities described in the ANZSCO definition of engineering professionals do not correlate with the specific occupations listed within the classification itself, however, the ANZSCO classification does list a number of occupations with the words 'engineer' or 'engineering' in the title description, and these occupations have been used in research as proxies for engineering occupations as a whole.

By restricting the definition of engineers to occupational classifications, and excluding the educational requirements of employment, the ANZSCO based definition of engineering demand counts all persons within a particular occupation as 'engineers' regardless of their level and nature of their qualifications. This approach is typically used in the analysis of demand for persons in engineering related occupations, such as the engineering demand analysis found in the Department of Employment, Education and Workplace Relations (DEEWR), *Skill Shortages Australia 2010* publication (DEEWR, 2011a). A key advantage of this approach is the accessibility of frequent data from the ABS Labour Force Survey (ABS, 2011).

Definitions of engineering have also been developed that focus on the educational requirements underpinning engineering occupations, and limit the reliance on the occupation classification itself. For example, Engineers Australia (2010) defines the professional engineering total labour force as consisting of persons who hold at least a Diploma or Advanced Diploma qualification in the field of engineering and related technologies (as defined by the Australian Bureau of Statistics (ABS), Australian Standard Classification of Education (ASCED) (ABS, 2001), and who are active in the labour force.

Research utilising this definition has primarily investigated the supply of persons in the labour force with engineering related skills and qualifications, and is found in reports such as the Australian National Engineering Taskforce paper, 'Engineering Skills Capacity in the Road and Rail Industries' (ANET, 2011).

Engineers Australia has also developed a definition of professional engineers that addresses the research question relating to the extent of utilisation of persons with engineering related skills and qualifications in the labour force (Engineers Australia, 2010). This definition describes employed professional engineers as being persons who hold at least a Diploma or Advanced Diploma educational qualification in the field of engineering and related technologies (as defined by the Australian Standard Classification of Education (ASCED)), and who are employed within ANZSCO occupations that Engineers

Australia has determined as requiring a level and type of skill commensurate with those viewed as being typical of a professional engineer.

The Engineers Australia approach combines elements of the occupation category and educational oriented definitions, and a modified version of this approach has been combined with the DEEWR approach to analyse engineering demand and supply within this paper. This new approach provides estimates of demand for workers in engineering management occupations, as well as professional occupations and engineering technicians and trades workers. Appendix B contains the list of ANZSCO occupations that comprise each of these three categories, and the utility of this list in our analysis of engineers demand and supply is described in detail in subsequent chapters.

Engineering occupations

The definition of an engineering occupation used for the demand analysis in this paper has been primarily shaped by the need to utilise data available in the Australian Bureau of Statistics (ABS) Census of Population and Housing and the ABS Labour Force Survey (ABS, 2011). The 2006 Census data has been used as a baseline from which growth rates are estimated, and the methodology used to calculate this baseline figure is based on that developed by Engineers Australia.

The ABS Census and Labour Force Survey groups all employed respondents into the ANZSCO categories. Under this classification, specific occupations can be separated into three broad categories; Managers, Professionals, and Technicians and Trades. Evidence indicates that engineers work in a wide range of occupations, and the analytical expertise of engineers is recognised and applied in an expanding range of fields. These include managers, computer software and hardware specialists, financial analysts, as well as traditional engineering occupations (Engineers Australia, 2010).

The specific engineering related occupations used in baseline and projected demand can be found in Appendix B. The majority of occupations included in this list were selected by Engineers Australia in their 2010 report *The Engineering Profession in Australia: A profile from the 2006 Population Census*, and the selection of each occupation in this list has been based on whether the occupation would reasonably allow a qualified engineer to utilise engineering related skills in undertaking the work.

The main point of difference between Engineers Australia list and that produced for this paper is the inclusion of engineering technicians occupations into a new ‘technician and trades workers’ category.

Engineering qualifications

As engineering has developed from the traditional disciplines of electrical, mechanical, chemical and civil to include the variety of disciplines found in Appendix B, the qualifications required for engineers has also expanded, and ranges from vocational certificate level qualifications to tertiary doctorate levels.

