The Senate

Education, Employment and Workplace Relations References Committee

The shortage of engineering and related employment skills

July 2012

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3.28 The committee recommends that the government seeks recommendations from the Chief Scientist about how it can best continue to support the development of science, technology, engineering and mathematics courses.

Recommendation 2

3.29 The committee recommends that the government works through the Council of Australian Governments to promote science, technology, engineering and maths ability in states and territories.

Recommendation 3

3.42 The committee recommends that the government requests the Australian Workforce and Productivity Agency, or a similar body, to investigate the reason why attrition rates for Vocational Education and Training courses in engineering trades are so high. Based on the findings of this study, the committee recommends that the government work with Vocational Education and Training providers and the states and territories to improve completion rates.

Recommendation 4

3.43 The committee recommends that the government considers extending funding for government supported places to all domestic students accepted into public higher education Engineering Technology programs accredited by the Tertiary Education Quality and Standards Agency.

Recommendation 5

3.67 The committee recommends that the industry committees advising universities take an active role in ensuring engineering courses are suited to industry requirements. To ensure their effectiveness, committees should include representatives with direct experience supervising and working with engineering graduates.

Recommendation 6

4.41 The committee recommends that the government consider creating senior technical engineering roles in the Australian Public Service. This measure would ensure that highly qualified technical engineers may continue to build upon specialist knowledge while enjoying career progression in the public sector.

Recommendation 7

4.42 The committee recommends that the Department of Finance and Deregulation reviews the Commonwealth Procurement Guidelines to ensure that the government is an informed purchaser of engineering infrastructure and that

appropriate advice is provided in relation to procurement decisions that require specialist technical knowledge.

Recommendation 8

5.39 The committee recommends that the government work with states and territories through the Council of Australian Governments to engage with engineering industry peak bodies with a view to developing measures to encourage the provision of practical, paid work experience to university students.

Recommendation 9

5.47 The committee recommends that the government consider how it can encourage commonwealth contractors to provide graduate and cadetship programs through its procurement processes.

Recommendation 10

5.68 The committee recommends that the government work with the Australian Workforce and Productivity Agency and employers to develop targeted policies that encourage women to remain in, or return to, the engineering workforce.

Recommendation 11

5.75 The committee recommends that the government work with Australian Workforce and Productivity Agency to continue to develop targeted policies that encourage mature engineers to remain in or return to the workforce.

Recommendation 12

5.86 The committee recommends that the government continues to work with the states and territories through the Council of Australian Governments to make a national registration scheme for engineers a priority area for reform over the next decade.

Chapter 1

Introduction

1.1 On 7 November 2011 the Senate referred the shortage of engineering and related employment skills to the Senate Education, Employment and Workplace Relations References Committee for inquiry and report by 30 June 2012.[1]

1.2 The committee was asked to examine the nexus between the demand for infrastructure delivery and the shortage of appropriate engineering and related employment skills in Australia, with particular reference to:

- the implications of the shortage for infrastructure delivery in terms of economic development, cost, efficiency, safety and disputation;
- the impact of the long-term outsourcing of engineering activities by government on skills development and retention in both the private and public sectors;
- options to address the skill shortage for engineers and related trades, and the effectiveness and efficiency of relevant policies, both past and present;
- options for infrastructure delivery using alternative procurement models which aim to foster collaboration and achieve effective community outcomes, including skills development and retention;
- 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;
- opportunities to provide incentives to the private sector through the procurement process to undertake skills development;
- consequences of skills shortage in the construction sector to the public sector's capacity to effectively procure and manage infrastructure projects; and
- the impact of delayed and stalled infrastructure projects on economic development, workplace productivity and employment.

Structure of the report

1.3 This report is divided into five chapters:

- Chapter 1 (this chapter) sets out the administrative arrangements for the inquiry and provides a summary of other recent literature relating to the engineering skills shortage;

1 *Journals of the Senate*, No. 64, 7 November 2012, pp 1757–1758.

- Chapter 2 contains a background to engineering and the skills shortage in Australia;
- Chapter 3 outlines education and training pathways for engineering and related occupations;
- Chapter 4 discusses the impact of the skills shortage; and
- Chapter 5 examines the causes of the skills shortage and weighs up recommendations to address the problem.

Conduct of the inquiry

1.4 The committee advertised its inquiry on its website and in *The Australian* newspaper, calling for submissions by 3 February 2012.[2]

1.5 The committee also directly contacted a number of interested organisations and individuals to notify them of the inquiry and to invite submissions. A total of 82 submissions were received, as listed in Appendix 1.

1.6 The committee held public hearings in Perth on 27 March 2012, Brisbane on 28 March 2012 and in Canberra on 7 May 2012.

Other inquiries

1.7 The committee is cognisant of the attention that the engineering skills shortage has garnered and is aware of a number of relevant studies in recent times.

1.8 Australia's Chief Scientist, Professor Ian Chubb, released the *Health of Australian Science* report in May 2012. The report particularly focused on the important contribution that science, technology, engineering and mathematics (STEM) make to the 'future health, security, safety and prosperity as a nation, and as a planet'.[3] The findings of the Chief Scientist are discussed in this report where relevant.

1.9 Skills Australia is an independent statutory body that provides advice to the government on Australia's current, emerging and future workforce skills needs and workforce development needs.[4] Skills Australia made a number of recommendations to address engineering skills shortages in its 2010 report *Australian Workforce*

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2 Advertisements appeared in *The Australian* newspaper on 23 November 2011, 7 December 2011, 1 February 2012 and 15 February 2012.

3 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, Foreword, May 2012. Available online: http://www.chiefscientist.gov.au/wp-content/uploads/OCS_Health_of_Australian_Science_LOWRES1.pdf (accessed 25 May 2012).

4 Skills Australia, *Submission 80*, p. iv.

Futures.[5] More recently, Skills Australia hosted a seminar on engineering pathways in December 2011. The key themes and observations that emerged from that seminar are discussed in chapters 2 and 3 of this report.[6] Skills Australia was replaced by the Australian Workforce and Productivity Agency on 1 July 2012. The new agency is an expansion of the role and functions of Skills Australia.

1.10 The National Resource Sector Employment Taskforce was established in 2009 to consider how best to meet the skills requirements of more than 75 major resources projects in the pipeline over the next 5 years. The taskforce reported to government on 7 July 2010 with 31 recommendations to address skills shortages in the resources sector.[7] The government accepted all 31 recommendations in March 2011. The key areas identified for workforce development were to:

- promote workforce planning and sharing of information;
- increase the number of trade professionals;
- graduate more engineers and geoscientists;
- meet temporary skills shortages with temporary migration;
- strengthen workforce participation;
- forge stronger ties between industry and education; and
- address the need for affordable housing and community infrastructure.

1.11 The Australian National Engineering Taskforce (ANET) was set up specifically to assess the engineering skills shortage and develop a national strategy to develop Australia's engineering workforce.[8] ANET was established by the Association of Professional Engineers, Scientists, and Managers, The Australian Academy of Technological Sciences and Engineering, Engineers Australia, the Australian Council of Engineering Deans and Consult Australia. Together these partners represent professional industrial, commercial and academic interests in the engineering sector. In October 2010 ANET released a report titled *Scoping our future: addressing Australia's engineering skills shortage*.[9] The report highlights the challenges that skills shortages present to a range of industries. In response to this inquiry ANET

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5 Skills Australia, *Australian Workforce Futures: A national workforce development strategy*, Commonwealth of Australia, 2010. Available online: http://www.awpa.gov.au/national-workforce-development-strategy/Australian-Workforce-Futures/documents/WWF_strategy.pdf (accessed 5 July 2012).

6 Skills Australia, *Submission 80*, Appendix F.

7 National Resources Sector Employment Taskforce, *Resourcing the future*, 7 July 2010. Available online: http://www.deewr.gov.au/Skills/Programs/WorkDevelop/ResourcesWorkforce/Pages/NRSET.aspx (accessed 31 May 2012).

8 Australian National Engineering Taskforce, *Submission 73*.

9 Australian National Engineering Taskforce, *Scoping our future: addressing Australia's engineering skills shortage*, October 2010. Available online: www.anet.org.au.

titled its submission: *Realising an innovation economy: a practical roadmap to ease the Australian engineering skills shortage*. The recommendations made by ANET are discussed in chapter 4.

1.12 The United Nations Educational, Scientific and Cultural Organisation commissioned academics Emeritus Professor David Beanland and Professor Roger Hadgraft to research engineering education.[10] In their report, the release of which is forthcoming, the authors identified a number of weaknesses in the current approach and called for significant changes to engineering education. These findings and recommendations are considered in chapter 3.

1.13 The Business Council of Australia (BCA) released a report into Australia's capital investment on 7 June 2012.[11] The BCA draws attention to the $921 billion pipeline of investment in resources, energy and economic infrastructure, warning that Australia risks not being able to efficiently deliver these projects because it is becoming a 'high-cost' and therefore 'high-risk' place to invest. Further, the BCA reported that Australia's low labour productivity has reduced its competitiveness. In relation to skills shortages, the BCA concludes that Australia must train or attract 'high quality project planners and managers' in order to 'overcome major skills shortages'.[12]

1.14 The Australian Local Government Association released the 2012-2013 State of the Regions Report on 17 June 2012. The authors observed that many parts of Australia are not benefiting from the mining boom and recommend that the government establish dedicated funds to support local infrastructure projects.[13]

Acknowledgements

1.15 The committee thanks all those who contributed to this inquiry by making submissions, providing additional information or appearing before it to give evidence.

Note on references

1.16 References in this report to the Hansard for the public hearings are to the proof Hansard. Please note that page numbers may vary between the proof and official transcripts.

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10 Emeritus Professor David Beanland and Professor Roger Hadgraft, *Submission 29*, p. 1.

11 Business Council of Australia, *Pipeline or pipe dream? Securing Australia's investment future*, 7 June 2012. Available online: http://www.bca.com.au/Content/101987.aspx (accessed 12 June 2012).

12 Business Council of Australia, *Pipeline or pipe dream? Securing Australia's investment future*, 7 June 2012, p. 17.

13 Jessican Nairn, 'Regions struggling despite mining boom: report', *ABC News Online*, 17 June 2012, http://www.abc.net.au/news/2012-06-17/state-of-the-regions-report/4075302?section=business (accessed 18 June 2012).

Chapter 2

Engineering in Australia: a background

Introduction

2.1 People with engineering skills and qualifications are a critical component of Australia's economy. Engineers are not only directly employed in a vast array of different industries, many of which are among Australia's most economically important, such as mining, but are also essential for underlying infrastructure projects such as roads, power, bridges and the like. The first half of this chapter provides an overview of the engineering sector, the engineering profession and the labour market, and key government policies are described. The second part of the chapter describes the current skilled migration arrangements, before analysing the role that skilled migration might play in continuing to address the engineering shortage.

What is engineering?

2.2 It is important from the outset to provide a description of what engineers do. The committee noted a sense among witnesses and submitters that the role of engineers was not well understood by the broader population. Indeed the committee itself was enlightened to hear of the wide scope of work and many challenges facing engineers on a day to day basis across Australia. The Australian National Engineering Taskforce (ANET) described these responsibilities and challenges:

> Engineers design, build and maintain infrastructure routinely used by the community – roads, railways, ports, water, electricity, gas and communications. They perform key roles in feasibility scoping, structural and system design, damage control and maintenance – monitoring and addressing safety and quality throughout systems. Engineers develop and test practical solutions to everyday and extraordinary problems. Engineers conceive, design and manufacture innovative products, processes and systems that contribute to the nation's prosperity, security, health, culture and environment.[1]

2.3 Professor James Trevelyan had a slightly different perspective on the subject, describing the job of an engineer as being an influence on other people to achieve real value, on the basis that:

> Engineers do not build bridges. They do not build cars. They do not build roads. Engineers organise these things to happen, and the actual work is done by other people.[2]

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1 Australian National Engineering Taskforce, *Submission 73*, p. 4.

2 Professor James Trevelyan, *Proof Committee Hansard*, 27 March 2012, p. 12.

2.4 Professor David Beanland submitted that engineering is not a well understood profession, certainly in contrast to law or medicine which receive a lot of attention in the media.[3] Professor Roger Hadgraft observed that while people can 'look out the window and see the work of engineers' they don't actually understand what engineers do 'when they get to work in the morning and what the nature of that work is'.[4]

2.5 Skills Australia noted the challenge in capturing 'engineering' with a single consistent definition able to cover all the facets of the profession.[5] For the purposes of identifying relevant data, it chose the approach taken by Engineers Australia and the Australian Bureau of Statistics: the Australian and New Zealand Standard Classification of Occupations (ANZSCO).[6]

2.6 The ANZSCO approach looks at whether occupations include engineering work, and is less focused on the existence or otherwise of professional engineering qualifications. [7]

2.7 Engineering occupations were also defined by Engineers Australia in its 2010 Report: *The Engineering Profession in Australia: a profile from the 2006 Population Census.* In the report, Engineers Australia decided whether a particular occupation was an engineering one or not on the basis of whether the occupation 'would reasonably allow a qualified engineer to use engineering related skills when performing the work'.[8]

A history of engineering training in Australia

2.8 Up until the early 1990s the public sector provided engineering skills training to cadets and graduates. Typically employees would enter the public sector after high school or tertiary studies. Following perhaps a decade of on-the-job experience, many of these workers would be head hunted by private industry. The practical effect was that industry did not have to train its workers: governments did. This helped to create 'a climate in which companies did not need to invest in their own education or training capabilities'.[9]

2.9 Submitters to this inquiry agreed that the quality of training formally provided by government cadetships was very high. For example, the committee heard from

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3 Professor David Beanland, *Proof Committee Hansard*, 7 May 2012, p. 27.

4 Professor Roger Hadgraft, *Proof Committee Hansard*, 7 May 2012, p. 27.

5 Skills Australia, *Submission 80*, p.1.

6 Skills Australia, *Submission 80*, pp 1, 24. Note that Skills Australia was superseded by the Australian Workforce and Productivity Agency on 1 July 2012.

7 Skills Australia, *Submission 80*, pp 1, 24.

8 Skills Australia, *Submission 80*, p.1; See also, Engineers Australia, *Submission 67*.

9 Professor James Trevelyan, *Submission 31*, p. 15.

witnesses representing Consulting Surveyors National of the significant contribution that governments used to make to training the engineering workforce:

> Government has traditionally been a very good provider of opportunity for traineeships and cadetships and those sorts of things. Certainly in Victoria, Melbourne Water Corporation were very, very good at that. There was a great pathway for many surveyors, and we are losing those opportunities. Government is demanding in its service delivery from the private sector that it has to be snappy and it has to be on the money. We have to provide it as best we can and keep the costs as low as we can, and I guess that means that the opportunities to provide incentives to traineeships with private businesses are difficult. I think we are definitely suffering from that.[10]

2.10 It is a matter of historical record that, during the 1980s and 1990s, the public sector began to outsource infrastructure and other engineering work to private industry. Government public utility, infrastructure and other departments offered redundancies to engineers and public companies were privatised. Engineering positions in the public sector dried up, and cadetship programs were cut. Consult Australia cites a study of public sector employment share over 1984–2005. During this period the percentage of electricity, gas and water supply industry employees that are in the public sector dropped from 95.9 per cent to 54.7 per cent. In the construction industry this dropped from 12.2 percent to 0.5 per cent in 2005.[11]

2.11 The first and most obvious implication of this is that government departments, having shed their engineering staff, now lack any real in-house engineering expertise. Mr Ian Marler, Vice Chairman, Consulting Surveyors National, elaborated on the difficulties that arise when government departments lose their engineers with surveying skills, using a New South Wales example:

> [If] you took the Institution of Surveyors in New South Wales: many years ago it probably had 80 per cent government and 20 per cent private. I would say that almost the reverse would apply today. There has been a gradual transition as more and more government departments shed staff.
>
> That raises the other complexity, too, in that if you are tendering for government work, whether you have competent people within government able to assess the tenders and all of those sorts of things. It has that downside. But I would guess that it has been that 80/20 back to 20/80.[12]

2.12 In addition, industries which had previously drawn from the ranks of the public sector for the engineers now find themselves without a ready source of highly-trained and experienced workers. Private companies are increasingly required to take responsibility for the training and development of their own engineers.

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10 Mr Phillip Dingeldei, Chairman, Consulting Surveyors National, *Proof Committee Hansard*, 7 May 2012, p. 42.

11 Consult Australia, *Submission 66*, p. 16.

12 Mr Ian Marler, Vice Chairman, Consulting Surveyors National, *Proof Committee Hansard*, 7 May 2012, p. 42.

2.13 The consequences for particular engineering disciplines with a historical reliance on cadetships were severe. Mr Craig Woolridge, from the Australian Institute of Traffic Planning and Management, explained how the Victorian government had withdrawn from offering graduate positions and cadetships and how this had impacted on the skills of engineers in the sector:

> I started at 1983 at Main Roads. That was the last year they had an annual program and then they stopped and it went back to every second year. In late 1990s they stopped training altogether and decided to go to a skeleton workforce and the private sector will take care of all of our needs. Unfortunately, the private sector did not take care of all the needs and then we ended up with a training crisis. Main Roads has certainly stepped back into that fold. Whether that is enough effort is questionable. Particularly in some areas like traffic and transport, there is certainly not enough effort in there.[13]

2.14 Ms Leanne Hardwicke from Engineers Australia acknowledged that following the transition of engineers from the public sector, the private sector 'dropped the ball' on training, describing the transition in the following terms:

> When it first happened, when the public sector started not taking on so many and outsourcing everything, the training of engineers, particularly the graduates, actually fell by the wayside and they kind of had to take charge of their own training and development. As the skills shortages have developed and there has been more demand for engineers, one of the main recruitment tools that they have used is graduate development programs. They get them on the pathway of training in various areas, giving them lots of experience in different aspects and moving them towards becoming, for instance, a chartered engineer. Once they are a chartered engineer, then they are considered to be capable of independent practice and able to move around the company. So they do get all those opportunities, and the skills shortage has had a positive effect in terms of the private sector taking on that key training role that the public sector used to have.[14]

2.15 The Australian Power Institute accepted that industry had fallen 'asleep at the wheel'. Mr Simon Bartlett, Chairman of the Board, explained to the committee:

> The industry went through a period of really squeezing and cutting down. It went from government owned to privatised. Owners came in who really squeezed. I think the focus was taken off recruitment, development and the relationships with universities. That is not just a problem in Australia. That has happened in deregulated countries. The UK went through that. It has become even more serious there.[15]

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13 Mr Craig Woolridge, Australian Institute of Traffic Planning and Management, *Proof Committee Hansard*, 27 March 2012, p. 32.

14 Ms Leanne Hardwicke, Director, WA Division, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 5.

15 Mr Simon Bartlett, Chairman of the Board, The Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 28

2.16 Improvements to engineering training are discussed in Chapters 3 and 5.

Types of qualifications

2.17 Skills Australia divides engineering occupations into three categories in the table below, each of which is linked to a particular level of education. Engineers Australia and ANET accept this breakdown, noting that there are some limitiations to the approach.[16]

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

Source: Skills Australia.

2.18 Engineering courses taught in Australian universities are accredited by Engineers Australia, which will soon take on responsibility for accrediting TAFE courses too. Courses are accredited using regularly audited competencies developed against international standards. Engineers Australia uses these same competencies to assess the qualifications of applicants under skilled migration programs.[17]

2.19 Engineers who complete the qualifications outlined above are not recognised as fully qualified until they have completed a period of supervised practice. ANET notes that a professional engineer will usually reach the standard for admission to the status of Chartered Professional Engineer in three to five years.[18] Engineers Australia defines chartered status as 'a higher set of competencies than applied to degree accreditation and signifies the engineer offers all the attributes' of a professional.[19]

2.20 For reasons of simplicity, use of the term 'engineer' in this report will encapsulate people with any of the three categories of qualifications listed above.

The Australian engineering labour market

2.21 Skills Australia advises that it is difficult to properly analyse the labour market for engineers as there is no consistent definition of 'engineer' used in data

16 ANET, *Submission 73*, p. 4

17 Engineers Australia, *Submission 67*, p. 13

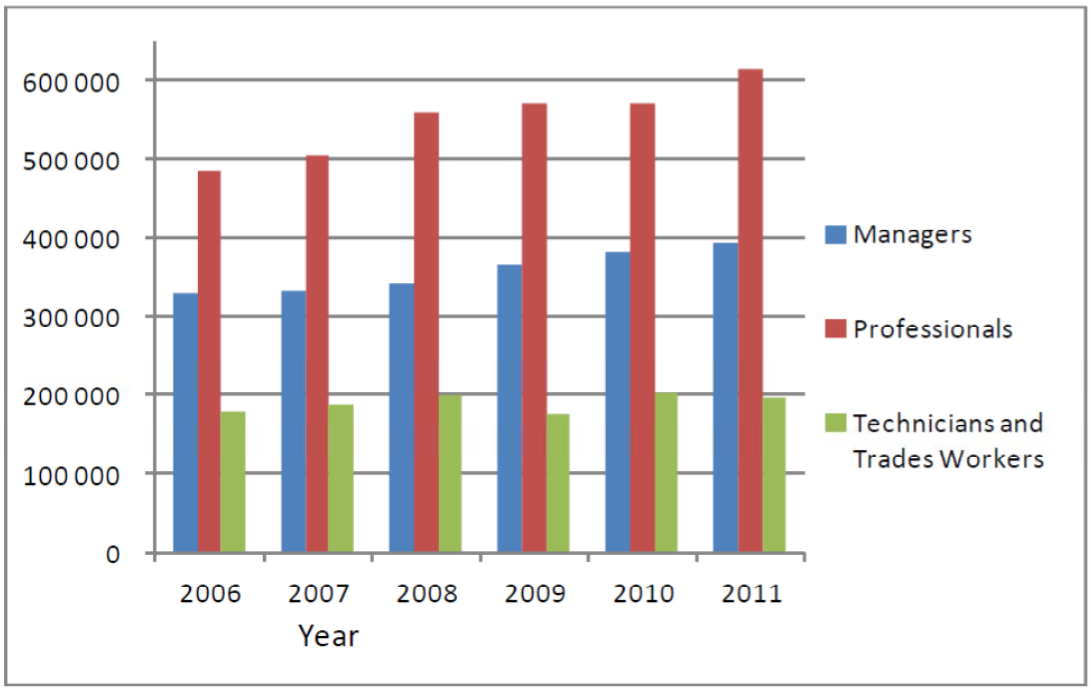
18 ANET, *Submission 73*, p. 4

19 Engineers Australia, *Submission 67*, p. 14.

collection by the Australian Bureau of Statistics.[20] Nevertheless, Skills Australia has worked with the available data to come to some interesting conclusions.

2.22 In the diagram below, Skills Australia presents the baseline engineering workforce from 2006 to 2011. The data presented in this graph reflects the total number of persons employed in occupations that best reflect the skills that engineers possess – therefore the total number of persons employed in these occupations is likely much higher than the number of persons with engineering qualifications.[21]

2.23 The graph below shows a gradual increase in the number of people employed as managers and professionals in engineering occupations during 2006–2011 (331,000 managers in 2006 to 393,000 in 2011, and 485,000 professionals in 2006 to 615,000 in 2011). In contrast, the number of technicians and trade workers was relatively constant during the same period (179,000 in 2006 to 195,000 in 2011). The trade cohort contracted by 11 per cent during the global financial crisis in 2009 but increased by the same amount in the following year.[22]



Source: Skills Australia[23]

20 Skills Australia, *Submission*, p. 1.

21 Skills Australia, *Submission*, p. 2.

22 Skills Australia, *Submission*, pp 1–2.

23 Skills Australia, *Submission 80*, p. 2. Data sourced from the Australian Bureau of Statistics.

2.24 Skills Australia reported that the number of fully qualified engineers has increased significantly. From 2006 to 2011:

- The number of engineers with professional qualifications has increased by 27 per cent;
- The number of engineers working in management has increased by 17 per cent; and
- The number of engineers working in technician and trade occupations has increased by 11 per cent.[24]

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.

Source: Skills Australia, Submission 80, p. 3.

2.25 University and VET pathways to engineering qualifications are discussed in Chapter 3.

Growth in demand for engineers

2.26 The demand for employees with engineering and related skills is higher than supply. The four main drivers of demand are the resources sector, defence, the National Broadband Network and other major infrastructure projects.[25]

2.27 While the figures in the previous section show that the engineering labour market is growing in all three qualification categories, this growth is not sufficient to meet the demand, and engineering skills shortages have been pronounced for many years.[26]

2.28 Skills Australia has applied the growth rates of the past 5 years to forecast Australia's workforce needs in 2016. A conservative estimate, based on the data, is that demand for professional and management engineers will increase by 37,000 persons by 2016 and technician and trade engineers by 6,000 persons.[27]

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24 Skills Australia, *Submission 80*, p. 3.

25 Skills Australia, *Submission 80*, pp 5–6.

26 Skills Australia, *Submission 80*, p. iv. Citing evidence from the Department of Education, Employment and Workplace Relations and the Australian National Engineering Taskforce.

27 Skills Australia, *Submission 80*, p. 3.

2.29 This estimate is conservative because the figures have not been adjusted to take into account the number of large infrastructure, defence and mining projects that are scheduled in the next few years. Further, these estimates have not accounted for the number of engineers approaching retirement which could be as high as 4 per cent annually.[28] Anticipated retirement rates vary between engineering fields, for example, the Australian Power Institute estimates that up to 30 per cent of engineers in that industry will retire in the next ten years.[29] Attrition through retirement is discussed in Chapter 5.

Resources

2.30 The resource sector's demand for labour is dependent on major project construction activity levels and mineral exploration investment. The Bureau of Resources and Energy Economics estimated the total value of projects at $456.5 billion, of which 102 advanced projects were valued at $231.8 billion. [30] Skills Australia forecasts that employment growth in mining operations will increase by 89,000 employees from 2010–2016, with an annual average growth rate of 7.9 per cent. Employment growth is expected to be highest for machinery operators and drivers, followed by technicians and trade workers.[31]

2.31 The committee received evidence during hearings in Queensland and Perth that was consistent with these forecasts.[32]

Defence

2.32 Engineering professions and trades are crucially important to the defence materiel supply industries. Many of these defence jobs require highly skilled employees with higher qualifications and extensive workplace experience. Skills Australia observed that these types of specialist skills are often subject to significant competition between employers, particularly the growing resources sector.[33] This situation is made even more acute when defence tenders occur at the same time as other major projects. Relevantly for the defence engineering sector, Skills Australia

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28 Skills Australia, *Submission 80,* p. 4.

29 Mr Michael Griffin, Chief Executive Officer, Australian Power Institute, *Proof Committee Hansard,* 28 March 2012, p. 25.

30 Cited in Skills Australia, *Submission 80,* p. 6.

31 Skills Australia, *Submission 80,* p. 6.

32 See for example, Mr Christopher Fitzhardinge, Former WA President, Engineers Australia, *Proof Committee Hansard,* 27 March 2012, p. 2; Mr Simon Bennison, Chief Executive Officer, Association of Mining and Exploration Companies, *Proof Committee Hansard,* 27 March 2012, p. 17; Mr Bruce Campbell-Fraser, Executive Officer, Chamber of Minerals and Energy of Western Australia, *Proof Committee Hansard,* 27 March 2012, p. 23, and Mr Kirby Anderson, Policy Leader, General Electric, *Proof Committee Hansard*, 28 March 2012, pp 11–12.

33 Skills Australia, *Submission 80,* p. 6.

identified likely skills gaps in electronic, electrical, mechanical and aerospace engineers.[34]

National Broadband Network

2.33 The National Broadband Network (NBN) is a roll out a national wholesale, open access, high speed broadband network. The government has forecast that the total capital expenditure will be $35.9 billion.[35] Construction of the network is scheduled to commence by December 2012 to more than 750 thousand premises.[36] NBN Co estimates that the entire project will directly create between 16 000 and 18 000 jobs.[37] Data is not available to estimate how many of these jobs will be engineering related, however Skills Australia considers the NBN to be a driver of demand for engineering skills.[38]

Other infrastructure projects

2.34 Across the country the federal government, along with state and territory governments are making belated investments in infrastructure. Skills Australia cites a 2010 OECD report which found that Australia has an 'infrastructure deficit' arising in part from under-investment in the 1980s and 1990s.[39] Particular problem areas are:

- Port and rail infrastructure. The demand for freight is expected to double between 2000 and 2020.
- Urban infrastructure. As the populations of cities increases, so does congestion, which is estimated to cost $13 billion a year (1.5 per cent of GDP). If urban infrastructure is not improved, this cost could be more than $20 billion by 2020.
- Water and Electricity infrastructure. Chronic water shortages and water restrictions are only partly connected to climate change. A high proportion of electricity infrastructure that was built in the 1960s now requires replacement.

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34 Skills Australia, *Submission 80*, p. 6.

35 Australian Government, National Broadband Network FAQs, 'How much will the NBN cost?'. Available online: http://www.nbn.gov.au/frequently-asked-questions/ (accessed 4 June 2012). This figure has been revised from the original estimate of $43 billion.

36 Australian Government, National Broadband Network, *May Update*, 2012, p. 9. Available online: http://www.nbn.gov.au/files/2011/05/NBNI-MAY-UPDATE-WEB.pdf (accessed 4 June 2012).

37 Australian Government, National Broadband Network, *May Update*, 2012, p. 9.

38 Skills Australia, *Submission 80*, p. 6.

39 Skills Australia, *Submission 80*, p. 6.

- Energy and rural water management, as a result of environmental concerns about greenhouse gas emissions, require significant capital investment.[40]

2.35 Infrastructure Australia was established to co-ordinate infrastructure spending and to provide advice to the government on policy. As a result of an infrastructure audit in 2008, nine priority projects and 28 other projects were identified, costed at more than $60 billion.[41] For example, the Department of Infrastructure and Transport is administering the Nation Building Program which represents an investment of more than $36 billion over six years in transport infrastructure alone.[42]

Skills shortage

2.36 When the term 'skills shortage' is used, it can mean one of two things: employers experiencing difficulty in recruiting a person for a specific vacancy; or existing employees not having the skills necessary for the position that they hold.[43] According to Skills Australia, the first situation is a recruitment difficulty and the second is a skills gap. For the purposes of the committee's deliberations, both are relevant.

2.37 Skills Australia pointed the committee to research indicating skills shortages are 'relatively widespread for engineering professional and para-professional occupations'.[44] Of the fifty engineering occupations surveyed only 3 were not experiencing skills shortages in 2011.[45] Significantly, a number of these professions have been experiencing skills shortages for protracted periods of time. For example, civil engineers have been in short supply since early 2000.

2.38 The Chamber of Minerals and Energy of Western Australia agreed that the skills shortage is more pronounced for professional and para professionals. Mr Bruce Campbell-Smith, Executive Officer, acknowledged the perception in the rest Australia that anyone could get a job in mining in Western Australia, and stated that this simply wasn't the case:

> There is an expectation issue and not just within the Eastern States. We are talking about growing our workforce another 20,000 in 2012. We are at pains to say that it is a skilled workforce we are chasing. For example, the number of jobs advertised on a popular employment website, Seek, for mining engineers, week to week you get up to 1,000 mining engineers advertised. Now, some of those may have dual ads, dual listings with

40 Skills Australia, *Submission 80*, p. 6. (Citing OECD data).

41 Skills Australia, *Submission 80*, p. 6.

42 Department of Infrastructure and Transport, *Submission 62*, p. 2.

43 Skills Australia, *Submission 80*, p. iv.

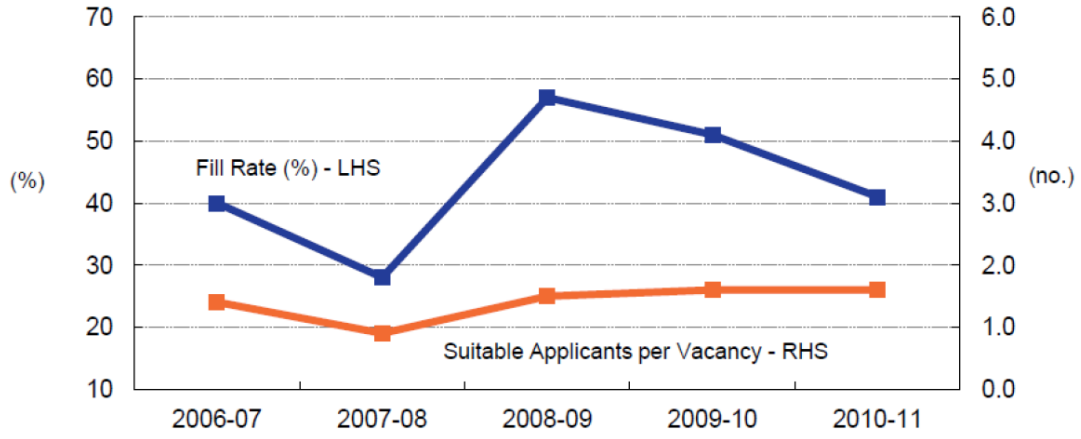
44 Skills Australia, *Submission 80*, p.12.

45 Skills Australia, *Submission 80*, Appendix D, p. 32.

different HR firms, but at the same week there will be 43 truck drivers advertised or 21 kitchen hands, in low, low numbers entry level positions into the mining industry. I think mining companies are not finding it hard to source entry level and unskilled people into the industry. Our challenge is skilled labour. With respect to some of the people in the eastern states, that problem is probably exacerbated.[46]

2.39 Employers throughout 2011 continued to have difficulty recruiting in most of the professional engineering specialisations, indeed the proportion of vacancies filled was only 41 per cent – lower than any other employment group assessed by DEEWR.[47]

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



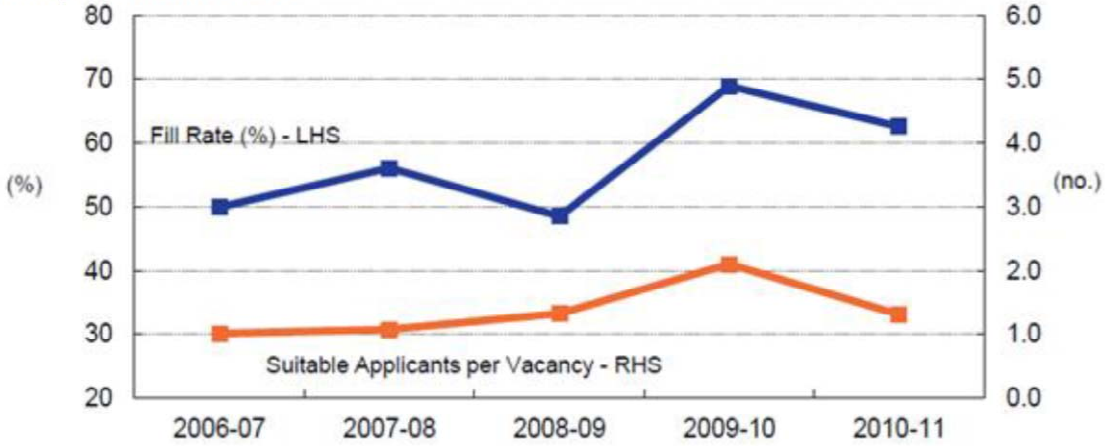
Source: DEEWR Survey of Employers who have Recently Advertised results

2.40 In relation to engineering trades, employers experienced some difficulty in recruiting appropriate staff, as demonstrated on the graph on the following page.

46 Mr Bruce Campbell-Smith, Executive Officer, Chamber of Minerals and Energy Western Australia, *Proof Committee Hansard*, 27 March 2012, p. 26.

47 Skills Australia, *Submission 80*, p. 13, citing DEEWR data.

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

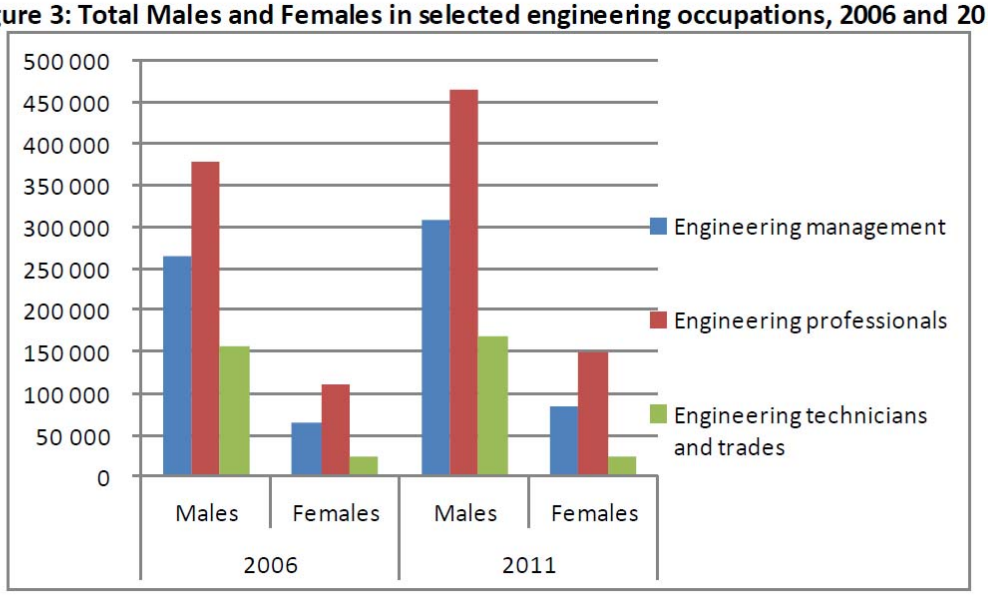


Source: DEEWR Survey of Employers who have Recently Advertised results.

Low participation rates of women

2.41 The low participation rates of women in engineering professions and trades are clearly an important factor in the skills shortage. As demonstrated by the graph below, the participation rate of women in engineering professions has increased by 1.7 per cent since 2006, but remains low at only 21.5 per cent.

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.

2.42 Dr Sally Male reported that the unemployment rate for female professional engineers is twice as high as it is for male engineers. Further, among engineers with five to ten years experience, women have an average salary that is 8.5 per cent less than their male counterparts.[48]

48 Dr Sally Male, *Proof Committee Hansard*, 26 March 2012, p. 9.

Government policies and programs

2.43 The Australian government has a number of policies and programs targeted at addressing skills shortages, or at the very least minimise their impact. This section outlines these programs, and the policy and advice structures that underpin them. While the focus here is on action taken by the federal government, the committee acknowledges that state and territory governments have also implemented measures to address skills shortages.[49] This policy area cuts across a number of government portfolios and in many instances enjoys bipartisan political support.

Skills and training

2.44 Unsurprisingly, measures to improve skills and training for engineers are central to government's efforts to address the shortage. Under machinery of government changes announced in November 2011, commonwealth administrative responsibility for skills and training moved from the Department of Education, Employment and Workplace Relations (DEEWR) to the Department of Innovation, Industry, Science and Research (DIISTRE). Neither department made a written submission to this inquiry, but DIISTRE did give evidence at a public hearing in Canberra. The committee would have found a submission from DEEWR (in particular) useful, and considers that, as a matter of course, the Department should make submissions to future inquiries of this committee.

2.45 The DIISTRE website provides the following statement in relation to government funding for skills development:

> The competitiveness and productivity of an organisation is dependent on its access to the skills it needs. To build a highly skilled Australian workforce, individuals and businesses require access to high quality training. The Australian Government meets this need through initiatives and programs designed to help individuals and businesses access training and workforce development advice. It also supports the organisations that provide these services.[50]

2.46 A number of training, trades and apprenticeship programs are administered by DIISTRE. These include:

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49 See for example, Government of South Australia, *Submission 43*, NORTH Link, *Submission 81*, p. 1 (programs funded by the Victorian government) and note that Professor Trevelyan's research is partly funded by the Government of Western Australia, *Submission 31*. The committee did not receive submissions from the federal department responsible for skills, or from any other state or territory governments.

50 Department of Industry, Innovation, Science, Research and Tertiary Education website, http://www.innovation.gov.au/TertiaryEducation/skills/Pages/default.aspx (accessed 12 June 2012).

- The National Workforce Development Fund, which provides funding to industry to support training and workforce development to meet current and future skill needs;

- The National Resources Sector Workforce Strategy, which addresses the skills and labour needs of the resources sector;

- The Critical Skills Investment Fund, which provides co-funding for industry projects that provide training and employment opportunities in critical industry sectors (this is part of the National Workforce Development Fund);

- The Australian Apprenticeships Access Program, which provides vulnerable job seekers with nationally recognised pre-vocational training, support and assistance to overcome any barriers they might experience when seeking skilled employment; and

- The Productivity Places Program, which provides training to support the development of skills in Australia to meet existing and future industry demands.[51]

2.47 An engineering cadetships program was announced by the government in December 2011. Over the next four years the government will fund 265 commencing engineering cadets a year for higher degree research students participating in the cadetship in engineering or science. The cadetships will involve a combination of formal research training at university and work experience with a business to conduct research and development tasks.[52]

2.48 In the past, the government has provided HECS-HELP discounts to engineering subjects. This practice was discontinued in the 2012-2013 budget. The department advised the committee that there is limited evidence that discounted student contribution amounts encourage students to pursue studies in a particular field, explaining that:

> Students are predominantly motivated not by price but by their interests, abilities and career preferences when selecting courses. This is particularly the case when students have access to an income contingent loan, such as HECS-HELP, that allows them to defer payment of their contribution amounts until they are earning enough to do so.[53]

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51 Department of Industry, Innovation, Science, Research and Tertiary Education website, http://www.innovation.gov.au/TertiaryEducation/skills/Pages/default.aspx (accessed 12 June 2012).

52 Department of Industry, Innovation, Science, Research and Tertiary Education, *Response to question taken on notice,* 7 May 2012 (received 6 June 2012), p. 4.