In order to carry out more in depth analysis of the engineering labour force at each broad occupational level (managers, professionals and technicians & trades workers), it is necessary to distinguish between the workforce within each level by their formal qualifications. This is particularly necessary in the determination of skills utilisation. For example, it would be difficult to determine the skills utilisation status of a professionally educated engineer employed in a technical or trade occupation without knowing their qualification level.

One significant limitation to this approach is that major Australian data collections (such as the ABS Census of Population and Housing) are restricted to collecting ‘highest level of qualification’, and ‘field of highest qualification’. This can lead to an undercount of qualified engineers in managerial roles due to the likelihood that many managers undertake postgraduate business related studies. In these cases, the business related post graduate degree would supersede the engineering related undergraduate qualification.

The broad levels of education which comprise engineering managers, professionals and technicians and trades workers are outlined in Table 1. All persons who have completed a qualification in the Australian Standard Classification of Education category 'Engineering and Related Technologies' can be classified as managers, professionals, or technicians and trades workers, depending on their highest level of qualification, and current occupation. The relationship between qualification level and occupation shown in Table 1 underpins the analysis found in this paper.

Table 1: Engineering qualifications, AQF levels and occupations

Engineering Qualification	AQF level	ANZSCO Skill Level	Engineering Occupation
Certificate III/IV	3, 4	3	Technicians and Trades Workers
Diploma/Advanced Diploma	5, 6	1, 2	Technicians and Trades Workers
Bachelor Degree and Above	7+	1, 2	Professionals, Managers

Most occupations in the engineering professionals and managers groups have a level of skill commensurate with a bachelor degree or higher qualification. In some instances relevant experience and/or on-the-job training may be required in addition to the formal qualification (ABS, 2001).

Appendix B

List of engineering occupations used in engineering demand analysis

Engineering Managers	
ANZSCO Code	ANZSCO Name
1110	Chief Executives, General Managers and Legislators, nfd
1112	General Managers
1324	Policy and Planning Managers
1325	Research and Development Managers
1331	Construction Managers
1332	Engineering Managers
1334	Manufacturers
1335	Production Managers
1336	Supply and Distribution Managers
1344	Other Education Managers
1351	ICT Managers
1391	Commissioned Officers (Management)
1392	Senior Non-commissioned Defence Force Members
1399	Other Specialist Managers
Engineering Professionals	
ANZSCO Code	ANZSCO Name
2241	Actuaries, Mathematicians and Statisticians
2244	Intelligence and Policy Analysts
2247	Management and Organisation Analysts
2252	ICT Sales Professionals
2254	Technical Sales Representatives
2311	Air Transport Professionals
2312	Marine Transport Professionals
2326	Urban and Regional Planners
2330	Engineering Professionals, nfd
2331	Chemical and Materials Engineers
2332	Civil Engineering Professionals
2333	Electrical Engineers
2334	Electronics Engineers
2335	Industrial, Mechanical and Production Engineers
2336	Mining Engineers
2339	Other Engineering Professionals
2340	Natural and Physical Science Professionals, nfd
2343	Environmental Scientists
2349	Other Natural and Physical Science Professionals
2421	University Lecturers and Tutors
2422	Vocational Education Teachers (Aus) / Polytechnic Teachers (NZ)
2611	ICT Business and Systems Analysts
2613	Software and Applications Programmers
2621	Database and Systems Administrators, and ICT Security Specialists
2631	Computer Network Professionals
2632	ICT Support and Test Engineers
2633	Telecommunications Engineering Professionals
Technicians and Trades Workers	
ANZSCO Code	ANZSCO Name

3100	Engineering, ICT and Science Technicians, nfd
3120	Building and Engineering Technicians, nfd
3121	Architectural, Building and Surveying Technicians
3122	Civil Engineering Draftspersons and Technicians
3123	Electrical Engineering Draftspersons and Technicians
3124	Electronic Engineering Draftspersons and Technicians
3125	Mechanical Engineering Draftspersons and Technicians
3126	Safety Inspectors
3129	Other Building and Engineering Technicians
3131	ICT Support Technicians
3132	Telecommunications Technical Specialists
3200	Automotive and Engineering Trades Workers, nfd
3220	Fabrication Engineering Trades Workers, nfd
3230	Mechanical Engineering Trades Workers, nfd
3231	Aircraft Maintenance Engineers
3234	Toolmakers and Engineering Patternmakers

Projected commencements in engineering related courses, by citizenship, 2010, 2015 and 2020[a].