53 Department of Industry, Innovation, Science, Research and Tertiary Education, *Response to question taken on notice,* 7 May 2012 (received 6 June 2012), p. 6.

Infrastructure

2.49 While programs administered by the Commonwealth Department of Infrastructure and Transport do not necessarily address the root cause of shortages, the Department assists the government to 'promote, evaluate, plan and invest' in infrastructure and aims to foster an improved transport system across Australia, and as such has a role to minimise the impact of shortages.[54] Infrastructure Australia was established to co-ordinate infrastructure spending and to provide advice to the government on policy. As a result of an infrastructure audit in 2008, nine priority projects were identified and 28 other projects flagged, costing more than $60 billion.[55]

2.50 The Department for Infrastructure and Transport is administering the Nation Building Program, representing an investment of more than $36 billion over six years to 2013–14 in transport infrastructure.[56] In its submission to this inquiry the Department identified three key initiatives aimed at improving infrastructure delivery:

- The National Infrastructure Construction Schedule (NICS), launched in May 2012;
- Microeconomic reform delivered through the Council of Australian Governments Infrastructure Working Group, including a prequalification system, public private partnerships, alliance contracting and design and construction; and
- Measures to encourage further competition through the involvement of international firms.[57]

2.51 Chief among these initiatives is the NICS, which establishes a national government infrastructure project pipeline. The NICS is implemented through collaboration between federal, state and territory and local governments, and aims to provide industry with online information on major infrastructure projects committed by governments across the country.[58]

2.52 The NICS contains information on all infrastructure projects over $50 million procured by the general government sector as defined by the Australian Bureau of Statistics. It also contains information on tender opportunities within a project for contracts estimated to be worth more than $25 million. Currently, the NICS only lists those projects seeking tenders on contracts. Over time, the NICS will show how

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54 Department of Infrastructure and Transport, *Submission 62*, p. 1.

55 Skills Australia, *Submission 80*, p. 6.

56 Department of Infrastructure and Transport, *Submission 62*, p. 2.

57 Department of Infrastructure and Transport, *Submission 62*, pp 3–4.

58 The National Infrastructure Construction Schedule website: https://www.nics.gov.au/ (accessed 12 June 2012).

projects move along the project lifecycle, 'leading to a deep and liquid pipeline of infrastructure opportunities.'[59]

2.53 Each government provides information on the NICS for the projects it has procured. This information will be updated on a regular basis, according to each jurisdiction's budget cycle. Where a government announces a new commitment, the NICS will be updated within a week of that announcement. Local Government projects will be included on a voluntary basis, with information updated regularly.[60] The NICS may also include information on projects below $50 million, or projects procured by Government Business Enterprises if the responsible jurisdiction provides the necessary information.

2.54 The NICS enjoys support among submitters, with a number calling for its establishment earlier this year.[61] Engineers Australia described the NICS as 'the first step toward providing a transparent, long-term view of infrastructure 'pipeline planning".[62]

2.55 The committee is pleased that the NICS has come to fruition, and can envisage the system helping to efficiently allocate scarce engineering and related skills across the pool of major infrastructure projects.

Advisory bodies

2.56 Professor Ian Chubb AO was appointed Chief Scientist on 19 April 2011 and commenced on 23 May 2011. The Chief Scientist provides independent advice to the government on matters related to science, technology and innovation.[63]

2.57 The government established the Prime Minister's Science, Engineering and Innovation Council, as the 'pre-eminent science advisory body to government'. [64] Members include the Prime Minister, Ministers, the Chief Scientist (Executive

59 The National Infrastructure Construction Schedule website: https://www.nics.gov.au/ (accessed 15 June 2012).

60 https://www.nics.gov.au/Home/About (accessed 12 June 2012).

61 Engineers Australia, *Submission 67*; Consult Australia, *Submission 66*, p. 25; Roads Australia, *Submission 61*, p. 6. Note that Roads Australia also called for government commitment to a pipeline down the track, not just based on election cycles.

62 Engineers Australia, *Submission 67*, p. 9.

63 Office of the Chief Scientist website, 'About', http://www.chiefscientist.gov.au/about/the-chief-scientist/ (accessed 6 June 2012).

64 Department of Industry, Innovation, Science, Research and Tertiary Education, http://www.innovation.gov.au/science/pmseic/Pages/default.aspx (accessed 12 June 2012).

Officer) and a group of experts. One of the five experts, Dr Cathy Foley, has an electrical engineering background.[65]

Skilled migration

2.58 A well-publicised consequence of the skills shortage across a number of industries has been the increased use of skilled migration. This can be approached by employers in one of two ways. Australian companies may recruit skilled workers from overseas, or project management tenders are awarded to international engineering companies who bring their employees into the country to fulfil the contract.

2.59 For many years the federal government has operated skilled migration programs to enable businesses to bring workers from overseas to address skills shortages. The most common program is the Temporary Business (Long Stay) – Standard Business Sponsorship (Subclass 457) visa (Subclass 457 visa). More recently, Enterprise Migration Agreements (EMAs) have been introduced to streamline the Subclass 457 visa application process. The government also operates a General Skilled Migration program, under which people with qualifications on the Skilled Occupations List may apply for permanent migration to Australia, independent of employer sponsorship. Most engineering occupations are listed on the Skilled Occupations List, which is produced by Skills Australia and used by the Department of Immigration and Citizenship (DIAC) to determine eligibility for independent skilled permanent migration.[66]

2.60 The table below, prepared by Skills Australia on the basis of data provided by DIAC, shows recent migration trends 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: Skills Australia [67]

65 Commonwealth Scientific and Industrial Research Organisation, "Dr Cathy Foley: Chief, CSIRO Materials Science and Engineering", http://www.csiro.au/Organisation-Structure/Divisions/Materials-Science--Engineering/CathyFoley.aspx (accessed 12 June 2012).

66 Skills Australia, *Submission 80*, p. 10.

67 Skills Australia, *Submission 80*, p. 11.

2.61 The table above indicates an increase in visa grants for subclass 457 temporary business visas and employer sponsored visas, but a reduction in visa grants under the General Skilled Migration program.

Subclass 457 visa

2.62 The 457 visas enable employers to recruit skilled overseas workers to meet the shortfall of skills demands in Australia. Among other requirements, employers with a business that operates in Australia must meet benchmarks relating to training Australian citizens and permanent residents to be eligible.[68] Employers who have been trading in Australia for more than 12 months may select between different training benchmarks:

- Training Benchmark A: the employer pays the equivalent of at least two per cent of recent payroll expenditure to an industry training fund for the training of Australian citizens or permanent residents, each year that the employer is a sponsor [69]; or
- Training Benchmark B: the employer must provide evidence of spending the equivalent of one per cent of payroll on training for their employees who are Australian citizens or permanent residents.[70]

2.63 Eligible expenditure for the purposes of meeting Training Benchmark B includes the following types of training:

- paying for a formal course of study for the business's employees who are Australian citizens and Australian permanent residents, or for TAFE or University students, as part of the organisational training strategy;
- funding a scholarship in a formal course of study approved under the Australian Qualifications Framework for the business's employees who are Australian citizens and Australian permanent residents or, for TAFE or University students, as part of the organisational training strategy;
- employment of apprentices, trainees or recent graduates on an ongoing basis in numbers proportionate to the size of the business;
- employment of a person who trains the business's Australian employees who are Australian citizens and Australian permanent residents as a key part of their job;

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68 Department of Immigration and Citizenship, 'Training Temporary Business (Long Stay) – Standard Business Sponsorship (Subclass 457)', available online: http://www.immi.gov.au/skilled/skilled-workers/sbs/eligibility-employer.htm (accessed 30 May 2012).

69 Department of Immigration and Citizenship, 'Training benchmarks, Frequently asked questions – sponsors, p. 2. Available online: http://www.immi.gov.au/skilled/skilled-workers/_pdf/faq-457-training-benchmarks.pdf (accessed 30 May 2012).

70 Department of Immigration and Citizenship, 'Training benchmarks, Frequently asked questions – sponsors, p. 3.

- evidence of payment of external providers to deliver training for Australian employees; and
- on-the-job training that is structured with a timeframe and clearly identified increase in the skills at each stage, and meeting specific criteria.[71]

2.64 The wages paid to staff for time spent attending training are not expenditure for the provision of training, and cannot be counted towards Training Benchmark B, except where the staff are apprentices, trainees or recent graduates.[72] In general terms, 100 per cent of apprentice, trainee and graduate salaries can be counted towards the training benchmark.

2.65 Where an applicant employs an apprentice or trainee, and there is a formal apprenticeship or traineeship agreement in place, 100 per cent of the salary provided to this apprentice or trainee can be counted towards calculating whether the training benchmark of one per cent of payroll expenditure has been met.[73]

2.66 Where a company has a formal graduate program, 100 per cent of the graduate's salary can be counted for the length of that program (up to two years). In order to be eligible, the graduate must be working in an occupation that is relevant or related to their recently completed qualification. Expenditure on graduate salaries where there is no a formal graduate program cannot be counted.[74]

2.67 Companies must provide 'auditable' evidence of expenditure to meet the training benchmarks and non-compliance will result in ineligibility to apply for subclass 457 visas in the future.

2.68 Employers must meet nine sponsorship obligations, including an obligation to ensure that sponsored employees enjoy equivalent terms and conditions of employment as Australian workers undertaking the same work at the business's workplace in the same location.[75] The temporary skilled migration income threshold

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71 Legislative Instrument IMMI 09/07, made under the *Migration Regulations 1994*, subregulations 2.59(d) and 2.68(e)

72 Department of Immigration and Citizenship, 'Training benchmarks, Frequently asked questions – sponsors, p. 4.

73 Department of Immigration and Citizenship, 'Training benchmarks, Frequently asked questions – sponsors, p. 3.

74 Department of Immigration and Citizenship, 'Training benchmarks, Frequently asked questions – sponsors, p. 3.

75 Department of Immigration and Citizenship, 'Training Temporary Business (Long Stay) – Standard Business Sponsorship (Subclass 457)', available online: http://www.immi.gov.au/skilled/skilled-workers/sbs/obligations-employer.htm (accessed 30 May 2012). Other obligations relate to cooperating with DIAC in its compliance role.

has been set at $49,330 per annum, meaning that workers in occupations that have a market salary below this rate may not be sponsored under the Subclass 457 program.[76]

2.69 A number of submitters praised the subclass 457 visa program, arguing it was a crucial measure to meet short term skills shortages. During the Brisbane hearings Ms Megan Motto, Chief Executive Officer, Consult Australia, explained to the committee that skilled migration was absolutely imperative, particularly because around two thirds of projects have been delayed in the short term, or indefinitely, because of skills shortages. Indeed, a reduction in skilled migration would 'cripple' Australian industry.[77] Ms Motto stated:

> I would say that the firm-sponsored skilled migrant entries—that is, those that come in on a 457 as sponsored by firms—have a very high success rate because they are hand-picked by the firms and the firms are picky about who they have working for them. They have good English language skills and they have a high degree of confidence that they will transition into the Australian culture and the particular firm's culture and that they will have a high degree of success, because firms are not going to go to the expense of bringing people into Australia if they think they are going to fail.[78]

2.70 The Association of Mining and Exploration Companies also praised the flexibility of the subclass 457 visa program, as it enable companies to meet short term demand in a cyclical industry.[79]

2.71 Submitters reminded the committee that the training requirements attached to the subclass 457 visa program assisted in addressing skills capabilities. These conditions were outlined in detail earlier in this chapter.

2.72 The committee asked Consult Australia to comment on the allegation that firms will always resort to use of skilled migration because it is cheaper than employing local labour, and that as a consequence, firms will have no incentive to train and develop staff capability. Mr Jonathan Russell, Senior Policy Adviser, Consult Australia, observed that most companies prefer Australian labour as it is cheaper and immediately productive, further, companies who recruit overseas workers

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76 Department of Immigration and Citizenship, 'Subclass 457 – Market Salary Rates'. Available online: http://www.immi.gov.au/skilled/457-market-salary-rates.htm (accessed 30 May 2012). Where the salary proposed for the nominated worker is equal or greater to $180 000 the sponsor does not have to provide evidence that this salary is set according to the market salary rate for that occupation.

77 Ms Megan Motto, Chief Executive Officer, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 21.

78 Ms Megan Motto, Chief Executive Officer, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 21.

79 Mr Simon Bennison, Chief Executive Officer, Association of Mining and Exploration Companies, *Proof Committee Hansard*, 27 March 2012, p. 19.

have to meet strict training criteria.[80] Ms Motto pointed out that there is a significant difference between 'employers who are doing the right thing by Australian industry but fundamentally need additional skills to complete projects' and 'those industries that are employing low-level non-technical labour style skills and whose industries have more of a history of abuse of the 457 system in terms of employing Australians to do the same level of work'.[81]

Enterprise Migration Agreements

2.73 Enterprise Migration Agreements represent a streamlined and fast tracked Subclass 457 visa program. In July 2010 the National Resource Sector Employment Taskforce recommended, among 30 other recommendations, that the government introduce EMAs. In March 2011 the government accepted all 31 recommendations.[82] On 10 May 2011 the federal government announced a new temporary migration initiative to help address the skill needs of the resources sector, Enterprise Migration Agreements (EMAs).[83]

2.74 EMAs are available to projects with a capital expenditure of at least $2 billion and a peak workforce of 1500 workers. Applicants must also submit a comprehensive training plan that demonstrates how the project will equip Australians to meets future skills needs in the resources sector. The EMA process is intended to streamline negotiation arrangements for access to overseas workers and guarantee faster processing times for visa applications.[84]

2.75 The first EMA was approved on 25 May 2012 and was granted to the new iron ore mining Roy Hill project in the Pilbara region of Western Australia. The EMA permits Roy Hill to sponsor up to 1715 workers through the 457 visa program during the three year construction phase, where Australian workers cannot be found. The project requires more than 8000 workers, and it is expected the remaining 6285 jobs will be filled by Australian workers. As part of the EMA, Roy Hill must provide 2000

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80 Mr Jonathon Russell, Senior Policy Advisor, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 22.

81 Ms Megan Motto, Chief Executive Officer, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 22.

82 National Resources Sector Employment Taskforce, *Resourcing the future*, July 2010. Available online: http://www.deewr.gov.au/Skills/Programs/WorkDevelop/ResourcesWorkforce/Pages/NRSET.aspx (accessed 31 May 2012).

83 The Hon. Chris Bowen MP, Minister for Immigration and Citizenship, 'Budget 2011-2012: New Temporary Migration Agreements to Further Address Skills Demand', Media Release, 10 May 2011. Available online: http://www.minister.immi.gov.au/media/cb/2011/cb165283.htm (accessed 31 May 2012).

84 Department of Immigration and Citizenship, Fact Sheet 48a – Enterprise Migration Agreements. Available online: http://www.immi.gov.au/media/fact-sheets/48a-enterprise.htm (accessed 31 May 2012).

training places for Australians, including more than 200 Australian apprentices and trainees.[85]

2.76 The Australian Association of Mining and Exploration Companies (AMEX) argue that EMAs should be available to all mineral resource projects regardless of their value or size, and the $2 billion threshold should be removed. AMEX reports that its members have indicated that smaller projects are also faced with labour shortages.[86]

General Skilled Migration program

2.77 The government also operates a General Skilled Migration program, where people with qualifications on the Skilled Occupations List may apply for permanent migration to Australia, independent of employer sponsorship..

2.78 Companies are increasingly resorting to skilled temporary migration in an attempt to fill vacancies. However this brings with it challenges, as without careful management can result in a deterioration of the underlying problem. The limitations of the skilled migration program are discussed in the next section.

The role of migration in addressing the shortage

2.79 Currently migration provides about half of the skilled engineering workforce in Australia. The committee received conflicting evidence in relation to migration policy in Australia. Some submitters called for greater migration, such as the expansion of the Enterprise Migration Agreements and skills visas, where other submitters called for caution – arguing that while skilled migration was essential, it would not address the skills shortage in the long term.

2.80 In simple terms, those who urged caution did so on the basis that the use of skilled migration can have both positive and negative effects. In the short term, if appropriately trained overseas workers are employed in industries suffering acute skills shortages, then projects may proceed without delay and are consequently more likely to be completed on time and to an appropriate standard. However, too strong a focus on overseas migration to address skills shortages can result in industry continuing to neglect investment in training and support for the Australian workforce, thereby entrenching the shortage and worsening the underlying problem.

2.81 The committee is aware of calls to expand the migration programs, or at least retain current conditions. For example, in a recent report, the Business Council of

85 The Hon. Chris Bowen MP, Minister for Immigration and Citizenship and The Hon. Martin Ferguson AO MP, Minister for Resources and Energy, 'First Enterprise Migration Agreement approved', Joint Media Release, 25 May 2012. Available online: http://www.minister.immi.gov.au/media/cb/2012/cb187050.htm (accessed 31 May 2012).

86 The Australian Association of Mining and Exploration Companies, *Submission 46*, p. 2.

Australia (BCA) makes several recommendations in relation to migration, calling on the federal government to:

- set policies to support a growing Australian population and workforce over time by committing to a long-term strategy in accordance with the projections in the 2010 Intergenerational Report
- maintain the annual permanent migration program at least at its current levels (currently at a minimum of 190,000 total; 129,500 of those are skilled migration)
- ensure flexibility in uncapped temporary migration schemes such as 457 visas and the efficient implementation of the Enterprise Migration Agreement program and do not make the requirements to comply with the EMA program any more onerous for eligible projects
- remove all barriers to the recruiting of engineers and project managers with the appropriate levels of experience to oversee very large projects in Australia.[87]

2.82 However, the committee received evidence that increased short term migration was not a sufficient measure to address the engineering skills shortage.

2.83 Skills Australia, while supporting the greater use of overseas students who have completed engineering studies in Australia to meet the shortfall, emphasised that any use of former international students or overseas workers should not supplant investments in skills developments for Australians.[88]

2.84 Engineers Australia warned that prolonged use of short term skills migration (in contrast to permanent migration) can exacerbate the impact of Australia's skills shortages in the long term. Mr Christopher Fitzhardinge explained to the committee:

> What happens is that you lose the ability for native engineering expertise to develop within your country and the types of components, the types of modules and services tend to be global rather than local. If we are trying to use the investment cycle we have now to grow our economy—the Australian economy tends to be quite volatile and lumpy—we have to capture economic advantage from investment cycles and we have to develop capability that will strengthen us in our economy in the longer term. Typically, that involves development of professional services not only on the construction side of projects but on the operation and long-term support of projects. The use of global procurement managers not only sabotages the local content and the development of local engineering

87 Business Council of Australia, *Pipeline or pipe dream? Securing Australia's investment future*, 7 June 2012. Available online: http://www.bca.com.au/Content/101987.aspx (accessed 12 June 2012), p. 23.

88 Skills Australia, *Submission 80*, p. 19.

> expertise during the construction phase but also has an impact on the longer term supply of goods and services to sustain that project into perpetuity.[89]

2.85 Engineers Australia cautioned that migration may not always be an available resource to companies, if costs in Australia continued to increase. Mr Christopher Fitzhardinge explained:

> Previously, Australia had a cost advantage in terms of migration from a number of countries. People could sell their houses, move here and make a significant profit. What has happened is that with the high Australian dollar, high Australian property prices and high Australian cost of living, the thing that will prevent us from securing the engineering skills that we need will be the differential cost structures between the countries that are our strong source of migration. In Western Australia, typically it has been the UK, Europe and South Africa that have provided a significant proportion of our engineering skills. It really depends on the economic drivers for people to migrate to Australia from those countries and at the moment they are not as positive as they were, say, five years ago.[90]

2.86 Professor James Trevelyan agreed with this assessment, submitting that the experience of migrant engineers in Australia 'is not a happy story universally'. Professor Trevelyan concluded that from his preliminary research for the Western Australian government, he believed many migrant engineers on subclass 457 visas would 'be on the next plane out' if there were improvements in economies in the rest of the world. [91] This observation is telling, when coupled Skills Australia's anecdotal evidence that a significant numbers of qualified but unsuitable applicants for engineering professions have come through the General Skilled Migration program.[92]

2.87 The Australian National Engineering Taskforce (ANET) submitted that reliance on immigration to meet the skills shortage is a risky, short term approach. This is because its success is dependent on the Australian economy performing well and remaining an attractive destination. ANET urged the government to adopt a target to reduce the reliance on immigrant engineers over the next ten years, by increasing domestic graduates and trades.[93]

2.88 The committee was also mindful of the fact that overseas workers who come to Australia to work in engineering jobs have a higher rate of unemployment. In a

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89 Mr Christopher Fitzhardinge, former WA Division President, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 7.

90 Mr Christopher Fitzhardinge, former WA Division President, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 3.

91 Professor James Trevelyan, *Proof Committee Hansard*, 27 March 2012, p. 15.

92 Skills Australia, *Submission 80*, pp 12–13.

93 Australian National Engineering Taskforce, *Submission 73*, p. 18. See also Mr Bruce Woolridge, Australian Institute of Traffic Planning and Management, *Proof Committee Hansard*, 27 March 2012, p. 30.