Courses	2010	2015	2020
Total Commencements			
Domestic	**18078**	**28450**	**37827**
Aerospace Engineering and Technology	1081	1733	2374
Automotive Engineering and Technology	99	928	1796
Civil Engineering	2734	4296	5891
Electrical and Electronic Engineering and Technology	1993	1889	1665
Engineering and Related Technologies	3668	5414	6865
Geomatic Engineering	286	227	161
Manufacturing Engineering and Technology	118	81	67
Maritime Engineering and Technology	206	317	396
Mechanical and Industrial Engineering and Technology	1615	1924	2152
Other Engineering and Related Technologies	4634	8412	11858
Process and Resources Engineering	1644	3229	4601
Overseas	**10637**	**13636**	**17718**
Aerospace Engineering and Technology	340	495	678
Automotive Engineering and Technology	86	358	693
Civil Engineering	1274	2007	2751
Electrical and Electronic Engineering and Technology	2046	1721	1517
Engineering and Related Technologies	1225	1356	1720
Geomatic Engineering	49	32	23
Manufacturing Engineering and Technology	209	199	166
Maritime Engineering and Technology	75	56	70
Mechanical and Industrial Engineering and Technology	1214	1282	1434
Other Engineering and Related Technologies	2908	4478	6313
Process and Resources Engineering	1211	1651	2353
Total	**28,715**	**42,086**	**55,545**

Source: Students, Selected Higher Education Statistics, Department of Education, Employment and Workplace Relations (DEEWR), 2011

a. Includes all domestic and international students in an engineering related field, at diploma level and above.

Projected completions in engineering related courses, by citizenship, 2010, 2015 and 2020[a].

Courses		2010	2015	2020
Total Completions				
Domestic		**8981**	**13972**	**20472**
	Aerospace Engineering and Technology	500	917	1398
	Automotive Engineering and Technology	44	136	642
	Civil Engineering	1372	2164	3306
	Electrical and Electronic Engineering and Technology	1257	1336	1192
	Engineering and Related Technologies	1157	1945	2609
	Geomatic Engineering	190	148	113
	Manufacturing Engineering and Technology	129	63	54
	Maritime Engineering and Technology	100	135	176
	Mechanical and Industrial Engineering and Technology	994	1154	1304
	Other Engineering and Related Technologies	2161	4172	6715
	Process and Resources Engineering	1077	1803	2963
Overseas		**6656**	**6784**	**9576**
	Aerospace Engineering and Technology	186	228	347
	Automotive Engineering and Technology	33	64	302
	Civil Engineering	682	429	655
	Electrical and Electronic Engineering and Technology	1569	1149	1025
	Engineering and Related Technologies	469	737	989
	Geomatic Engineering	45	21	16
	Manufacturing Engineering and Technology	200	178	152
	Maritime Engineering and Technology	17	20	26
	Mechanical and Industrial Engineering and Technology	674	698	789
	Other Engineering and Related Technologies	1977	2480	3992
	Process and Resources Engineering	804	781	1283
Total		**15637**	**20757**	**30047**

Source: Students, Selected Higher Education Statistics, Department of Education, Employment and Workplace Relations (DEEWR), 2011

a. Includes all domestic and international students in an engineering related field, at diploma level and above.

Appendix D

Skilled Migration of people with engineering qualifications by visa category

Visa Stream: GSM	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**Total**
Engineering Managers	488	606	573	365	327	2359
Engineering professionals	10891	10613	9754	11444	8952	51654
Technicians and trades workers	766	723	528	373	279	2669
Visa stream: 457 Temporary business visa						
Engineering Managers	2980	4090	3640	3492	4731	18933
Engineering professionals	12840	15700	13090	10610	15870	68110
Technicians and trades workers	2070	2750	2890	1710	2780	12200
Visa stream: Employer sponsored						
Engineering Managers	646	919	1141	1083	1013	4802
Engineering professionals	1357	1789	2635	2657	3391	11829
Technicians and trades workers	173	295	546	615	820	2449
Total	32211	37485	34797	32349	38163	175005

Source: Department of Immigration and Citizenship data.

a. Engineering managers includes General Managers, Policy and Planning Managers, Research and Development Managers, Construction Managers, Engineering Managers, Manufacturers, Production Managers, Supply and Distribution Managers, Other Education Managers, ICT Managers, Commissioned Officers (Management), Senior Non-commissioned Defence Force Members, Other Specialist Managers.