2010 survey conducted by DIAC, the unemployment rate of all independent skilled migrants was 3.3 percentage points higher than the national unemployment rate.[94] The survey results indicate that engineering professionals have a higher unemployment rate than total engineers, and this rate is also higher than the general unemployment rate in Australia. Research has not been conducted into the cause, but Skills Australia advises that is aware that 'some 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'.[95]

2.89 Australia's Chief Scientist, Professor Ian Chubb, told the committee that as 'a good global citizen' Australia should think about how it supports engineering capability in developing countries, and this was not done by 'drawing away their talent'. Professor Chubb submitted that Australians need to 'do something about our own back yard', rather than rely on skilled migration indefinitely:

> I do not think it is a solution simply to say we will import the skills when we need them and turn off the tap when we are replete. We actually have a need to ensure that we are trying to improve the supply within the country and to increase it as other countries are doing and then to top it off through immigration processes, to target particular skill areas where we might be deficient or take a long time to get up to the need of whatever it might be. So I think it is a combination but I do not think that, because we can presently recruit people, it means that we will always be able to in the areas we want, with the skill level we want, with the capabilities that we want.[96]

2.90 The committee considers that current skilled migration programs are an effective tool to address immediate skills shortages, but like the majority of submitters, does not take the view that it is a solution for the underlying need to invest in education and training programs domestically.

2.91 In the next chapter the committee examines the current education and training pathways for engineers in detail.

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94 Skills Australia, *Submission 80*, p. 11.

95 Skills Australia, *Submission 80*, p. 12.

96 Professor Ian Chubb AO, Australia's Chief Scientist, *Proof Committee Hansard*, 7 May 2012, p. 14.

Chapter 3

Education and training pathways

3.1 In this chapter the committee examines education and training pathways to engineering occupations, which include professionals/managers, technicians and trades workers.[1] The importance of science, technology, engineering and mathematics (STEM) at school is set out. The Vocational Education and Training (VET) pathway to engineering trade occupations is explained. Finally, the professional engineering bachelor degree is examined.[2] The committee has sought to provide a brief description of each pathway, and a summary of what is being done well in education and training where there are areas for improvement.

Science, technology, education and mathematics at school

Background

3.2 Whether an individual chooses to pursue tertiary or trade qualifications, the building blocks of education originate during schooling. Indeed, the success of students at STEM subjects in primary school and high school will fundamentally impact upon each student's options at the VET and university level. For this reason, there is cause for concern at the decreasing numbers of students studying STEM subjects in senior high school years. Engineers Australia and the Australian Council of Engineering Deans argue that by increasing STEM ability in late high school, many more students would be in a position to consider engineering at the tertiary level.[3]

3.3 Schooling is a responsibility of the states and territories, however the federal government does have a role in influencing policy and driving particular programs. Unfortunately the Department of Education, Employment and Workplace Relations did not make a submission to this inquiry, despite receiving an invitation. As noted in chapter 2, the committee would have found a submission from DEEWR useful, and considers that, as a matter of course, the Department should make submissions to future inquiries of this committee.

3.4 In May 2012 Australia's Chief Scientist, Professor Ian Chubb, published the Report, *Health of Australian Science*.[4] Chapter 3 of that report deals with science in

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1 Australian National Engineering Taskforce (ANET), *Submission 73*, p. 4

2 The term 'engineer' in this report is used to encapsulate persons with qualifications in any of the engineering occupations.

3 The Australian Council of Engineering Deans, *Submission 65*, pp 6–7; Engineers Australia, *Submission 67*, p. 10. This is also supported by Universities Australia, *STEM and non-STEM First Year Students*, January 2012.

4 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, Foreword, May 2012. Available online: http://www.chiefscientist.gov.au/wp-content/uploads/OCS_Health_of_Australian_Science_LOWRES1.pdf (accessed 25 May 2012).

secondary schools, and draws upon a number of other recent inquiries.[5] Study of science subjects has been declining for a number of years. For example, during the years 1992 and 2010 the percentage of Year 12 students studying:

- Biology has fallen from 35.3 per cent to 24 per cent;
- Chemistry has fallen from 22.9 per cent to 17.2 per cent;
- Physics has fallen from 20.8 per cent to 14.2 per cent; and
- Mathematics has fallen from 76.6 per cent to 72 per cent (and in addition, there has been a shift from intermediate and advanced levels down to elementary levels).[6]

3.5 The Office of the Chief Scientist observes that despite this decline, Australian students still perform well in STEM subjects in relation to other countries. However, the Office warns that we must be careful that Australia's performance levels do not remain static while those of its neighbours continue to improve.[7] The *Health of Australian Science Report* did identify some positive responses to the decline of STEM studies. For example the Australian Academy of Science's 'Science by Doing' program and CSRIO's Scientists in Schools program.[8]

3.6 Surveys of senior secondary school students, conducted by the Office, reveal that it is teachers who are the largest factor 'in determining a student's interest in and attitudes towards science'. [9] In order to improve STEM participation and standards during school years, the Office of the Chief Scientist recommends that teachers need to 'interact' better with students to ensure that existing students remain interested in STEM and that other students are attracted to the subject. The survey found that students and many teachers found an interactive style of teaching, featuring student-led research, practical activities and real world examples, to be most engaging.[10] However, the research concluded that many teachers took a more traditional didactic approach due to 'time and resource constraints' and, for some, because of a lack of

5 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, May 2012, p. 42.

6 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, May 2012, p. 10.

7 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, May 2012, p. 10.

8 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, May 2012, p. 43

9 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, May 2012, p. 10.

10 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, May 2012, p. 51.

confidence and training.[11] A further difficulty is that STEM teachers are in high demand, particularly in rural and regional areas.[12]

Initiatives to improve STEM ability in schools

3.7 The committee received evidence about a number of initiatives undertaken to engage primary and high school students in STEM subjects. The Australian Council of Engineering Deans advised that a survey conducted a couple of years ago identified 600 examples of outreach programs between higher education engineering bodies and schools.[13] A few indicative examples are provided here.[14]

3.8 The New South Wales division of the Institute of Public Works Engineering Australia (IPWEA) runs a Build a Bridge program for selected year 10 and 11 high school students near Wagga Wagga. The program provides students with a three day live-in program centred on engineering. Mr Paul Di Iulio explained the success of the program to the committee during the Canberra hearing:

> About 124 students have progressed through this. At this stage about 25 per cent of those have taken up the challenge of undertaking an engineering path at university, another five have taken not necessarily an engineering path, but have taken on work in local government, which has been good, and a number of them are still at school. We believe that this is a fantastic opportunity to engage with people while they are still in secondary school.[15]

3.9 The committee heard that, were the IPWEA to receive additional funding of $1500 a student it could extend this program – and its success – through local councils around the country.[16] The committee is encouraged by the success proportion of students who progress through the program and go on to study engineering, and would be pleased to see the program rolled out more widely by local councils.

3.10 Another positive example is the University of the Sunshine Coast's integrated learning program in regional schools. The university targets those students in regional areas who find it too difficult to attend university and assists them by sending out

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11 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, May 2012, p. 55.

12 Office of the Chief Scientist, *Health of Australian Science*, Commonwealth Printing, May 2012, p. 45.

13 Professor John Beynon, President, Australian Council of Engineering Deans, *Proof Committee Hansard*, 7 May 2012, p. 31.

14 Many other examples were provided to the committee throughout this inquiry. For example, surveyors in Victoria have sponsored a program called 'Surveying: a life without limits', which involves the interaction of surveyors with school children, and a demonstration of surveying tools and work: Mr Phillip Dingeldei, Chairman, Consulting Surveyors National, *Proof Committee Hansard*, 7 May 2012, p. 41.

15 Mr Paul Di Iulio, National President, Institute of Public Works Engineering Australia, *Proof Committee Hansard*, 7 May 2012, p. 57.

16 Mr Paul Di Iulio, National President, Institute of Public Works Engineering Australia, *Proof Committee Hansard*, 7 May 2012, p. 57.

academics to work with teachers in the school. Students study up to two first year engineering subjects in late high school, which can be used as credit for those students who subsequently decide to study engineering at university. Professor Mark Porter described the early success of this program:

> I believe we have run this program with great success over the last three years. Because it is particularly targeted at students with an interest in construction and construction engineering we are working with the body Construction Skills Queensland. Together, we want to extend that program across Queensland. We believe we can do that for schools in regional Queensland. CSQ, Construction Skills Queensland, is in fact considering sponsorship of those students when they come on to university. They are helping to select the students, target them at engineering and then support them at the university.[17]

3.11 Engineers Australia runs a program called EngQuest that is offered to primary school teachers across Australia. The program aims to assist teachers to deliver fun and interesting programs that inspire children to participate in engineering and the science and mathematics behind it.[18]

3.12 The Australian Power Institute collaborates with the Academy of Technological Sciences and Engineering's project which runs renewable energy projects for year 8 and 9 students in more than 240 schools across Australia. The Australian Power Institute sponsors that program and has also recently approved a solar car challenge for years 8 and 9. Power Institute bursary students, discussed later in this chapter, participate in promoting engineering to high school students by participating in the solar car challenge. Mr Michael Griffins advised the committee that:

> We have made a condition of receiving the bursary that our students go into the high schools and judge the challenge. They talk about what engineers do and what they are studying at university. We try to enlighten the young people in years 8 and 9 who are struggling with how maths and science are relevant to their life. Hearing it from just recent young graduates is important; they connect, because they are a similar generation.[19]

3.13 The Chamber for Minerals and Energy of Western Australia praised initiatives taken by Curtin University to provide high school students with practical exposure to engineering. Mr Bruce Campbell-Fraser explained the benefits of mining camp:

> Our companies are very supportive of Curtin University's focus on mining camp, which is aimed at high school students considering a career in mining engineering. We encourage them to come on-site, and they work

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17 Professor Mark Porter, Professor of Engineering, University of the Sunshine Coast, *Proof Committee Hansard*, 28 March 2012, p. 31.

18 Ms Leanne Hardwick, Director, WA Division, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 6.

19 Mr Michael Griffins, Chief Executive Officer, Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 27.

> with Curtin to be provided access. I have seen indications that about 75 per cent of high school students that go on that camp end up in mining engineering. So there are very good numbers working their way through that. Our companies are engaged through that summer break, heavily and happy. I still think there is that expectation about what working in the resource sector might be like, and work experience can help address some of that. It is not for everyone, despite their expectations about what life may be as an engineer.[20]

3.14 The committee believes that initiatives like the ones outlined in this section are an important example of how local councils, universities, industry groups and companies can promote engineering to school children and explain, in a fun and practical way, what it is that engineers do.

State and federal government initiatives

3.15 The committee received a detailed submission from the South Australian Government, which outlined its response to the decline in STEM skills in schools and in the workplace, which was introduced in August 2011.[21] Key strategies include a:

- STEM Cabinet Taskforce that meets quarterly and ensures that government programs are coordinated and complementary (members are relevant ministers with responsibility for science, education, skills, employment, trade, defence and mineral resources);
- STEM Skills decision making framework that meets fortnightly to review existing STEM programs and develop new policy approaches (members are the chief executives of relevant departments).[22]

3.16 Some programs initiated by the South Australian Government include:

- Professional development and mentoring for science and mathematics teachers;
- Incentives for science and mathematics teachers to teach in rural, remote and low socio-economic metropolitan schools;
- Targeted recruitments of science and mathematics teachers; and
- Bridging courses for students wishing to upgrade STEM skills to pursue careers in defence related industries.

3.17 The South Australian Government noted that it was aware of similar efforts to improve STEM ability at school by the Victorian and Queensland governments.[23]

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20 Mr Bruce Campbell-Fraser, Executive Officer, Chamber of Minerals and Energy WA, *Proof Committee Hansard*, 27 March 2012, p. 28.

21 Government of South Australia, *Submission 43*.

22 Government of South Australia, *Submission 43*, p. 5.

23 Government of South Australia, *Submission 43*, p. 8.

3.18 In its submission, the South Australian Government reiterated its recommendation that promotion of STEM skills be discussed at the Council of Australian Governments, with a view to developing a national approach.[24]

3.19 The Warren Centre for Advanced Engineering has criticised government responses to STEM promotion in schools. Further, career advice is usually provided in years 10 and 12, by which time students have already made subject choices which will impact their careers.[25] The Warren Centre suggests that the United Kingdom approach to solving STEM shortage has merit.[26] The Warren Centre explained that it has

> ...been particularly impressed by the UK Government's recognition not only of the need for a National Strategic Plan to promote STEM studies, but also the support they have provided for the mapping of current initiatives (a necessary first step in any strategic plan) and follow-through on Action Plans that, five years later, have resulted in a number of professionally managed initiatives.
>
> We have also noted that the USA, although some three years behind the UK, is following the same course of action.[27]

3.20 The Warren Centre calls upon the Australian government to also develop a strategic plan to address STEM skills shortages.[28]

3.21 The committee heard that outreach should also be conducted to career advisors in schools, to ensure that students are aware of the engineering opportunities available through trade or university. Mr Dan Reeve, Capacity Chapter Member, Roads Australia considered that the solution was as simple as finding a way to communicate to students and career advisers what it is that engineers actually do:

> A lot of career advisers do not really understand what is involved in being an engineer. Some people think it is an office job and all we do is paperwork; other people think that it is just being a project manager building something. You do not know the full sphere of what engineers are involved in, and, if we can get people involved in the early understanding of maths and science and how it is applied—because what we do as engineers is apply the law of physics to things and materials so that you can build things—then early they understand it and see that there are well-paid careers, and then they will take an interest in it and, hopefully, go to university to be engineers.[29]

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24 Government of South Australia, *Submission 43*, p. 8. The South Australian Government advised that it made this recommendation earlier at the Commonwealth States and Territories Advisory Council on Innovation.

25 The Warren Centre for Advanced Engineering, *Submission 27*, pp 2–3.

26 The Warren Centre for Advanced Engineering, *Submission 27*, p. 4.

27 The Warren Centre for Advanced Engineering, *Submission 27*, p. 6.

28 The Warren Centre for Advanced Engineering, *Submission 27*, p. 6.

29 Mr Dan Reeve, Capacity Chapter Member, Roads Australia, *Proof Committee Hansard*, 7 May 2012, p. 4.

3.22 The Australian Council of Engineering Deans believes that school mathematics and science curricula could be improved by finding connections between these disciplines and practical engineering applications.[30] Professor Roger Hadgraft and Professor David Beanland also agree with this recommendation.[31] Given the observations in the *Health of Australian Science* report about student interest in practical, real life examples, this proposal may have some real merit. The committee however did not receive any evidence on this point from education departments.

3.23 The Warren Centre argues that government STEM policies should be particularly targeted at school children aged 12 to 15 and need to be supported by business and industry.[32]

Committee view

3.24 The committee believes that the promotion of STEM subjects in primary and high school is important for the engineering profession, as well as for Australia as a nation. The committee understands that a number of measures to achieve higher STEM ability are being implemented across the states and territories, and that the Chief Scientist is tracking this trend and identifying areas where improvement can be made.[33] The committee hopes that these efforts to address the decline of STEM ability will be fruitful.

3.25 The committee believes that the examples outlined demonstrate the varied ways that industry, local governments and universities can engage school students in STEM subject matter, with an engineering focus. This engagement is important because increasing student participation in STEM subjects will increase the number of students who are eligible to study engineering at university and the number of students who decide to pursue an engineering related career through trade training.

3.26 However, as the bulk responsibility for primary and high school education rests with the states and territories, the committee believes that a multifaceted approach is needed to address the decline in STEM ability. The committee was particularly impressed with the STEM Skills Strategy developed by the South Australian government, and believes that this could be used as a model for other states and territories looking to improve the capacity of students to pursue careers requiring STEM skills.

3.27 The committee is also aware that the federal government can play a lead role in promoting STEM across Australia, particularly in light of the recently published findings by the Chief Scientist.

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30 Australian Council of Engineering Deans, *Submission 65*, p. 1.

31 Emeritus Professor David Beanland and Professor Roger Hadgraft, *Proof Committee Hansard*, 7 May 2012, p. 28.

32 The Warren Centre for Advanced Engineering, *Submission 27*, p. 1.

33 Skills Australia, *Submission 80*, p. 18.

Recommendation 1

3.28 The committee recommends that the government seeks recommendations from the Chief Scientist about how it can best continue to support the development of science, technology, engineering and mathematics courses.

Recommendation 2

3.29 The committee recommends that the government works through the Council of Australian Governments to promote science, technology, engineering and maths ability in states and territories.

Vocational Education and Training

3.30 Engineering technicians and trade workers have obtained qualifications, generally, through VET.[34] The demand for trade engineers was discussed in Chapter 2. Skills Australia reports that VET engineering and related technologies commencements between 2005 and 2010 increased by 21 per cent overall, mostly at the Certificate III level.[35] During the same period:

- Advanced Diploma commencements decreased by 26 per cent
- Diploma commencements decreased by 12 per cent
- Certificate IV commencements increased by 79 per cent[36]

3.31 During 2005 and 2010, VET engineering and related technologies total completions between 2005 and 2009 increased by 44 per cent. During the same period:

- Advanced Diploma completions decreased by 12 per cent
- Diploma completions decreased by 4 per cent
- Certificate IV completions increased by 83 per cent[37]

Criticisms

3.32 The VET pathway did not receive the robust criticism that was directed at university teaching of engineering. This may be in part because the VET sector is targeted practical training, and because it often occurs within an apprenticeship framework, students are 'work ready' when they complete their qualifications.

3.33 The main criticisms about current VET education were that the pathways from VET to tertiary study were not at times clearly articulated and that employers often overlooked engineering technologists with a three year qualification, preferring

34 Some engineering technicians have completed a three year bachelor degree at university, nevertheless, that qualification is dealt with in this section.

35 Skills Australia, *Submission 80*, p. 10. (Citing data from the National Centre for Vocational Education Research). Skills Australia was superseded by the Australian Workforce and Productivity Agency on 1 July 2012.

36 Skills Australia, *Submission 80*, p. 10.

37 Skills Australia, *Submission 80*, p. 10.

instead to employ professional engineers with the four year bachelor degree.[38] Skills Australia believes that the qualification completion rates are 'unacceptably low'. If completion rates were improved then industry demand could more easily be met.[39]

Improvements

3.34 As discussed earlier, the Government of South Australia has developed a detailed response to the engineering skills shortage in that state. One measure, to promote the use of apprentices, is a requirement that 15 per cent of total on-site labour hours in South Australian Government building and civil works must be worked by apprentices, trainees, Aboriginal people, local people with barriers to employment and through up skilling.[40]

3.35 The Australian Council of Engineering Deans and the South Australian Government both called for attention to be given to improving the STEM ability of the workforce, noting that more support should be provided for mid-career entry to STEM occupations.[41] Skills Australia also believes that the pathway from trade to tertiary qualification could be improved, for example, through improved career advisory services and the three year technologist degree provided by the Chisholm Institute, discussed below.[42]

3.36 The Australian National Engineering Taskforce (ANET) has called for an increase in graduates from the three year para-professional degree. ANET argues that this would take the pressure off in-demand professional engineers. Further, these graduates could then move to professional status after a period of time.[43]

3.37 The Chisholm Institute, a Melbourne based VET organisation that also offers a 3 year engineering technologist degree, submitted that the three year course can enable students with a weak mathematics background to enter engineering studies because of course requirements and emphasis.[44] The engineering technologist program focuses on 'technology and systems' whereas the four year professional program focuses on research and development and design.[45] The Australian Council of Engineering Deans suggested that the expansion of the Chisholm Institute into the three year degree could be replicated by other VET providers.[46]

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38 Chisholm Institute, *Submission 42*, p. 6; Skills Australia, *Submission 80*; Australian Council of Engineering Deans, *Submission 65*.

39 Skills Australia, *Submission 80*, p. 10.

40 Government of South Australia, *Submission 43*, p. 6. (On works worth more than $5 million and at least 6 months in duration).

41 Australian Council of Engineering Deans, *Submission 65*, p. 1; Government of South Australia, *Submission 43*, p. 8.

42 Skills Australia, *Submission 80*, p. 2.

43 Australian National Engineering Taskforce, *Submission 73*, p. 18.

44 Chisholm Institute, *Submission 42*, p. 5.

45 Chisholm Institute, *Submission 42*, p. 6;

46 Australian Council of Engineering Deans, *Submission 65*, p. 9.

3.38 The Chisholm Institute recommends that, in accordance with the federal government's response to the Bradley review, the government funding of government supported places should be extended to all domestic students accepted into public higher education Engineering Technology programs accredited by the Tertiary Education Quality and Standards Agency. This will increase the number of students attracted to study the three year engineering technologist degree. The committee believes this idea has some merit, however, notes evidence from the Australian Council of Engineering Deans that many students who attain the three year qualification use it as a spring board to pursue further study to attain professional status.[47] Professor King noted that the three year qualification is very well suited, for example, to maintenance management, however employers are not aware of the capabilities of people with the three year qualification.[48]

3.39 NORTH Link recommended that effective mentoring programs and support for apprentices, especially for small companies with limited human resource management capabilities, may improve retention rates. This is because early problems with the apprentice/employer relationship can be quickly resolved and any decision to leave employment will be carefully considered.[49] NORTH Link calls for a pilot mentoring program to be established.

Committee view

3.40 The committee notes that completion levels among VET students are too low, and that pathways from trade to tertiary skills are not as clearly articulated as they might be. The committee notes Skills Australia's observation that, if everyone who started a VET qualification in an engineering related trade completed it, the skills shortage would be diminished. However, having reached these conclusions, the committee does not consider that it is in a position to recommend a comprehensive suite of responses. Rather, the committee considers that the government should commission a study into the underlying causes of student attrition in VET, with a view to achieving better student outcomes.

3.41 The committee is also cognisant of the important role that para-professional engineers can have in the workforce, and supports the Chisholm Institute's recommendation that where a VET provider offers an accredited three year course this should also receive commonwealth support, in the way that students studying the same course at university are supported.

Recommendation 3

3.42 The committee recommends that the government requests the Australian Workforce and Productivity Agency, or a similar body, to investigate the reason why attrition rates for Vocational Education and Training courses in engineering

47 Professor John Beynon, President and Professor Robin King, Executive Officer, Australian Council of Engineering Deans, *Proof Committee Hansard*, 7 May 2012, p. 36.

48 Professor Robin King, Executive Officer, Australian Council of Engineering Deans, *Proof Committee Hansard*, 7 May 2012, p. 36.

49 NORTH Link, *Submission 81*, p. 5.

trades are so high. Based on the findings of this study, the committee recommends that the government work with Vocational Education and Training providers and the states and territories to improve completion rates.

Recommendation 4

3.43 The committee recommends that the government considers extending funding for government supported places to all domestic students accepted into public higher education Engineering Technology programs accredited by the Tertiary Education Quality and Standards Agency.

University

3.44 Universities offer three year engineering technologist degrees, and the much more popular four year engineering bachelor degree.[50] The committee heard from some witnesses that engineering courses do not produce 'work ready' graduates, and that university engineering programs are do not contain sufficient practical experience.

3.45 During 2001–2010 the overall domestic commencement figures in engineering have increased by 19.5 per cent, from 13 502 in 2001 to 16 131 in 2010.[51] However, the committee notes that completions rose only 12.5 per cent for the same period.

Commencements and completions for domestic engineering students, Bachelor degree and above, by gender[52]

	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

50 Chisholm Institute is the only VET provider who offers the accredited 3 year engineering technologist degree.

51 Skills Australia, *Submission 80*, p. 7.

52 Skills Australia, *Submission 80*, p. 7. (Sourced from DEEWR higher education statistics, unpublished data from the Higher Education Data Cube. Note that commencement cannot be directly compared to completions for determination of retention and attrition).

3.46 In contrast, international student commencing numbers, have increased by 83.4 per cent since 2001, and international students completing university qualifications in engineering have increased by 126 per cent.

Commencements and completions for international engineering students, Bachelor degree and above, by gender [53]

	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

3.47 As indicated on the tables above, completion rates have also improved over time. However, there remain a high proportion of students who commence but do not complete an engineering degree. The data does not provide information about why students drop out of engineering courses. Indeed, some students may merely be transferring from one institution to another, and would be recorded as a dropout from one course, and a commencement at another.[54]

3.48 The reasons why students drop out include lack of passion for engineering, poor academic results and because the course is not what the student expected.[55] Skills Australia believes that completion rates could be further improved if sufficient career advisory services were provided, while others have suggested that better articulated pathways from Vocation Education and Training qualifications to tertiary education would improve both commencement and completion rates.

3.49 Skills Australia has forecast that the total number of projected commencements in engineering courses could increase by 93.4 per cent by 2020.[56]

53 Skills Australia, *Submission 80,* p. 7. (Sourced from DEEWR higher education statistics, unpublished data from the Higher Education Data Cube. Note that commencement cannot be directly compared to completions for determination of retention and attrition).

54 Skills Australia, *Submission 80,* p. 8.

55 Skills Australia, *Submission 80,* p. 9.

56 Skills Australia, *Submission 80,* p. 9.

	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.

Criticism

3.50 The committee received evidence about weaknesses in university engineering courses. For example Professor Trevelyan argued that tertiary education did not prepare engineers, because it was focused on training students to 'write exam papers'.[57] As a result of weaknesses in the current university style of teaching engineering, higher numbers of students drop out and those that do graduate do not, in a general sense, exhibit the attributes that employers require.

3.51 The United Nations Educational, Scientific and Cultural Organisation commissioned academics Emeritus Professor David Beanland and Professor Roger Hadgraft to research and publish their findings on engineering education.[58] The professors argue that university engineering education must be transformed because the:

- attraction rate of students is very low;
- failure and drop-out rate over the course is approximately 40 per cent across Australia;
- attraction of female students into engineering remains low at approximately 12 per cent;
- graduates of engineering programs tend to strong on technical knowledge and deficient on the personal capabilities required to be effective engineers; and
- number of engineering graduates in Australia has been approximately half of the number required in each year of the last decade.

3.52 Professor Hadgraft and Professor Beanland argue that engineering programs should produce graduates who have the right capabilities and attributes to suit the profession. This can be achieved through project based learning and tailoring courses to ensure that students take an active role in learning rather than passively listening to lectures.[59] Professor Beanland observed that mathematical ability had also become an obstacle to students, even though it was becoming less important at a time when

57 Professor Trevelyan, *Proof Committee Hansard,* 27 March 2012, p. 4.

58 Emeritus Professor David Beanland and Professor Roger Hadgraft, *Submission 29*, p. 1. A manuscript has been prepared for publication by UNESCO and is forthcoming.

59 Emeritus Professor David Beanland and Professor Roger Hadgraft, *Proof Committee Hansard*, 7 May 2012, p. 23.

'simulation and computational methods' can be used to solve problems. Further, the relationship between employers and universities was described as 'very deficient' and a greater emphasis on workplace learning needed in engineering programs.[60]

3.53 The Australian Council of Engineering Deans commissioned a study into engineering attrition rates in 2011. The study found that 65 to 70 per cent of students who commence a tertiary engineering program graduate. A five year study of retention is currently on foot.[61]

Improvements

Course structure

3.54 Submitters to the inquiry called for improvements to course material, increased practical experience and flexible learning. For example, some of the reforms proposed by Professors Beanland and Hadgraft include:

- Recognising that mathematical ability is not the only skill required by engineers. (As other skills such as communication, writing, project management and relationship management are also important).[62]
- Accepting a wider range of students, and then streaming them after a two year general engineering course into the three year and four year degrees.[63]
- Establishing a standard two year engineering program in universities across Australia[64]
- Enabling students who have completed the two year general engineering qualification to graduate, and undertake a Diploma of Education. This ensures that teachers in high schools have a background in engineering and technology, not just maths and science[65]
- Reforming engineering teaching so that there is more project based learning and practical, interactive assessment from first year.[66]

3.55 During the Brisbane hearing Ms Megan Motto, Chief Executive of Consult Australia, called for more flexible delivery of university courses, noting that this

60 Emeritus Professor David Beanland, *Proof Committee Hansard,* 7 May 2012, p. 23.

61 Australian Council of Engineering Deans, *Submission 67*, p. 6.

62 Emeritus Professor David Beanland and Professor Roger Hadgraft, *Proof Committee Hansard,* 7 May 2012, pp 26–27.

63 Emeritus Professor David Beanland and Professor Roger Hadgraft, *Proof Committee Hansard,* 7 May 2012, pp 26–27.

64 Emeritus Professor David Beanland, *Proof Committee Hansard,* 7 May 2012, p. 28.

65 Emeritus Professor David Beanland, *Proof Committee Hansard,* 7 May 2012, p. 28.

66 Professor Roger Hadgraft, *Proof Committee Hansard,* 7 May 2012, pp 26–27.

would free up professionals to teach courses and also assist other people in full time employment who wanted to up-skill from a trade to a professional engineer.[67]

3.56 Ms Megan Lilly, representing the Australian Industry Group (AiG), acknowledged that some of the criticisms about universities were valid. For example, a number of AiG's members send engineering graduates to TAFE for a few courses 'to give them the practical know-how'. However, Ms Lilly believes that the natural bias of universities towards academia could be overcome if engineering were taught 'in the context of the application of engineering, the employment of engineering and engagement with companies more broadly.[68]

3.57 The Australian Council of Engineering Deans (ACED) responded to criticisms about the quality of engineering education, arguing that a number of reforms had been implemented in the past five years and that the purpose of university education is not to produce 'work ready' graduates 'because the nature of engineering work is so diverse'.[69] The ACED also noted that engineering academics have a high work load and with reduced staff numbers many struggle to implement known improvements to engineering education.[70]

3.58 In relation to the proposal that the program should introduce identical two year programs across all engineering faculties, the ACED argued that this would not help students who had already decided on the engineering field they wanted to pursue.[71] The ACED also reported, in contrast to Professor Trevelyan's research, that engineering graduates were highly employable. For example, nearly 100 per cent of graduates with mining specialisations obtained work within 3 months, and electrical and mechanical engineering graduates employment rates were approached 'the high 80s and 90s' in percentage terms.[72]

3.59 The ACED called for closer engagement between the engineering industry and universities in the areas of curriculum development, provision of case study and project development, structured training and scholarships.[73] These suggestions are discussed further in Chapter 5.

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67 Ms Megan Motto, Chief Executive, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 16

68 Ms Megan Lilly, Director Education and Training, Australian Industry Group, *Proof Committee Hansard*, 27 March 2012, p. 47.

69 Professor John Beynon, President, Australian Council of Engineering Deans, *Proof Committee Hansard*, 7 May 2012, p. 30.

70 Professor John Beynon, President, Australian Council of Engineering Deans, *Proof Committee Hansard*, 7 May 2012, p. 31.

71 Professor Robin King, Executive Officer, Australian Council of Engineering Deans, *Proof Committee Hansard*, 7 May 2012, p. 36.

72 Professor Robin King, Executive Officer, Australian Council of Engineering Deans, *Proof Committee Hansard*, 7 May 2012, p. 35. Professor King noted there had been a recent 'dip' in employment rates for computer engineering graduates.

73 Australian Council of Engineering Deans, *Submission 67*, p. 8.

3.60 The University of the Sunshine Coast provided a positive example of effective engineering education. The university obtained funding to build a new engineering building from the Education Infrastructure Fund. The facility will enable practical hands on learning for students and include a 'visualisation laboratory' that provides virtual reality modules to enable students to participate in 'engineering design and operational behaviours'.[74] The committee asked the university to respond to concerns raised by other submitters to the inquiry that university teaching is out of date and does not equip students for engineering work. Professor Mark Porter advised the committee that the program had been developed in consultation with industry, and that students were having no difficulty obtaining engineering work:

> [I] think eight students going to graduate from our new program this April, all have jobs already. We have had phenomenal industry support and cooperation on the Sunshine Coast. They have been instrumental in helping to set up our degree, in making sure that it works according to what they want. In the consulting world, virtually every major international civil consultant now has an office on the Sunshine Coast. The majority of them are involved in supporting and advising us. Many have been giving us scholarships and many have been asking us for students for job positions, either part time while they are studying—in fact one of the local construction firms is offering, as a continuing offer, to send any of our third or fourth year students half time and they will give them a half-time job as well. They think fairly highly of what we are turning out. The way that we have developed it has been hand in glove with professional engineers and companies, and I think that is working.[75]

3.61 Professor Porter added that the students in the engineering programs were all employed and that many students had obtained employment at the end of the third year of a four year degree.[76] The committee asked Professor Porter why his evidence contrasted so sharply with the evidence provided by Professor Trevelyan in Perth. Professor Porter considered it might be because the circumstances in the east and west of Australia varied. He also noted that at the University of the Sunshine Coast they try to counsel students, to assist them in determining whether engineering is the right career choice for them.[77]

Completion

3.62 Skills Australia data, discussed in Chapter 5, reveals that while completion rates are improving, there are still a high proportion of students who commence but do not complete an engineering degree. The data does not provide information about why

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74 Professor Mark Porter, Professor of Engineering, University of the Sunshine Coast, *Proof Committee Hansard*, 28 March 2012, p. 32.

75 Professor Mark Porter, Professor of Engineering, University of the Sunshine Coast, *Proof Committee Hansard*, 28 March 2012, pp 32–33.

76 Professor Mark Porter, Professor of Engineering, University of the Sunshine Coast, *Proof Committee Hansard*, 28 March 2012, p. 33.

77 Professor Mark Porter, Professor of Engineering, University of the Sunshine Coast, *Proof Committee Hansard*, 28 March 2012, p. 33.

students drop out of engineering courses, but Skills Australia believes that completion rates could be further improved if sufficient career advisory services were provided, while others have suggested that better articulated pathways from Vocation Education and Training qualifications to tertiary education would improve both commencement and completion rates.

From VET to tertiary qualifications

3.63 Changes also need to be made to assist workers with a trade background to transition to tertiary engineering qualifications. The committee heard that in Europe it is quite common for a person with a trade qualification to pursue an engineering degree, however this is less common in Australia. Mr Chris Fitzhardinge, Engineers Australia, explained to the committee:

> A generation ago, to become an engineer you undertook an engineering degree. Now there are a variety of different pathways, including articulation from a diploma or a certificate qualification through into a degree qualification. In Europe it is quite common for people in the building trades to go on and do a degree in engineering. It is quite uncommon in Western Australia, typically because you lose salary going from being a tradesperson to being a newly qualified engineer. But, where engineering is highly respected within the community, there is strong articulation from the trades into engineering degrees. I think that is a pathway which needs to be encouraged—to take a basic interest or some skills and some background in engineering and then articulate it to becoming a professional engineer.[78]

3.64 Some work has been done in this area, for example The University of the Sunshine Coast is working the Queensland Department of Education and Training and TAFE institutions to provide a seamless pathway from TAFE to university engineering courses.[79]

Committee view

3.65 The committee considers that engineering teaching at university faculties can be improved. However, there are challenges. Professors Beanland and Hadgraft believe that engineering education can and should be radically changed at the university level. The committee notes that the Professors' UNESCO publication is forthcoming, and that the trial of a reformed program commenced at RMIT this year. The committee believes that it is prudent to await the results of the RMIT trial. The committee encourages the Australian Council of Engineering Deans and Skills Australia to track the Royal Melbourne Institute of Technology trial of 'reformed' engineering program, and consider whether the trial's findings have wider application.

3.66 Professor Trevelyan and others have called for more practical training of engineers after graduation. The ACED has stated that better engagement is needed

78 Mr Chris Fitzhardinge, former WA Division President, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 6.

79 Professor Mark Porter, Professor of Engineering, University of the Sunshine Coast, *Proof Committee Hansard*, 28 March 2012, p. 32.

between the engineering industry and universities in the areas of curriculum development, provision of case study and project development, structured training and scholarships.[80] The committee believes that industry committees advising universities need to be more involved in curriculum development on an ongoing basis, and not only when a new course is established. To achieve optimal results, the members of industry advisory committees should be selected on the basis of their direct interaction with graduates in their own organisation. If this is the case, industry representatives will be better able to provide practical, constructive feedback to universities.

Recommendation 5

3.67 The committee recommends that the industry committees advising universities take an active role in ensuring engineering courses are suited to industry requirements. To ensure their effectiveness, committees should include representatives with direct experience supervising and working with engineering graduates.

Conclusion

3.68 In this chapter the committee has highlighted the alarming decline in STEM ability, and provides some recommendations to address this trend. The VET and university pathways to engineering careers have been outlined, and the committee has recommended that completion rates in both streams need to be improved. The committee now turns to consider the impact of the skills shortage on the Australian economy and community.

80 Australian Council of Engineering Deans, *Submission 67*, p. 8.

Chapter 4

The impact of the engineering skills shortage

4.1 In this chapter the committee examines the impact of the engineering skills shortage on infrastructure delivery, economic development, workplace productivity, public sector capability and employment.

4.2 As well as the significant economic costs and project delays outlined in this chapter, diminished engineering capacity can have serious consequences for public safety.[1] Reports from the National Engineering Registration board, cited by Australian National Engineering Taskforce (ANET), indicate that a number of public disasters—some of which have caused loss of life—were the result of 'engineering issues',[2] including the Thredbo landslide, Lane Cove Tunnel collapse and Canberra Hospital implosion. This advice is sobering and is a reminder how important public sector engineering capability is to our communities.

4.3 It is clear to the committee that the consequences of the skills shortage are being felt every day by employers, employees, governments and the community.

Impact on economic development and infrastructure delivery

4.4 Entrenched engineering skills shortages, depending on their severity, are likely to reduce investment and productivity growth in Australia, and result in poor quality or delayed construction projects. The resulting economic effects are felt in sectors as diverse as resources, roads, manufacturing, construction and the development of infrastructure.[3]

4.5 Engineers Australia listed the general impacts of the engineering skills shortage as including:

- Increases in wages of engineers and others with engineering skills
- Reduced retention rates, as employers with a skills shortage offer higher and higher wages
- The introduction of skills that are not 'embedded in the local culture' or 'within that particular industry'
- Cost overruns and increases in the cost of labour (up to 20 per cent of total project cost)
- Loss of engineering activity to the economy

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1 Australian National Engineering Taskforce, *Submission 73*, p. 22.

2 Australian National Engineering Taskforce, *Submission 73*, p. 22.

3 Skills Australia, *Submission 80*, p. 16.

- The loss of projects to overseas, as costs force cancellations, and
- Reduction in the quality of project outcomes.[4]

4.6 Representing professional engineering firms, Consult Australia anticipated that unless skills shortages are addressed, there will be sustained negative impacts for both the private and public sector. Ms Megan Mott, Chief Executive Officer, observed that government is negatively impacted not just as a client, but also as a policy maker:

> I say that because a lot of the significant challenges that governments, not only in Australia but across the world, face in population and demographic change, poverty, climate change mitigation and adaptation and stability of political environments will require significant engineering input into their long-term solutions. If there are not enough engineers in the market in Australia, particularly in our regional significance but also worldwide, that will have significant implications for delivery of solutions for those problems.[5]

4.7 The Business Council of Australia (BCA) released a report into Australia's capital investment on 7 June 2012.[6] The report points to the $921 billion pipeline of investment in resources, energy and economic infrastructure, warning that Australia risks not being able to efficiently deliver these projects because it is becoming a 'high-cost' and therefore 'high-risk' place to invest. Further, the BCA reported that Australia's low labour productivity has reduced its competitiveness, and in relation to skills shortages, the BCA concludes that Australia must train or attract 'high quality project planners and managers' in order to 'overcome major skills shortages'.[7]

4.8 A lack of qualified applicants can mean that engineers without all the necessary skills for the job are being hired.[8] This can result in inadequate planning and 'trial and error' problem solving, which can then lead to mid-project changes which put pressure on timelines and costs. Alternatively, some projects will not proceed at all if adequate staff cannot be recruited.[9] Engineers Australia reported that nearly

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4 Mr Christopher Fitzhardinge, former WA Division President, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 2.

5 Ms Megan Mott, Chief Executive Officer, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 15.

6 Business Council of Australia, *Pipeline or pipe dream? Securing Australia's investment future*, 7 June 2012. Available online: http://www.bca.com.au/Content/101987.aspx (accessed 12 June 2012).

7 Business Council of Australia, *Pipeline or pipe dream? Securing Australia's investment future*, 7 June 2012, p. 17.

8 This can have particular impacts on construction and infrastructure programs. For example, the shortage of consulting surveyors has a particularly pronounced impact due to the small number of specialists with such qualifications, and the high demand for surveying skills during conceptual and detail design in major infrastructure projects, and later during the construction phase: Consulting Surveyors National, *Submission 37*.

9 Engineers Australia, *Submission 67*, pp 6–7.

30 per cent of respondents to a 2010 survey 'indicated that the skills shortages led to major problems including project delays and cost increases'.[10]

4.9 The committee received evidence suggesting that a number of infrastructure projects across Australia experience delays and cost blow outs. The Senate Foreign Affairs, Defence and Trade Committee recently reported that 'for many years the Australian Defence Organisation's program for procurement of major capital assets has been dogged by delays and cost overruns'.[11] Professor Trevelyan explained that, although they are better publicised, it is not just public sector projects that fall victim:

> BHP have a public record of major project failures. They have the HBI plant in the North-West—$3.6 billion. It was sold for scrap metal. There is the Ravensthorpe nickel project—$3.3 billion. It was sold to a Canadian company for around $250 million, I believe. I would have to check those actual figures. They are on the public record, but there are many, many other project failures which are occurring every day which are not on the public record. As I have said in my submission, the Australian Department of Defence cops a lot of criticism for its failures, which are public, but you will find just as many if not more failures in the private sector if you open the lid and look hard enough. The difficulty is that the private sector has an interest in covering up these failures, time and time again, and that is reflected in all of the information that has come my way.[12]

Scoping

4.10 Poor scoping at the initial project stages can add to cost blowouts and delays. For example, in 2011 the Association of Professional Engineers, Scientists and Managers Australia (APESMA) warned that the repair bills for the Queensland floods could blowout by up to 20 per cent as a result of poor scoping, due to a shortage of engineers.[13] The committee heard that poor scoping can lead to adversarial relationships and poor project outcomes. This in turn can lead to legal disputes arising from project failures. For example, Consult Australia advised the committee that $6 billion a year is 'wasted on disputation in projects across Australia'.[14] The committee notes that much of this expense is borne by taxpayers, as many, if not all, large projects are commissioned by governments.