b. Engineering professionals includes Actuaries, Mathematicians and Statisticians, Intelligence and Policy Analysts, Management and Organisation Analysts, ICT Sales Professionals, Technical Sales Representatives, Air Transport Professionals, Marine Transport Professionals, Urban and Regional Planners, Chemical and Materials Engineers, Civil Engineering Professionals, Electrical Engineers, Electronics Engineers, Industrial, Mechanical and Production Engineers, Mining Engineers, Other Engineering Professionals, Environmental Scientists, Other Natural and Physical Science Professionals, University Lecturers and Tutors, Vocational Education Teachers (Aus) / Polytechnic Teachers (NZ), ICT Business and Systems Analysts, Software and Applications Programmers, Database and Systems Administrators, and ICT Security Specialists, Computer Network Professionals, ICT Support and Test Engineers, Telecommunications Engineering Professionals.

c. Engineering technicians and trades workers includes Architectural, Building and Surveying Technicians, Civil Engineering Draftspersons and Technicians, Electrical Engineering Draftspersons and Technicians, Electronic Engineering Draftspersons and Technicians, Mechanical Engineering Draftspersons and Technicians, Safety Inspectors, Other Building and Engineering Technicians, ICT Support Technicians, Telecommunications Technical Specialists, Aircraft Maintenance Engineers, Toolmakers and Engineering Patternmakers.

Appendix E

Skills Shortages in Engineering Occupations

ANZSCO code	Engineering Occupation	2011 DEEWR Rating	Years in Shortage 5 years to 2011	Years in Shortage 10 years to 2011
Professions - Bachelor Degree (AQF 7) and above				
133211	Engineering Manager	Shortage	4	4
233111	Chemical Engineer	Recrutment Difficulty	4	5
233112	Materials Engineer	Not Surveyed by DEEWR	(na)	(na)
233211	Civil Engineer	Shortage	5	9
233212	Geotechnical Engineer	Not Surveyed by DEEWR	(na)	(na)
233213	Quantity Surveyor	Not Surveyed by DEEWR	4	5
233214	Structural Engineer	Shortage	3	3
233215	Transport Engineer	Shortage	2	2
233311	Electrical Engineer	Shortage	5	7
233411	Electronics Engineer	No Shortage	2	3
233511	Industrial Engineer	Not Surveyed by DEEWR	(na)	(na)
233512	Mechanical Engineer	Shortage	4	5
233513	Production or Plant Engineer	Not Surveyed by DEEWR	1	1
233611	Mining Engineer (excluding Petroleum)	Shortage	5	7
233612	Petroleum Engineer	Shortage	4	5
233911	Aeronautical Engineer	Not Surveyed by DEEWR	(na)	(na)
233912	Agricultural Engineer	Not Surveyed by DEEWR	(na)	(na)
233913	Biomedical Engineer	Not Surveyed by DEEWR	(na)	(na)
233914	Engineering Technologist	Not Surveyed by DEEWR	(na)	(na)
233915	Environmental Engineer	Not Surveyed by DEEWR	(na)	(na)
Para-Professional/Associates - Diploma (AQF 5), Adv. Diploma, Ass. Degree (AQF 6)				
3122	Civil Engineering Draftspersons and Technicians	Shortage	4	4
3123	Electrical Engineering Draftspersons and Technicians	No Shortage	4	4
3124	Electronic Engineering Draftpersons and Technicians	Not Surveyed by DEEWR	2	2
3125	Mechanical Engineering Draftspersons and Technicians	Not Surveyed by DEEWR	2	2
3129	Other Building and Engineering Technicians	Not Surveyed by DEEWR	(na)	(na)
Trades* - Certificate III (plus 2 years on-the-job training), Certificate IV				
322111	Blacksmith	Not Surveyed by DEEWR	(na)	(na)
322112	Electroplater	Not Surveyed by DEEWR	(na)	(na)
322113	Farrier	Not Surveyed by DEEWR	(na)	(na)
322114	Metal Casting Trades Worker	Not Surveyed by DEEWR	(na)	(na)
322115	Metal Polisher	Not Surveyed by DEEWR	(na)	(na)
322211	Sheetmetal Trades Worker	Shortage	4	9
322311	Metal Fabricator	No Shortage	3	7
322312	Pressure Welder	Not Surveyed by DEEWR	(na)	(na)
322313	Welder (First Class) (Aus) / Welder (NZ)	Regional Shortage	3	8
323111	Aircraft Maintenance Engineer (Avionics)	Shortage	5	5
323112	Aircraft Maintenance Engineer (Mechanical)	Regional Shortage	5	5
323113	Aircraft Maintenance Engineer (Structures)	Not Surveyed by DEEWR	(na)	(na)
323211	Fitter (General)	Shortage	4	9
323212	Fitter and Turner	Shortage	4	9
323213	Fitter-Welder	Shortage	4	9
323214	Metal Machinist (First Class)	Shortage	4	9
323215	Textile, Clothing and Footwear Mechanic	Not Surveyed by DEEWR	(na)	(na)
323311	Engraver	Not Surveyed by DEEWR	(na)	(na)
323312	Gunsmith	Not Surveyed by DEEWR	(na)	(na)
323313	Locksmith	Shortage	5	6
323314	Precision Instrument Maker and Repairer	Not Surveyed by DEEWR	(na)	(na)
323315	Saw Maker and Repairer	Not Surveyed by DEEWR	(na)	(na)
323316	Watch and Clock Maker and Repairer	Not Surveyed by DEEWR	(na)	(na)
323411	Engineering Patternmaker	Not Surveyed by DEEWR	(na)	(na)
323412	Toolmaker	Shortage	3	8