4.11 Proper scoping requires specialist engineering expertise, as the task involves:

- identification of the fundamental objectives of the project;

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10 Engineers Australia, *Salary and Benefits Survey 2010*, Canberra, February 2011, p. 5.

11 Senate Foreign Affairs, Defence and Trade References Committee, *Procurement procedures for Defence capital projects – Preliminary Report*, 15 December 2011, p. 1.

12 Professor James Trevelyan, *Proof Committee Hansard*, 27 March 2012, p. 12.

13 Cited in Consult Australia, *Submission 66*, p. 14.

14 Ms Megan Motto, Chief Executive, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 22.

- development of the principal's project requirements to achieve the fundamental objectives, taking into consideration stakeholder and end user requirements and risk;
- deciding upon the most appropriate contractual model and risk profile to deliver the project; and
- inclusion of those requirements into appropriate contractual scope documents for the project.[15]

4.12 In a 2008 survey conducted by Blake Dawson, 83 per cent of respondents reported that skills shortages negatively impacted their ability to develop scope documents to an adequate standard.[16] More than half of respondents felt that their project was 'inadequately scoped' before it went to tender on the market.[17] Mr Phillip Dingeldei, Chairman, Consulting Surveyors National, observed that when adequate scoping has not been conducted by government, the costs to business of responding to a tender are very high.[18]

4.13 The Hickory Group, one of Australia's largest apartment builders with origins in Melbourne, observed that diminished engineering capacity in government meant that many government departments were poorly equipped to participate fully in scoping exercises. This meant that there were more contractual disputes during the life of the project, and the end product cost more and was subject to more changes. Hickory suggests that the preferred approach is for government to be involved in the 'scoping of a project with a number of selected preferred contractors, an exploration of capabilities, and a finalising of the scoping of the project during this process', after which a preferred contractor is identified.[19]

Delay or postponement of projects

4.14 Delay or postponement of infrastructure projects has a huge impact on the community. Engineers Australia reported that a large number of projects are delayed because of difficulties recruiting expert skilled engineers.[20] For example, the Australian Institute of Traffic and Planning Management advised the committee that the loss of productivity as a result of peak hour congestion traffic is $1.2 billion a year

15 Blake Dawson, *Scope for Improvement*, 2008, cited in Australian National Engineering Taskforce, *Submission 73*, p. 20.

16 Cited in the Australian National Engineering Taskforce, *Submission 73*, p. 20.

17 Cited in the Australian National Engineering Taskforce, *Submission 73*, p. 20.

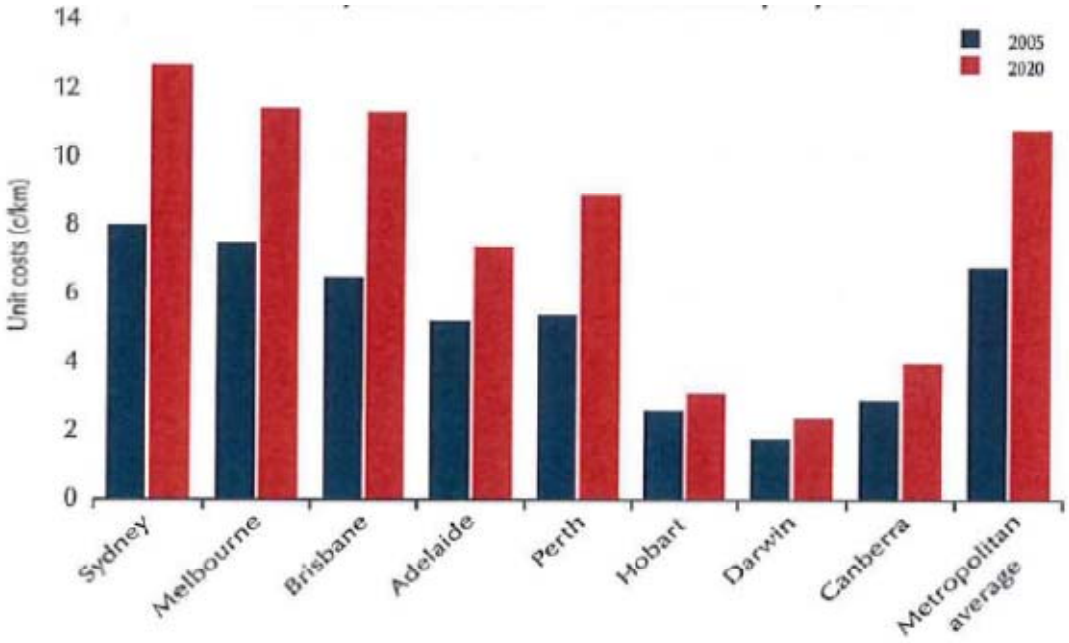
18 Mr Phillip Dingeldei, Chairman, Consulting Surveyors National, *Proof Committee Hansard*, 7 May 2012, p. 45. In the example provided during the hearing, the company was advised simply that a pipeline needed to be built from A to B. No further detail was provided.

19 Hickory Group, *Submission 75*, p. 3.

20 Mr Brent Jackson, Director of National and International Policy, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 2.

in Perth alone. This is expected to grow to $2 billion by 2020.[21] The projected impact of delayed road projects is severe, and this is illustrated by the table on the following page which sets out the estimated urban traffic and congestion cost trends for Australian cities.

Average unit costs of congestion for Australian metropolitan areas – current and projected



Source: Department of Infrastructure and Transport [22]

4.15 The effects of the skills shortage are felt more acutely because of the 'lumpy' workload of a lot of government work, and this can also cause delays. During the Canberra hearing Ms Donna Findlay from Roads Australia explained the problem, and called for the states and the commonwealth to work together:

> [We] think the states and the federal government need to come together and have clear transport plans so that you can see where the investment lies. The contracts of a lot of big projects are being let at the same time. We will talk about an A-team of engineers and B-team of engineers. Your A-team go off and they are all working on this project and then another big project comes up and the B-team are working on that project. Another project comes up, so you start to have all these great engineers on one project but not on the other projects. We would like to see all the states and the federal government come together and have a clear pipeline of road projects for the future.[23]

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21 Mr Craig Woolridge, Australian Institute of Traffic Planning and Management, *Proof Committee Hansard*, 27 March 2012, p. 32.

22 Department of Infrastructure and Transport, Additional Information Received, 19 April 2012. The graph was obtained from BTRE, Working Paper 71, p. 16.

23 Ms Donna Findlay, Policy Director, Roads Australia, *Proof Committee Hansard*, 7 May 2012, p. 2.

4.16 Roads Australia pointed out that communication between the states is often inadequate, resulting in major projects being programmed at the same time, so that companies cannot field their best people, who are otherwise occupied, to do the job.[24] To address this problem, Roads Australia has taken a proactive approach, setting up the Roads Australia Pipeline on its website for government agencies to input plans for the next 12 to 18 months.[25]

4.17 The national infrastructure pipeline is anticipated to address part of this concern, as well as the federal government's National Infrastructure Construction Schedule which commenced in May 2012 and is discussed in Chapter 4.[26] However it is too early for the committee to assess the effectiveness of this policy.[27]

Impact on employment

4.18 Skills shortages have an impact on employment in a number of ways. The most significant impact is on training and workforce development. Companies have focused on meeting the requirements of the boom. The Australian National Engineering Taskforce reported that companies have responded to capacity constraints by increasing reliance on contractors and external consultants rather than building capacity among the existing workforce.[28] This affects general workforce training and standards across the engineering profession.

Retention

4.19 The mining boom in Queensland and Western Australia has driven up demand for workers with engineering and related skills which, because of the skills shortage, have been recruited to a significant extent from the manufacturing, power and traffic sectors. This demand exacerbates skills shortages in other engineering sectors, and creates frustration when recently trained apprentices depart for the mines.

4.20 The committee heard that a large number of engineers were migrating from the eastern states to Queensland and Western Australia. The Chamber of Minerals and Energy Western Australia observed that 11 per cent of population growth in Western Australia was from interstate migration, and this 'historically is a very, very high number'.[29]

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24 Mr Dan Reeve, Capacity Chapter Member, Roads Australia, *Proof Committee Hansard*, 7 May 2012, p. 2.

25 Mr Dan Reeve, Capacity Chapter Member, Roads Australia, *Proof Committee Hansard*, 7 May 2012, p. 2.

26 www.nics.gov.au (accessed 4 June 2012)

27 Department of Infrastructure and Transport, *Submission 62*, p. 21

28 Australian National Engineering Taskforce, Engineers Survey, March 2010, p.14.

29 Mr Bruce Campbell-Fraser, Chamber of Minerals and Energy WA, *Proof Committee Hansard*, 27 March 2012, p. 25.

4.21 Roads Australia advised the committee that once workers attain a higher level of certification 'they are off to the mining industry'.[30] Other submitters reported a similar trend.[31] The Australian Industry Group observed that the mining boom has created a situation where the manufacturing sector trains apprentices who, once fully trained, are subsequently attracted to the resources sector. The impact on the manufacturing sector is significant, and creates a disincentive to train more apprentices:

> This places enormous strain on the manufacturing sector to retain a highly skilled workforce at the very time the sector is under considerable competitive pressure from overseas and is in a period of structural adjustment. The resultant reluctance by manufacturing enterprises to engage apprentices who subsequently depart to the resources sector contributes to the existing skills shortage of engineering trades.[32]

4.22 This observation was echoed by Manufacturing Skills Australia, who reported that manufacturing workers are 'poached' by the construction sector.[33]

4.23 The impact of the skills shortage is also exacerbated for local governments which tend to have fewer resources but must compete with the mining and private civil construction sectors for engineers.[34] Local governments have a large and diverse set of responsibilities. Local Government Managers Australia noted that local government engineers 'administer and supervise the design, construction and maintenance of roads and bridges, pedestrian and cycle facilities, regional airports, buildings, storm water drainage, recreational facilities, parks and waste disposal'.[35]

4.24 The Institute of Public Works Engineering Australia (IPWEA) represents engineers who provide engineering services to local communities through local governments. During the Canberra hearing the committee asked about the impact of the skills drain, and the National President, Mr Di Iulio explained that some local councils had excellent engineering capability but other councils were struggling:

> With the number of highly skilled people now being pulled out of our industry into the mining industry and so forth, having people who are qualified and who can actually make those appropriate decisions at the right time are running a bit thin.[36]

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30 Mr Dan Reeve, Capacity Chapter Member, Roads Australia, *Proof Committee Hansard*, 7 May 2012, p. 2.

31 See for example, Consulting Surveyors National, *Submission 37*, p. 2.

32 Australian Industry Group, *Submission 58*, p. 1.

33 Manufacturing Skills Australia, *Submission 25*, p. 5.

34 Local Government Managers Australia, *Submission 57*, p. 4.

35 Local Government Managers Australia, *Submission 57*, p. 2.

36 Mr Paul Di Iulio, National President, Institute of Public Works Engineering Australia, *Proof Committee Hansard*, 7 May 2012, p. 59. See also *Submission 64*.

4.25 However, it is worth bearing in mind that even mining companies, those to whom skilled workers most commonly are attracted, sometimes struggle to keep staff. The Association of Mining and Exploration Companies (AMEC) reported that most of their members are small companies who struggle to retain quality staff, as many move to larger companies once they have developed their skills. Mr Justin Fromm explained:

> [AMEC's] membership is the explorers, the emerging miners, the smaller end of town: small numbers of staff, engineers are few and far between. The anecdotal stories that we hear when we talk to our members are that the bigger companies drag through those engineers. They will stay with the smaller companies for a little while to get their careers started and then they will be drawn off to the larger companies. From our point of view, the difficulty is that the little companies are struggling with their engineering skills. The big companies can take care of themselves with respect to their graduate programs—and I do not have a full understanding of those programs—but our issue is for the little companies trying to access those same engineering skills for their projects.[37]

4.26 As discussed in Chapter 2, many companies are not interested in recruiting graduates. JSM Appointments, a recruitment company based in Western Australia, reported that among those graduates who do secure employment, there is a high turnover as they seek better opportunities elsewhere in the industry, and higher level roles being offered by competing firms to lure them into the company.[38]

4.27 Retention in the context of an aging workforce is discussed in Chapter 5.

Impact on public sector capability

4.28 The move away from in-house engineering in the public sector has had a noteworthy impact on the quality of engineering-related public sector outcomes.

4.29 Consult Australia expressed strong concerns to the committee about the decline in public sector engineering capability. While Consult Australia did not believe that there will be, or should be, a return to large public works departments in government, it considers that government capability can be improved because:

> There is…a significant lack of skill sets in high-level procurement—people who are able to develop scopes of work, develop conceptual arrangements for projects, assess tenders in government and then manage those tenders and manage those jobs with the appropriate allocation of risk as opposed to complete risk shifting. There is an innate conservatism because there is lack of confidence in the skill set to manage and understand risk on projects.[39]

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37 Mr Justin Fromm, Senior Policy Officer, *Proof Committee Hansard*, 27 March 2012, p. 18.

38 JSM Appointments, *Submission 34*, p. 4.

39 Ms Megan Motto, Chief Executive, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 16

4.30 The Australian Institute of Traffic and Planning Management reports that as a result of skills shortages, particularly in Queensland and Western Australia, organisations are now employing staff with minimal traffic and transport skills, and a number of experienced staff will shortly retire. At the same time, demand for traffic and transport infrastructure is increasing.[40]

4.31 Following the reduction of engineering teams in government agencies across Australia in the 1980s and 1990s, Engineers Australia inquired into the impact of the loss of engineering expertise in a report released in 2000 titled, 'Government as an informed buyer'.[41] Engineers Australia warned that as a consequence of the reduction in expertise, governments may be unable to manage engineering contracts because contracting staff lacked the necessary technical expertise. Further, contracting staff may also be unable to adequately assess the engineering competencies of contractors and subcontractors.[42]

4.32 The Australian National Engineering Taskforce 2010 Survey reported some concerning trends in public sector engineering capability. Quotes from anonymous respondents reveal the acute skills shortages in government agencies:

> Over the last two years, our Engineering department has dropped from a peak of over 100 people to just 16. We have barely enough people to maintain existing product, without considering any new projects.[43]
>
> ...
>
> We have insufficient qualified people to make effective judgement calls regarding the expenditure of public money. We have a large number of partially qualified people doing the job of senior engineers.[44]
>
> ...
>
> There are a number of specialist vacancies that have been very difficult to fill, despite national and international searches - in some cases we have compromised by appointing relatively inexperienced engineers, with a view to an intensive skills development program. In the interim we have a greater reliance on consultants to fill the gap. Challenge will be to keep the employees once trained up, particularly given the market environment.[45]
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> ...

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40 Australian Institute of Traffic Planning and Management, *Submission 39*, p. 2.

41 Athol Yates, Government as an Informed Buyer, Recognising technical expertise as a crucial factor in the success of engineering contracts, Institution of Engineers Australia, Canberra, 2000.

42 Engineers Australia, *Submission 67*, p. 12.

43 Australian National Engineering Taskforce, Engineers Survey, March 2010, p. 3. Available online: http://www.anet.org.au/wp-content/uploads/2010/03/survey_report_summary.pdf (accessed 4 June 2012).

44 Australian National Engineering Taskforce, Engineers Survey, March 2010, p. 4.

45 Australian National Engineering Taskforce, Engineers Survey, March 2010, p. 4.

> 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.[46]

4.33 In 2003 Engineers Australia released a policy on government purchasing. In this document Engineers Australia set out recommendations and advice to government to promote the need for government to properly address technical and engineering risks when purchasing engineering, information technology and other technical products.[47]

4.34 Engineers Australia warned the committee that government cannot rely simply on contract management experience in engineering procurement, arguing that 'these skills are vital, but are not a substitute for technical engineering expertise'.[48]

4.35 The Australian National Engineering Taskforce, of which Engineers Australia is a member, supports these observations, reminding the committee that the Orgill report into the Building the Education Revolution (BER) identified only the Queensland Government as an informed purchaser of capital works projects.[49] The committee is very familiar with these conclusions, as it also conducted an inquiry into the BER and was alarmed at the waste of resources through mismanagement, particularly in New South Wales.[50]

4.36 Finally, the committee notes that filling positions that do still exist in the public sector is difficult, with recruiters facing the same challenges as their private sector counterparts. Mr Craig Woolridge, representing the Australian Institute of Traffic Planning and Management explained to the committee the difficulty in recruiting quality staff in the public sector:

> Within government organisations, whether they be state or local government ones, we are seeing significant problems in recruiting staff. In my role at the department of transport I have a 25 per cent vacancy rate. While we have tried recruiting locally and nationally, that has failed. Primarily, the people that we after have 10-years-plus experience. Getting

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46 Australian National Engineering Taskforce, Engineers Survey, March 2010, p. 4.

47 Engineers Australia, *Submission 67*, p. 12.

48 Engineers Australia, *Submission 67*, p. 12.

49 Australian National Engineering Taskforce, *Submission 73*, p. 21.

50 Education, Employment and Workplace Relations References Committee, *Primary Schools for the Twenty First Century Program*, Final Report, March 2011.

> graduates is a bit easier. Obviously, some companies and governments have taken advantage of the slowdown in other countries through the GFC. We would see that as a temporary initiative and, obviously, as economies around the world do pick up those opportunistic pick-ups will not be there in the numbers that they have been in recent times.[51]

Committee view

4.37 It is clear that public sector capability to act as an informed purchaser and adequately scope and oversee large infrastructure and construction projects has been severely eroded over the past decades.

4.38 The committee accepts that the federal government, along with state, territory and local governments have decided over recent decades to outsource much of their engineering skills. However, a role that government cannot outsource is quality decision making, efficient use of taxpayer money and properly scoped requests for tender. For this reason the committee believes that governments of all levels should enhance their engineering capacity.

4.39 The committee agrees with a recommendation made by Engineers Australia that senior technical specialist roles could be created to provide a technical career pathway (in tandem with traditional managerial/generalist career pathways) for those seeking to build specialist knowledge while continuing to enjoy career progression in the public sector. This would reduce the incentive for experienced engineers to move to the private sector.[52]

4.40 The committee notes the recommendations made by the Australian National Engineering Taskforce that:

- the Federal Government increase its engineering capacity to ensure that it is an informed purchaser of engineering infrastructure, in line with the recommendations of the Building the Education Revolution Implementation Taskforce, and establish a small Procurement Unit, residing within the Department of Finance and Deregulation.
- the Federal Government, through that Procurement Unit conduct an audit of its procurement capability across all agencies.
- the Federal Government take to the relevant Standing Council of COAG a proposal that all States and Territories conduct their own audit, to ensure that the community is receiving value for-money in infrastructure delivery; and
- that following this audit, the Federal Government put in place a series of requirements for baseline engineering competence and capacity in

51 Mr Craig Woolridge, National Vice President, Australian Institute of Traffic Planning and Management, *Proof Committee Hansard*, 27 March 2012, p. 29

52 Engineers Australia, *Submission*, p. 13.

jurisdictions, including local government, for the management of projects funded by the Federal Government.[53]

Recommendation 6

4.41 The committee recommends that the government consider creating senior technical engineering roles in the Australian Public Service. This measure would ensure that highly qualified technical engineers may continue to build upon specialist knowledge while enjoying career progression in the public sector.

Recommendation 7

4.42 The committee recommends that the Department of Finance and Deregulation reviews the Commonwealth Procurement Guidelines to ensure that the government is an informed purchaser of engineering infrastructure and that appropriate advice is provided in relation to procurement decisions that require specialist technical knowledge.

Conclusion

4.43 The engineering skills shortage has a significant impact on Australia's economy, workforce, infrastructure and project delivery. The 82 submissions received by the committee are a testament to how the engineering skills shortages are impacting a whole range of groups in Australia. The committee received submissions from industry groups, consulting firms, employer groups, governments, universities and training providers. In this chapter the committee has provided a snapshot of the effect that the engineering skills shortages are having.

4.44 The shortage has resulted in poorly conceived and poorly delivered projects by both the public and private sectors, culminating in cost blow outs and delays. In part this is because of a decreased engineering capability in the public sector – which impacts on the quality of tender selection and indeed even on the request for tender proposal itself. However, the committee also heard that poorly delivered projects are also a feature of private enterprise.

4.45 The demand for engineering skills by the mining and resources industries has impacted on the capacity of other sectors, as engineers migrate to more lucrative fields. The manufacturing sector and local government sectors are particularly impacted by this trend.

4.46 The skills shortage has serious flow on effects for the training of engineers. Many industries feel like they do not have time to train graduates, particularly as graduates with more than three or four years' experience are highly employable and likely to move to another job. Training and development for experienced staff can fall by the wayside amidst high workloads and low retention rates, further worsening an already deficient situation.

53 The Australian National Engineering Taskforce, *Submission 73*, p. 47.

4.47 Having established the depth and breadth of the problem that engineering skills shortages pose, the committee now turns to consider its specific causes and what might be done to address them.

Chapter 5

Addressing the causes of the skills shortage

Introduction

5.1 Chapter 3 dealt with the structural factors in the career pathway of an engineer that have helped to bring about the current skills shortage, and has proposed some potential measures to remedy them. Chapter 4 examined the impacts of the shortage. In this Chapter the committee continues to explore the causes of the skills shortage and how they might be addressed. This necessitates an examination of how graduate training and recruitment can be improved, how engineers can be encouraged to join and remain in the engineering profession, and how the profile of engineers in the community can be promoted.

5.2 Engineers Australia acknowledged the difficulties inherent in the task of addressing skills shortages. During the Perth hearing Mr Brent Jackson, Director of National and International Policy, advised the committee:

> Our work in engineering skills shortages shows that there are no simple answers and that there is no simple remedy. Shortages are not uniformly spread across locations, engineering specialisations or industry sectors. The problem is complex and so too are the solutions.[1]

5.3 Consult Australia agreed with this assessment. Ms Megan Motto, Director, told the committee during the Brisbane hearing that there was no simple solution:

> It is a complex issue, which unfortunately means there is no silver bullet. There are both multifaceted reasons for the skills shortages and also potential solutions to the skills shortages.[2]

5.4 Nevertheless, as the examples in this chapter will testify, the committee was impressed by the considerable measures that governments, universities and the industry have implemented to respond to the challenges they face, and to plan for the future.

Graduates

Graduate numbers

5.5 The committee received conflicting evidence from other witnesses about whether there are too many or insufficient engineering graduates. Some witnesses, such as Engineers Australia and the Australian Council of Engineering Deans, believe that there are insufficient numbers of engineering graduates.[3] Engineers Australia has

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1 Mr Brent Jackson, Director of National and International Policy, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 1.

2 Ms Megan Motto, Director, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 15.

3 Engineers Australia, *Submission 67*, p. 10.

argued that engineering must compete for students who have strong mathematical and scientific skills with medical and actuarial courses at universities.[4] To address the skills shortage in engineering, these organisations suggest a number of initiatives to improve the numbers of students studying engineering at university.[5]

5.6 Skills Australia estimated that 7400 new engineering professional and management jobs will be created annually over the next five years, and this number is only slightly lower than the recent figures of domestic student graduations (8,521 in 2010).[6] On the face of it, this would appear to suggest that there are sufficient graduates to meet the demand.

5.7 Conversely, other witnesses such as Professor James Trevelyan point to data that indicates there are too many engineering graduates.[7]

5.8 The committee also observes that there can be little benefit in increasing the number of engineering graduates without a corresponding increase in graduate positions, a subject it deals with below.

Work readiness

5.9 Making potential engineering workers 'work ready' is critical to addressing the skills shortage. The committee heard that a significant number of applicants, while being qualified engineers, were unsuitable for the particular positions on offer. Significant numbers of these were said to have come onto the labour market through general skilled migration programs.[8]

5.10 Professor James Trevelyan argues that the problem lies with engineering graduates not being 'work ready' and therefore not meeting the needs of employers.[9] This view is supported by a survey conducted by DEEWR where employers reported that:

- Chemical engineering graduates 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; and

4 Ms Jackson, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 7.

5 Australian National Engineering Taskforce, *Submission* 73, p. 7; Australian Council of Engineering Deans, *Submission 65*.

6 Skills Australia, *Submission 80*, p. 8.

7 Professor James Trevelyan, *Submission 31*, p. 1.

8 Skills Australia, *Submission 80*, pp 12–13.

9 Professor James Trevelyan, *Submission 31*, p. 1.

- 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.[10]

5.11 This was consistent with evidence from Skills Australia, who submitted that 80 per cent of employers surveyed in 2011 sought to recruit staff with 5 to 10 years' experience.[11] The Australian Council of Engineering Deans observed that, while many companies do provide good graduate programs:

> [In] the global environment of contract-based engineering services, and price based competition, Australian companies will tend to seek to employ experienced personnel **from wherever they can be sourced**, and minimise training costs. One result of these imperatives is that there can simultaneously be high levels of graduate unemployment and shortages of engineers.[12]

Graduate programs and cadetships

5.12 Professor Trevelyan reported to the committee that his research indicated the training provided to graduate engineers was generally extremely poor. The best outcomes were experienced by graduates who secured a position that was part of a graduate program.[13]

5.13 Traditionally, only very large companies provided graduate programs and cadetships, and the bulk of entry level training was provided by the public sector. As engineering skills were increasingly outsourced, it has a taken many years for the industry to pick up on this responsibility. The committee heard that in the past many companies simply did not have the time or resources to invest heavily in graduate programs.

5.14 Mr Bruce Campbell-Fraser, Executive Officer at the Chamber of Minerals and Energy Western Australia agreed with this assessment, telling the committee that graduate programs were still important but were very expensive, particularly if the individual was 'poached' by a competitor after a couple of years:

> It is true that the best potential employee is someone who has previous experience in the role you are offering. Five to eight years' experience would be ideal, so that person might be undertaking a role for another company or another organisation or industry. Companies are putting a fair bit of effort into identifying and working with students, particularly mining engineering and petrochemical engineering students, while they are in university. As you would be aware, many of these courses require exposure and work experience through internships so companies are getting a look at potential employees and drafting a potential employee who is showing the requisite skills and ability at university into their workforce and graduate

10 Skills Australia, *Submission 80*, p. 14.

11 Skills Australia, *Submission 80*, p. 14 (citing DEEWR Research).

12 Australian Council of Engineering Deans, *Submission 67*, p. 3. Emphasis in original.

13 Professor Trevelyan, *Proof Committee Hansard*, 27 March 2012, p. 11.

> program. The chamber has done a bit of work with Professor Trevelyan over some of his research and I am very familiar with much of that. But there is that bit of skills gap between what a graduate can offer, particularly an international student graduate who may have some language issues, and what a company's requirements are.
>
> I think larger companies, certainly the ones that we represent, are very focused and have a solid graduate program. Graduate programs, like recruitment processes, are expensive and you do want to make sure you get the right person, retain them in the long run and invest in their skills and ability. So that is what companies are focused on. The intern program that runs at university is proving quite a success. It would be great if there were more exposure.[14]

5.15 Worley Parsons, the largest employer in Australia of engineers and project delivery personnel, considers that it takes five years of training and support before a graduate is independent and useful.[15] Manufacturing Skills Australia, a government funded Industry Skills Council, suggested that enterprises dependent on government contracting are reluctant to employ graduates or cadets when funding is tied to electoral cycles usually three years or less. When it takes three to five years to train an engineering graduate, employing graduates is a real risk when there is no certainty of employment.[16]

5.16 Australia's Chief Scientist, Professor Ian Chubb, who is the former Vice Chancellor of the Australian National University, advised the committee that he believed graduates were of good quality, and it was inadequate for industry to simply blame government or universities if they did not believe graduates were of a sufficient standard:

> Let me start by saying that I was once at a meeting with employers and they were telling me that graduates were useless for four years. I find that really remarkable since I think that today's graduates are substantially smarter than graduates of my generation were in a whole lot of ways. So I said to them, after they had been at it a little while: 'Look, I've been around a long time. I know the people who employed you said the same thing about you that you are now saying about today's graduates. What have you done about it in the meantime?' And the view was: 'Nothing. It's the government's responsibility.' I do not share that view. I think it is a shared responsibility.[17]

5.17 Consult Australia argues that it is difficult for consultancy engineering firms to employ graduates – which typically requires an investment of 5 years – when there

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14 Mr Bruce Campbell-Fraser, Executive Officer, Chamber of Minerals and Energy Western Australia, *Proof Committee Hansard*, 26 March 2012, p. 25.

15 Ms Verena Preston, Director, Global Consulting Practices, Worley Parsons, *Proof Committee Hansard*, 28 March 2012, p. 16.

16 Manufacturing Skills Australia, *Submission 25*, p. 3.

17 Professor Ian Chubb, Australia's Chief Scientist, *Proof Committee Hansard*, 7 May 2012, p. 13.

is not a pipeline of projects that the company knows are coming up. Ms Megan Motto explained that:

> The issue for firms is to provide a good pipeline of projects for those graduates to work on so that they end up being five- or 10-year qualified or experienced. That is something that our industry is unable to do if there is not a solid and assured pipeline of projects from governments. So government spending decisions and good information regarding pipelines of projects is significant here in providing the comfort level that the private sector needs to employ these people and know that they are still going to have useful work for them to do in two, three, five, 10 years time.[18]

5.18 Nevertheless, the committee is cognisant of data provided by the Australian Bureau of Statistics that, at a time of apparent skills shortage in the industry, 33 per cent of the engineering workforce is either unemployed or not employed 'in a manner commensurate with their training' and who 'could not be said to be productively used'.[19] Consult Australia suggested this could be in part because some engineering professions are in less demand then they were ten years ago (for example, water engineers). Secondly, Consult Australia observed that graduates with a background in a language other than English often have poor English language skills, even though they studied in Australia. The committee was surprised to hear that a student could graduate from an engineering program at an Australian university with poor language skills. Mr Jonathan Russell, Senior Policy Adviser at Consult Australia, reported that he:

> …had this conversation with universities recently and they all go on to say things such as that it is perhaps not the written message that they assess but their level of understanding of the concepts required to graduate. But the employers need a much higher level of communication skills so they can actually deal with clients and write briefs and write reports. A lot of these people are probably being set up to fail by the migration system where the migration system sets a bar for language skills for independent migration. It was until recently IELTS level 5. What we hear from employers is that IELTS level 7 is probably the bare minimum to be able to function without too much supervision in terms of their communicating with clients. That is part of the problem. I do not think you will see too many domestic graduates driving taxis.[20]

5.19 Some larger companies that employ engineers have begun to invest in graduate programs – realising that there are not enough engineers in the marketplace. General Electric (GE) runs a graduate program with 20 positions each year. Mr Kirby Anderson, Policy Leader Energy Infrastructure, explained why GE had decided to invest in graduates:

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18 Ms Megan Motto, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 20.

19 Australian National Engineering Taskforce, *Submission 73*, p. 53. (Citing Australian Bureau of Statistics 2006 census data).

20 Mr Jonathan Russell, Senior Policy Adviser, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 21.

> We have been traditionally in the business of attracting staff primarily with that five or greater years experience and then going about the business of retaining them. We are attracting the staff which our customers may also be seeking to attract as well. This is a real commitment. We need to also be in the business of developing and retaining staff rather than simply attracting and retaining those staff in Australia.[21]

5.20 The GE graduate program provides rotation throughout different business areas, and mentoring support. Mr Anderson acknowledged that GE's graduate program was a risk for the company, as essentially there were no guarantees the graduates would stay, once they had received a 'passport for them to work across the industry'.[22]

5.21 Ms Verena Preston, Director, Worley Parsons, described the company's graduate program to the committee:

> As a program that covers a range of technical as well as non-technical skills, we would expose them to all aspects of being able to deliver a project. Obviously, we want them in line with becoming a registered engineer. It is a really important piece of that. We give them buddies and mentors. There is a whole organisation and budget to complete that.[23]

5.22 Professor Trevelyan submitted that industry needed to create a cost code for training newly graduated engineers, so that senior professionals had a way to account for the time taken to mentor and support a new worker:

> One of the questions that I ask and have asked consistently over the last few years when I visit a company and talk to them about the training program is: 'When a senior engineer has to help a junior engineer, what charge code do they have? How do they account for the time they spend doing that?' Very few companies even have a charge code. So the senior engineers are put in the position where they have to take time out. They either have to charge it to a project which they are working on or do it effectively in their own time. There is so little emphasis and so little value placed on workplace training.[24]

5.23 The committee believes that the creation of a cost code for senior engineers to use to account for time spent training new engineers is an excellent suggestion, and its implementation may serve to improve outcomes for graduates. One of its principal virtues is that it would put a dollar figure on training and development, and in doing so give employers a better handle on the quantum of investment necessary to bring a new recruit up to speed and keep them there.

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21 Mr Kirby Anderson, Policy Leader Energy Infrastructure, General Electric, *Proof Committee Hansard*, 28 March 2012, p. 9.

22 Mr Kirby Anderson, Policy Leader Energy Infrastructure, General Electric, *Proof Committee Hansard*, 28 March 2012, p. 10.

23 Ms Verena Preston, Director, Global Consulting Practices, Worley Parsons, *Proof Committee Hansard*, 28 March 2012, p. 16.

24 Professor Trevelyan, *Proof Committee Hansard*, 27 March 2012, p. 11.

Committee view

5.24 Despite some criticisms of graduate programs, the committee believes that properly funded and supported graduate programs are a crucial measure to address the skills shortages in engineering. The committee recognises that if only a handful of companies provide this training and support then those companies may be disadvantaged as their competitors will recruit trained workers for free. However, if more players in the industry provided graduate programs this potential problem would be alleviated.

Industry experience for university students

5.25 Throughout this inquiry the committee heard time and time again that industry cadetships had been crucial in motivating and supporting engineering students. For example, IPWEA strongly supported the development of opportunities to work part time for undergraduate students, and called for the federal government to subsidise this work.[25] Mr Ross Moody argued that early engineering work experience achieves much better outcomes for the student and the industry:

> A lot of undergraduates have to work to earn money to pay for their living expenses and also pay for their HECS fees, but most of that work is done in a non-technical area; it might be at McDonald's, dare I say, or some other place where they are getting no benefit other than earning an income.[26]

5.26 Reflecting on his own experience of early industry exposure, Mr Moody commented that:

> When I was studying at university each year, and this started from first year, I was able to work in local government during the vacation periods and it was the university that made those placements. Of course, that gave me work experience along the way. I got an appreciation of what civil engineers did and I ended up working in local government.[27]

5.27 The Australian Industry Group spoke highly of cadetships and work experience for university students. Ms Megan Lilly cautioned the committee that in order to be really useful for students sandwich courses was a 'structured and assessable' component of the curriculum, not just 'time off from the course'. Ms Lilly explained:

> I think that is where the guarantees are built in terms of consolidating the student's learning in the first instance, or applying it, plus setting up a framework for continuation of that learning but also getting the employer engagement around that individual. As long as there is a really strong curriculum framework built around that sandwich course—and there

25 Institute of Public Works Engineering, *Submission 64*, p. 18.

26 Mr Ross Moody, National Executive Officer, Institute of Public Works Engineering Australia, *Proof Committee Hansard,* 7 May 2012, p. 57.

27 Mr Ross Moody, National Executive Officer, Institute of Public Works Engineering Australia, *Proof Committee Hansard,* 7 May 2012, p. 57.

> generally is, so that is not necessarily a criticism but it is a safeguard—I think it is a terrific solution.[28]

5.28 However, Professor James Trevelyan believed that industry would not support lengthy work experience or cadetships for students:

> I think that most of my faculty colleagues would welcome that kind of development. It has been discussed extensively at the industry advisory panel meetings that I have attended. The difficulty is that companies will tell you: 'We like internship programs, because that gives us a chance to look at the graduates that we would later employ. But we think that more than 12 weeks is far too long.' In other words, they see the cost of supervising and training these graduates and then saying: 'But they are going to leave us. They are not even going to stay with us after the 12 months.' So the practical difficulty is how to get companies to provide support for this.[29]

The Australian Power Institute Bursary example

5.29 The Australian Power Institute was established by the power industry to respond to the engineering skills shortages in that sector. The Australian Power Institute runs a bursary program that provides paid work experience to selected engineering university students. During the Brisbane hearings Mr Michael Griffin, Chief Executive Officer, explained the program to the committee:

> Our bursary program has been running for just over five years. We have currently about 180 bursary holders across Australia. Each year we go and promote the bursary program to all the universities across Australia that have a commitment to power engineering—in other words universities that have a power engineering curriculum. We use industry members to promote power engineering, what power engineers do et cetera. We generally get into the first year and second year classes. When we first went we had on the order of 50 bursaries to give in the year and we had about 160 bursary applications. Last year we had 50 again and we had about 300 applications, so we are getting a lot of interest amongst young people. The word is getting out there from our existing bursary holders to their mates and the like.[30]

5.30 The Australian Power Industry conducted surveys to identify what Generation Y students find attractive in engineering. Mr Michael Griffin summed up for the committee the key motivators for students: 'be in demand, be challenged, be rewarded and make a difference.[31]

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28 Ms Megan Lilly, Director of Education and Training, Australian Industry Group, *Proof Committee Hansard*, 7 May 2012, p. 47.

29 Professor James Trevelyan, *Proof Committee Hansard*, 27 March 2012, p. 16.

30 Mr Michael Griffin, Chief Executive Officer, Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 26.

31 Mr Michael Griffin, Chief Executive Officer, Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 25.

5.31 Mr Griffin outlined the selection process for selecting bursary holders, emphasising that students are chosen by the industry itself and the achievement of successful applicants is properly recognised:

> What we do is that when we select those bursary holders they are not selected by the university academics; they are selected by our industry members. So, on a state-by-state basis, I go around the country and bring our industry member representatives together and they look at all the applications they got for their state and select the bursary holders on some stated criteria that we have. At the end of the year we have an awards ceremony for our bursary holders and we invite chief executives and state or federal ministers to come and present the awards. We try to make a big deal of it. We ask their parents to come along. We want that recognition aspect so that they feel it is a really worthwhile program to be part of. We then organise vacation employment for them throughout their studies. On the summer vacations we organise that with our industry members. They can work anywhere between a month and three months. This is really invaluable.[32]

5.32 The committee was especially interested to hear that the bursary program is paid work experience for students and that industry members of the Australian Power Institute support this program without the assistance of government funding. Mr Griffin told the committee that a high number of industry members are active supporters of the program:

> Generally 80 per cent of our member companies would take people. From year to year there might be no project, so the smaller consulting companies may not be able to take someone. There may be commercial pressures or whatever. I think we are very well supported generally by our membership: 80 to 90 per cent of them will take more than one of our bursary holders. But, having said that, we have to work hard to get them. If we could have some incentives and some support from government for the program—maybe some contribution—that might even lift it by 20 per cent. It might make the difference between a company taking a bursary student and not, if you know what I mean.[33]

5.33 The committee asked the Australian Power Institute if it could assess the effectiveness of this program. Mr Griffin said that while the program was still new, already the benefits could be seen:

>]By] having 50 of these graduates and potentially, throughout years 1, 2 and 3, 180 right across Australia, there is in fact a pull through. These bursary holders do not live in a vacuum. Their mates will see what they are doing, what they are getting to experience. We are seeing in the universities a commensurate increase in interest from students who miss out on our bursary program in undertaking power engineering electives and that sort of

32 Mr Michael Griffin, Chief Executive Officer, Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 26.

33 Mr Michael Griffin, Chief Executive Officer, Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 27.

> stuff. We are seeing some early signs of success that our bursary program is leading to increasing enrolments in undergraduate study in our field. That is because we actually get 300 applications a year. There are 300 students each year who actually have to go and find out something about this industry to put in an application. [34]

5.34 The Australian Power Institute also reported that the number of workers in the industry aged below 30 has more than doubled.[35] However, the Australian Power Institute was at pains to point out to the committee that only 50 bursaries are offered each year (selected from 160 applicants in the last round) and the power industry needs 1300 graduates over the next 5 years.[36] The Australian Power Institute would like government support so it can offer more bursaries, but did acknowledge that membership fees to the Institute – through which the bursaries are funded – are likely to be tax deductable.[37]

5.35 The Institute has also launched a website to promote engineering careers to high school and early university students.

Committee view

5.36 As discussed in chapter 3, the Australian Council of Engineering Deans (ACED), Professor Bean and Hadgraft, and others, called for more practical work exposure for university students.[38] However, the ACED noted that there are significant challenges in implementing good quality practical work experience for students, and one of the largest challenges was to find sufficient numbers of employers willing to take on more than 6000 students a year. The committee believes that practical work experience provides benefits to industry, government and students and in the long run will assist in addressing the skills shortage. The committee hopes that over time as the success this program becomes more apparent other industries will decide to adopt its model.

5.37 The committee believes that the Australian Power Institute bursary program, sponsored by companies in the power industry, is an excellent example of the type of paid work experience that should be available to many more engineering students in many more engineering-related industries.

5.38 Currently university students are required to have 60 days work experience across their whole degree. In the committee's view while this is better than nothing it

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34 Mr Michael Griffin, Chief Executive Officer, Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 27.

35 In 2004, 14 per cent of the industry was under age 30. In 2012 this rate increased to 25 per cent. Mr Michael Griffin, Chief Executive Officer, Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 30.