Source: DEEWR Skills Shortage Research 2001 - 2011

Note: Occupations with employment below 1500 at the 2006 Census are not included in DEEWR research. Occupations above 1500 and deemed low risk with respect to shortages may also be excluded.

**DEEWR ratings for trades are from 2010.*

Appendix F

Engineering Pathways Seminar
A summary of the outcomes

December, 2011

Background
On Thursday 1 December 2011, Skills Australia hosted a seminar on Engineering Pathways to initiate a national dialogue between key stakeholders to discuss ways to address skills shortages in the engineering occupations. The seminar focussed on the role of engineering VET Diplomas and Advanced Diplomas, both in their own right and as potential pathways to higher education.

The purpose of this seminar was to:

- provide a forum for discussion on issues of concern for the engineering industry identified by recent research, including skills shortages;
- identify opportunities for stakeholders to work together to address these issues and;
- suggest ways to improve the supply of engineering skills for the Australian workforce.

The seminar brought together forty stakeholders representing Industry Skills Councils, VET and higher education providers, researchers, industry peak bodies and employers. It was facilitated by Professor Rod MacDonald, Ithaca Group.

Presentations were made on recent research and practice by:

- Professor Robin King, *Pathways from VET Awards to Engineering Degrees: a higher education perspective*
- Dr Louise Watson and Dr John McIntyre, *Scaling up: building engineering workforce capacity through education and training*
- Maree Roberts, NuCoal Resources, *Case study presentation*

We plan to make copies of these presentations available on the Skills Australia website (currently seeking approvals from presenters).

Alan Bradley from Engineers Australia also gave a brief presentation.

Identifying the key issues
Round table discussions focussed first on identifying and agreeing on the key issues. These were:

- Engineers not working as Engineers
- Decreasing AQF 5/6 enrolments in VET
- Roadblocks in VET-HE pathways
- Lack of clarity around the purpose of para-professional qualifications
- Demand issues - increasing the inputs
- Workforce planning and retention
- Training Package content

Outcomes of round table discussions
There was strong agreement that there is a need to attract more people into engineering studies and to consider ways to make engineering more attractive to prospective students, in both VET and higher education. The “value proposition” for working in engineering occupations needs to be clearly articulated and more widely understood.

In relation to paraprofessional qualifications at Australian Qualifications Framework (AQF) levels 5 and 6 there is a need to better define their purpose and job outcomes. This would assist in attracting people into paraprofessional engineering occupations and in differentiating paraprofessional qualifications from both trade and professional qualifications. It was considered that they need to have a clear purpose and occupational outcome in their own right, not just as pathways.

One of the critical issues exposed was that few providers are offering technician level training in civil engineering. In recent years there has not been a single enrolment in the training package Advanced

Diploma in Civil Engineering, though there have been enrolments in national accredited courses. The Associate Degree in Civil Engineering, a higher education qualification, taught by universities and two TAFE institutes may be providing an alternative preparation for both para-professional occupations and entry to Bachelor Degrees.

In relation to pathways it was agreed that Certificates III/IV provided fertile ground in which to encourage students to progress to higher qualifications in engineering. Foundation skills, especially maths, were seen as critical cornerstones for all engineering qualifications and especially important for students progressing to higher education. Pathways were seen to be difficult to navigate, although some providers have negotiated arrangements to facilitate progression. It was also noted that the differential funding models for VET and higher education in areas such as student fees, income support and loan arrangements “muddy the waters” and may be affecting student choice.

Workplace issues were also seen to be critical in addressing skills shortages, and employers needed to find strategies to attract and then retain engineering graduates. There was a need to use the skills of employees effectively so they were not overstretched or underutilised. Employers also need to ensure workplace culture is inclusive; in particular that it supports women in engineering occupations.

A more detailed summary of the points raised at the seminar by participants is provided at TAB A.

Ways forward
At the end of the round table discussions the seminar participants agreed the following strategies might constitute “ways forward”. It was agreed that the importance of employment /labour market structures was an overarching consideration that should be taken into account.

- Make engineering a stronger value proposition
- Clarify exactly what maths is needed
- Use certificate III/IV as fertile ground for growing the engineering technicians and professionals of the future
- Ensure the quality and relevance of higher level VET qualifications
- Employers to make better use of the skills of their engineering workforce

Next steps
Participants agreed it had been productive to bring the key stakeholders together and there should be ongoing discussion. Skills Australia recommends the issues raised be taken forward by the Industry Skills Councils, the Australian Council of Engineering Deans (ACED), the Australian National Engineering Taskforce (ANET) and Engineers Australia. ANET is holding a series of workshop in 2012 which will provide an opportunity to further progress the issues raised in the seminar. The recently announced Senate inquiry into *the shortage of engineering and related employment skills* also provides a vehicle for further analysis and action.

TAB A

Outcomes of round table discussions

The facilitator tasked each table with an issue to discuss. The following points reflect the outcomes of each round table discussion.

Engineers not working as Engineers

- The core issue is getting people into the engineering profession.
- This wouldn't be an issue if we had enough supply.
- The actual opportunities an engineering degree provides have not been clearly conveyed.

Decreasing AQF 5/6 enrolments in VET.

- Are there jobs that relate to these qualifications?
- Should AQF 5/6 qualifications be promoted in their own right? i.e. not just as an articulation pathway.
- Need to understand why students choose or do not chose to enrol in these courses
  - Is there research data available that identifies what influences choices at the school level?
  - What are the aspirations of students enrolling in these courses?
  - What role do parents and career counsellors play?
  - Parents typically encourage children to apply to university rather than into VET. VET is still considered a second choice.
- Maths capability of school leavers limits the pool of talent.
- The depth and rigor of VET qualifications needs to be assured.
- Some engineering programs in VET were wound down in the 1990's and now the facilities and technology and teaching expertise has been lost.

VET/Higher education pathways

- Certificate III and IVs are fertile ground to encourage student to progress to further study and into para-professional occupations. It is important to market para-professional qualifications to holders of Certificate III and IVs, not just to school leavers.
- Foundation skills are needed for a successful transfer from Cert III/IV to higher level qualifications.
- Pathways need to be employer driven eg cadetships. Employers need to be accountable and not just rely on government.
- How relevant are higher level VET qualifications to industry? Do they provide a good end point, not just as a pathway? Need to better define the value and use to industry of VET higher level quals.
- Is there a desire for a higher level 'master trade' qualification? If so is it rewarded?
- How can industry be questioning training packages when they design them?
- There are weak pathways overall but some stand out providers.

Is para-professional shortage the problem?

- The branding of the para-professional is an issue. How are para- professionals positioned in industry are and what does a globally competent technician do.
- How attractive is the para-professional occupation to students?
- There are substantial funding differences between VET and Higher Education sectors particularly around Associate Degrees. Differential fees and other funding support may be having an impact on student choice and distorting the "market".
- The quality of maths in pathways to Associate Degrees is an issue. There was consensus that school students needed to receive a strong message about the consequences of dropping maths in school and that, as a result, some jobs may be excluded to them.
- Is the para-professional qualification an end point or a starting point for a career?

- Training packages are constructed by ISCs but delivered by RTOs. Does this "division of responsibility" create problems?

<u>Demand – increasing the inputs</u>

- What is the value proposition for students? Identify the benefits of a career in engineering and then "sell it".
- There is a high return on investment but take up is low.
- At present universities are taking as many people as meet entry requirements.
- There is a need to examine the consequences of engineering shortages to the economy. Some are very clear such as low productivity and low innovation.
- Poor perception of what an engineer is.
- More community involvement and better communication about the value of doing engineering is required.
- There is a persistent perception of a shortage and people need to be made aware of the value of investing in this profession.
- Engineering is a more attractive occupation in other countries. Why is this not the case in Australia?
- There is a need to fix the pathway option. Studying part time for 7 years is not an attractive option for a young tradesperson or para-professional.
- A need to strengthen maths and science at all levels was identified. Currently there is concern that there is not enough of an emphasis on maths and science. But also a question about how much maths and science is really needed?
- Why isn't there a 'talent focus' in TAFEs and schools to encourage high achieving students to embark on careers in engineering? Why not a talent management strategy?
- What incentive is there to attract qualified engineers back into an engineering occupation?
- What are the work place conditions in engineering companies like?
- How inclusive are these workplaces e.g. for women?
    - It was noted that in the 1980s there were lots of women in chemical and electrical engineering but now it seems not enough. Factors influencing this may include the lack of universities offering these disciplines, and that women may not follow a career path if they perceive it is not conducive to their future aspirations, such as raising a family.
    - Women may not see the culture as welcoming – it's up to employers to create the right workplace.
    - There is a low proportion of young women doing maths at school.
- Find out why engineers leave – are they jumping ship or going to better pastures?

<u>Workforce planning and retention</u>

- The work culture of engineering professionals needs to be more attractive and inclusive. Do we know enough about workplace culture and why people are leaving?
- We need to make workplaces attractive to a diverse range of people.
- Retention of women is a problem.
- There is a need to attract women back into the engineering workforce and provide more flexible workplaces.
- An attractive job is very important and merely providing extra pathways is not enough. Need to have clear job outcomes.
- Engineers used to be under paid and the message that they are now higher paid does not flow down to younger generations when they are making career decisions.
- Need to have a focus on workforce planning and a closer matching of skills to the job.
- Need a change in thinking of companies – does the role actually require an engineer?
- Professional engineers are sometimes working in jobs for which they are overqualified and sometimes in roles they are not qualified for – need accountability.

- Engineers are working as project managers on engineering projects rather than working as engineers
- There is a need to target specialist engineers.
- Workplaces need to identify what they really need – how many professionals and para-professionals.
- Content of units of study might not be relevant.
- Match the job to the qualifications.

Training Package content

- Articulation pathways are important. Strong articulation pathways enable progress through VET qualifications.
- Para-professional training packages appear to be developed from the trades. Are they meeting the need for paraprofessionals well enough?
- Civic engineering is a particular problem. There are no trade equivalents for civil engineers and there are few providers offering technician level training in civil engineering.
- There is concern by some in industry that training packages are not meeting their needs–. However, it was acknowledged that training packages are developed in consultation with industry.
- Concerns were raised about the mathematical ability of school leavers and the job opportunities and prospects once they have completed an AQF 5/6.
- Some trades at the Certificate III level have high outcomes. Can these outcomes be converted to the Diploma level?
- It was important to consider how the qualification is valued, i.e. what is motivating students to do the para-professional level qualification?
- Trade work is different to technician work.
- There used to be a fantastic engineering cadetship program, however Government policies are now more focused on the foundation level qualifications.
- Articulation between Diploma and Advanced Diploma is fine, but there is a large gulf between these qualifications and HE.
- Every qualification level is looked at separately, e.g. apprenticeships focus on a hands-on qualification linked to a job. There is insufficient focus on preparing for the next level qualification.
- Some RTOS use courses “sitting on their shelves” rather than training packages.
- Training packages specify the required competency outcomes and providers can build theoretical content into their delivery.
- The idea of a master tradesperson may be attractive but is there an occupational outcome? Are people remunerated at this level?