36 Mr Simon Bartlett, Chairman, *Proof Committee Hansard*, 28 March 2012, p. 24; Mr Michael Griffin, Chief Executive Officer, *Proof Committee Hansard*, 28 March 2012, p. 26.

37 Mr Simon Bartlett, Chairman, *Proof Committee Hansard*, 28 March 2012, p. 29.

38 For example, Australian Council of Engineering Deans, *Submission 67*, p. 8.

is not good enough and the Australian Power Institute's bursary program represents best practice.

Recommendation 8

5.39 The committee recommends that the government work with states and territories through the Council of Australian Governments to engage with engineering industry peak bodies with a view to developing measures to encourage the provision of practical, paid work experience to university students.

Workforce training

5.40 It is clear that training for experienced engineers has also been diminished by the demand for their services in revenue earning activities.

5.41 The Australian Institute of Traffic Planning and Management observed that training has tapered off in recent years, and this has impacted workplace productivity:

> A lot of workforce planning has been undertaken to various degrees around Australia, but the action to address those key findings has been slow and, in some cases, nonexistent. With that in mind, it is no coincidence that productivity in Australia has been declining. One of the contributing factors to that decline since the early 1990s is a lack of training and a lack of a focus on training.[39]

5.42 The committee was impressed by the practical attitude taken by some organisations. Mr Dan Reeve, representing Roads Australia at the Canberra hearing, but also the General Manager for the Snowy Mountains Engineering Corporation's Australian operations, explained that he viewed training as an important way to address skills shortages:

> Even though I am from an engineering consultancy, I have been involved in a number of the large alliances. I am on the alliance leadership team and therefore I get active involvement in the governance and leadership of those large projects—for instance, the Ballina bypass and the Banora Point upgrade projects. I work with the contractors on that. Part of what we do there is look at how we train and upskill our people as part of those projects. We do not want to just employ the people, have them do the job and disappear. We realise that, because we cannot get enough people, we have to upskill the people we have got. We help a lot of the labourers to get their certificate IV for training in different levels so that they can have skills. We find that, by giving them that education as part of the project, they have more interest, they perform better and they have something to go away.[40]

5.43 Mr Reeve's attitude demonstrates that even in the midst of short term government contracting, it is possible to see the benefits of training staff for a project

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39 Mr Bruce Woolridge, Australian Institute of Traffic Planning and Management, *Proof Committee Hansard*, 27 March 2012, p. 29

40 Mr Dan Reeve, Capacity Chapter Member, Roads Australia, *Proof Committee Hansard*, 7 May 2012, p. 1.

as the returns will come in the future on the next project, when the firm has a 'larger pool of skilled workers to call from'.[41] In the committee's view this is an attitude more engineering employers should share.

5.44 The Australian Institute of Traffic Planning and Management has developed a pilot program to recruit people to engineering. The program outcome was trialled by Western Australian Roads with excellent results. Mr Woolridge told the committee:

> We selected training programs from a variety of providers out there—things like road safety audit training; crash investigation; traffic management in roadworks; traffic signal training; AutoCAD, to improve design skills; and design seminars. So we tried to cover the broad cross-section of training requirements. Some of that was through training courses, some through experiential learning. They spent six months in each location, some in the traffic services area where they deal with local governments. In the traffic operations project and development area they learnt how projects are developed. In the traffic operations centre they saw how real-life traffic works. There was meant to be a placement at local government, a reciprocal right, so we are getting skills built up in both of those. I do not think local government proceeded after I left Main Roads but they had a different component in there.[42]

5.45 General Electric suggested that training and workforce development would be improved if it was a mandatory inclusion in project plans for large developments. Mr Kirby Anderson told the committee that companies need to explain:

> How do they compete with other infrastructure potential, particularly here in Queensland, where we are talking about upgrading the Bruce Highway and other initiatives? How is the energy sector going to compete with that demand for skills? So we think there is a good reason for having some sort of inventory into how these projects are going to develop and what the skill requirement is going to be. I think that sends a powerful signal not just to companies like us but to registered training organisations—the TAFEs—and also to governments, to say, 'How do we address this future skill demand?'[43]

Committee view

5.46 The committee believes that cadetships, graduate positions and workforce training are crucial measures to address the skills shortage. The committee believes that governments can use their purchasing power to encourage industry to meet its training obligations. The recommendations made by Roads Australia and General Electric appear to have some merit, although the particulars of any incentive program

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41 Mr Dan Reeve, Capacity Chapter Member, Roads Australia, *Proof Committee Hansard*, 7 May 2012, p. 2.

42 Mr Craig Woolridge, Australian Institute of Traffic Planning and Management, *Proof Committee Hansard*, 27 March 2012, p. 31.

43 Mr Kirby Anderson, Policy Leader Energy Infrastructure, General Electric, *Proof Committee Hansard*, 28 March 2012, p. 9.

attached to requests for tender processes will need to be looked at closely by government.

Recommendation 9

5.47 The committee recommends that the government consider how it can encourage commonwealth contractors to provide graduate and cadetship programs through its procurement processes.

Engineers working in non-engineering roles

5.48 It seems relatively well accepted that another cause of the engineering skills shortage is the choice by qualified engineers to work in other fields – either as a result of promotion within their organisation, or as a result of a decision to work in a different field. Added to this, a number of international students graduating from Australian universities decide to return home after study, and those who remain often do not possess sufficient communication skills to be easily employable.

5.49 Census data from 2006 reveals that reveals that only 55 per cent of engineering graduates were employed in an engineering occupation.[44] Skills Australia observed that an individual's 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'.

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.

5.50 During the committee's hearing in Perth, Professor Trevelyan explained where he believed engineering graduates were ending up:

> [We] actually have huge numbers of engineering graduates who are employed in unrelated occupations, and many of them emerge extremely frustrated because they find that the job they thought was waiting for them on graduation simply isn't there.
>
> ...
>
> The reality is that we train large numbers of graduates and they go out and end up working elsewhere. ABS statistics will tell us that there is a surplus

44 Skills Australia, *Submission 80*, p. 12.

> of somewhere around 20,000 to 30,000 graduates. They are out in the community now, many of them driving taxis. Some are real estate agents. They could be engineers.[45]

5.51 Consult Australia submitted that the problem is exacerbated by the fact that university engineering qualifications are attractive to other industries. During the Brisbane hearing Ms Megan Motto, Chief Executive Officer, told the committee:

> [There may be] many graduates but they are being poached by other sectors and not doing engineering at all. The number of graduates that are going into the financial services sector, that are being picked up by the big management consultancies, that are going into the banking sector and that are going into project management in IT and other fields is quite extraordinary. Our industry is also competing with those other market sectors that are now significant competitors for the best graduates with the analytical and problem-solving skills. They are greatly valued.[46]

5.52 Skills Australia cited anecdotal evidence that graduates are often targeted by the financial and insurance sectors who can offer higher wages, and who value the analytical skills that engineering graduates possess.[47] If more graduate opportunities were available for graduates in engineering sectors, Skills Australia believes more of these students could be retained in the engineering discipline.

5.53 Mr Kirby Anderson of General Electric made similar observations:

> The other issue that I think Engineers Australia have identified, particularly in their submission to the National Resources Sector Employment Taskforce, is that some of those qualified engineers that do actually take up their degree and join the workforce are also quickly moved into the management of companies, so therefore their engineering skills are lost to the company and they are used more as management personnel. There are many examples of that even within GE; many of our senior managers are also senior engineers. You cannot stop them from moving up the chain.[48]

5.54 The committee believes that if a higher number of graduate opportunities were available, more engineering graduates would choose to pursue a career in an engineering related field.

Retention

5.55 Employers compete against each other for engineering talent in Australia and internationally, and attracting, training and retaining graduates is hard, as discussed in the preceding section. The committee heard that it has been particularly difficult for engineers who are women to stay in their profession and that industry is feeling the

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45 Professor Trevelyan, *Proof Committee Hansard*, 27 March 2012, p. 12.

46 Ms Megan Motto, Chief Executive Officer, Consult Australia, *Proof Committee Hansard*, 28 March 2012, p. 20

47 Skills Australia, *Submission 80*, p. 12.

48 Mr Kirby Anderson, Policy Leader Energy Infrastructure, General Electric, *Proof Committee Hansard*, 28 March 2012, p. 10.

impact of the retirement of older, more experienced engineers. Efforts have been made in some companies to promote the participation of these experienced engineers.

5.56 Furthermore, positive retention policies to encourage indigenous people to join and remain in the engineering workforce are in their infancy but are being developed. One such example, the National Resources Sector Workforce Strategy report, *Resourcing the Future*, recommended measures the federal government should take to promote indigenous participation in the workforce sector. In another development, the federal government is aiming to boost Indigenous employment opportunities through its Memorandum of Understanding (MOU) on Indigenous Employment and Enterprise Development, entered into with the Minerals Council of Australia. The MOU recognises the value in developing regional partnership approaches between Indigenous communities, the minerals industry and governments.[49]

Women

5.57 The rate of workplace participation in engineering jobs among women is very low. Low participation rates can be traced to low numbers of women graduating with engineering qualifications, but also to low retention rates of those women who do obtain employment in an engineering related field. These rates are usually attributed to inflexible and male dominated workplaces and a traditional association of engineering with masculinity.

5.58 Engineers Australia reported to the committee that only 14.4 per cent of domestic students who commence engineering bachelor degrees are women, with the percentage of women graduating slightly higher than that of men.[50] Ms Leanne Hardwicke, Director of the WA Division of Engineers Australia, told the committee that while women had high completion rates, the difficulty was retaining women once they entered the workforce:

> I think the problems come when they get into the workforce and they find that it is not as female friendly as they had hoped, that it is very difficult if they take maternity leave, for instance, to come back in in a part-time capacity. The expectations of the job are that you will come in full time and the time that you have missed away is time when you could have been building a career.[51]

5.59 Skills Australia's research supports Ms Hardwicke's conclusions, finding that female engineers tend to leave 'for reasons connected with the workplace culture (with

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49 Government Response to the National Resources Sector Workforce Strategy Report *Resourcing the Future*, March 2011. Available online: http://www.deewr.gov.au/Skills/Programs/WorkDevelop/ResourcesWorkforce/Documents/AGResponseNRSET.pdf (accessed 31 May 2012).

50 Engineers Australia, *Submission 67*, p. 11.

51 Ms Leanne Hardwicke, Director, WA Division, Engineers Australia, *Proof Committee Hansard*, 27 March 2012, p. 4.

discrimination and sexual harassment), family responsibilities, travel and study'.[52] A survey conducted by the Association of Professional Engineers, Scientists and Managers (APESMA) reported that one quarter of female respondents planned to leave the engineering sector because of work life imbalance or a need to change for career advancement.[53]

5.60 Dr Sally Male echoed these views and provided a sobering observation of the experiences of many women in the engineering profession:

> Women in engineering have fewer children than men in engineering or women in other professions—that is not just women in general; that is women in other professions—in Australia, indicating that there is a barrier to women with children in engineering. Over 20 per cent of women in studies report having experienced sexual harassment in the workplace. With all of that evidence, it is no wonder that women also leave the engineering profession at higher rates than men. Having recognised that there are barriers to women in engineering, we need to look at what they might be caused by. There has been a lot of focus on doing things to change the women, such as helping them become more aware of opportunities in engineering, or on making minor changes to the environments in which women might work, which are valuable, including things like parental leave. However, we need to look at the sources of these barriers.
>
> There is plenty of evidence that these barriers are arising from entrenched cultures. The men and women in those cultures, without realising it, are involved in processes whereby they are making decisions and engaging in engineering practices but are not seeing the assumptions that are made around the stereotypical masculine ideal forms of engineers—for example, that the ideal engineer has a wife at home looking after the children and therefore does not have to leave at a certain time.[54]

5.61 The committee heard that steps were being taken to begin to address the obstacles to employing and retaining women with engineering qualifications. Looking at the problem, the National Resources Sector Employment Taskforce recommended:

> That DEEWR or the Equal Opportunity for Women in the Workplace Agency work with the Minerals Council of Australia, Australian Petroleum Production & Exploration Association, Australian Constructors Association, unions and education and training providers in appointing a consultant to develop a strategy for attracting and retaining women in the resources and construction sectors.[55]

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52 Skills Australia, *Submission 80*, p. 15.

53 Association of Professional Engineers, Scientists and Managers, *Submission 69*, pp 11–12.

54 Dr Sally Male, *Proof Committee Hansard*, 27 March 2012, pp 9–10.

55 National Resources Sector Employment Taskforce, *Resourcing the future*, 7 July 2010, recommendation 5.5. Available online: http://www.deewr.gov.au/Skills/Programs/WorkDevelop/ResourcesWorkforce/Pages/NRSET.aspx (accessed 31 May 2012).

5.62 The government accepted this recommendation and has made the Office for Women available to assist businesses increase the number of women working in the resources and construction sectors.[56]

5.63 Skills Australia reported that the private sector was also rising to the challenge by improving workforce flexibility, part time career opportunities and access to childcare.[57]

5.64 In June 2011 the Australian Mines and Minerals Association received funding from the government to lead a project to attract and retain women in the resources and related construction sectors.[58] For its part, Engineers Australia has established the Women in Engineering National Committee to attract, retain and support women in the engineering profession.[59]

5.65 The Chamber of Minerals and Energy of Western Australia has also put measures in place to increase the participation of underrepresented groups in engineering professions. Mr Bruce Campbell-Fraser told the committee that:

> Currently, about 22 per cent of our workforce is made up of females. That is up from about 19 per cent in 2008 so that has been a good focus for companies. We are the largest employer of Indigenous people in Western Australia: about 4.2 per cent of our workforce is Indigenous. To put that in context, only 2.3 per cent of the WA public sector is Indigenous, and the Indigenous population in Western Australia is 3.8 per cent. Those numbers are much higher in the Pilbara both in terms of population and participation. That is primarily where many of our major operators are.[60]

5.66 To address gender and other imbalances in the long term, Dr Sally Male suggested that the engineering profession should reassess its 'cultural bias':

> We need education for engineers at all levels in the engineering workforce to help them to critically analyse decision-making processes and practices within engineering and to uncover ways in which the culture is causing

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56 Australian Government response to the National Resources Sector Employment Taskforce Report: *Resourcing the Future*, March 2011. Available online: http://www.deewr.gov.au/Skills/Programs/WorkDevelop/ResourcesWorkforce/Documents/AGResponseNRSET.pdf (accessed 31 May 2012).

57 Skills Australia, *Submission 80*, p. 4.

58 Skills Australia, *Submission 80*, p. 4. The Australian Government is providing $534,000 to support this project, see Department of Education, Employment and Workplace Relations, 'National Resources Sector Workforce Strategy: More women working in resources and construction–attracting and retaining women', http://www.deewr.gov.au/Skills/Programs/WorkDevelop/ResourcesWorkforce/Documents/MWWRC.pdf (accessed 5 July 2012).

59 Engineers Australia, *Submission 67*, p. 11.

60 Mr Bruce Campbell-Fraser, Executive Officer, Chamber of Minerals and Energy of Western Australia, *Proof Committee Hansard*, 27 March 2012, p. 23.

> those decision-making processes and engineering practices to impact differently on women and men and then to work out how to address that.[61]

Committee view

5.67 The committee believes that if the participation of women in the engineering workforce were to increase, this would go some way to addressing the skills shortages. The committee encourages employers of engineers to work to promote diversity in their workplaces and seek to recruit and retain women engineers.

Recommendation 10

5.68 The committee recommends that the government work with the Australian Workforce and Productivity Agency and employers to develop targeted policies that encourage women to remain in, or return to, the engineering workforce.

Mature workers

5.69 A number of engineers are not participating in the workforce or will leave the workforce in the next few years. For example, 30 per cent of workers in the road industry are expected retire by 2019, and in Western Australia this figure is estimated to be over 50 per cent.[62]

5.70 Some engineering firms have taken steps to encourage older engineers to return to the workforce, for example as mentors for younger engineers. Ms Verena Preston, Director, Worley Parsons told the committee that they were considering how they could tap into the older workforce:

> I think it is certainly an issue that we are grappling with, and trying to address pretty aggressively at the moment, because with the ageing workforce we have to come up with ways that we can actually engage them in a different way. That is certainly something that we are doing. And yes, there are many examples that spring to my mind where we have people within the organisation that actually started out in the public sector and they are in that mentoring phase at the moment. We are really trying to support that and make it work. It would be nice to make that a bit more official.[63]

5.71 Ms Preston observed that in her experience there are not that many engineering professionals actually retiring. What is more common is 'retired' engineers return to the workforce. Usually to industry associations, universities or their former company.[64]

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61 Dr Sally Male, *Proof Committee Hansard*, 27 March 2012, pp 9–10.

62 Mr Bruce Woolridge, Australian Institute of Traffic Planning and Management, *Proof Committee Hansard*, 27 March 2012, p. 29

63 Ms Verena Preston, Director, Worley Parsons, *Proof Committee Hansard*, 28 March 2012, p. 18.

64 Ms Verena Preston, Director, Worley Parsons, *Proof Committee Hansard*, 28 March 2012, p. 18.

5.72 Engineers Australia recommended that government departments at the federal, state, territory and local level should implement policies to retain internal engineering expertise. It suggests that this could be achieved through

> ...the creation of senior technical specialist roles that would provide a technical career pathway (in tandem with traditional managerial/generalist career pathways) for those seeking to build specialist knowledge while continuing to enjoy career/hierarchical progression.[65]

5.73 Skills Australia advised that it is working to develop strategies to keep older workers in the workforce across the board, and reported that if workforce participation in Australia could be increased from 65 to 69 per cent of eligible persons The economic benefit to Australia would approach $25 billion by 2025.[66]

Committee view

5.74 The committee believes that it is important that the government develop policies to encourage older engineers to remain in the workforce for longer. Older workers possess a wealth of experience and their contribution to the engineering profession and trades could prove invaluable in addressing the skills shortage.

Recommendation 11

5.75 The committee recommends that the government work with the Australian Workforce and Productivity Agency to continue to develop targeted policies that encourage mature engineers to remain in or return to the workforce.

The profile of engineers and engineering in the community

5.76 The low profile of engineers in the community was a consistent theme in the submissions received by the committee and the evidence taken during hearings. Many submitters linked the low profile to a lack of awareness of what 'being an engineer' means. For example, Mr Ross Moody from the Institute of Public Works Engineering, explained that most people did not know what an engineer was, and those that did know, would not think a public works engineer was exciting. [67]

5.77 The Australian National Engineering Taskforce (ANET) believes that the low profile of engineers, and in turn, the skills shortage, can be addressed by creating a federally funded position of the Office of the Australian Engineer. ANET posits that this office could increase the level of interest among school leavers in engineering careers and improve overall support for the engineering profession.[68] ANET believes the Office of the Chief Scientist performs an important role, but cannot represent

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65 Engineers Australia, *Submission 67*, p. 13.

66 Mr Robin Shreeve, Chief Executive Officer, Skills Australia, *Proof Committee Hansard*, 7 May 2012, p. 63.

67 Mr Ross Moody, National Executive Officer, Institute of Public Works Engineering Australia, *Proof Committee Hansard*, 7 May 2012, p. 57.

68 Australian National Engineering Taskforce, *Submission 73*, Recommendation 6.

engineers as 'a scientist can advise on issues relating to science, while an engineer can deliver tangible solutions in forms as manufactured products, systems and infrastructure'.[69] The committee asked Australia's Chief Scientist, Professor Ian Chubb, to comment on the proposal, Professor Chubb responded:

> I think government needs good advice and government needs input into these areas, probably in ways that it might not have had before. Whether you do that through having a chief engineer in a sort of similar role to the one I occupy or whether you have it as part of the overall office so that you have maths, on the one hand, where there is also a problem, so you might think about that too; engineering, so you might think about that; and science more generally, I think there is an issue about how you get really good independent advice to government all the time on these key matters.[70]

5.78 The Australian Power Institute advised the committee that its research did not indicate that prestige was particularly important. Rather, other factors attracted graduates to the industry, such as making a difference and travelling. Mr Simon Bartlett, Chairman, told the committee:

> We have done some research into what attracts young Australians to a career. I am not sure that prestige is high up there. There is wanting to make a difference to the world and they do see—and we are trying to promote this—that the power industry is a way by which we can make a difference to Australia by a reduction in carbon footprint and helping with renewable generation. They want to be challenged and rewarded, so we are promoting that. It is a skill that is transportable. There is travel that comes with it. Travel is a big attractor.[71]

5.79 Mr Bartlett also observed that engineers in the power industry held some prestigious roles, and that while a Chief Engineer might be helpful, it was not essential.[72] The committee gave particular weight to observations made by the Australian Power Institute due the success its bursary program has had in promoting power engineering to university students.

5.80 The ANET also called for a national registration scheme for professional engineers. This proposal was also supported by other submitters, such as Consult Australia, the National Engineering Registration Board, and the Institute of Public Works Engineering Australia.[73] ANET argued that registration would 'assign value to the profession' and establish regional boards which 'can promote the profession and

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69 Australian National Engineering Taskforce, *Submission 73*, p. 37.

70 Professor Ian Chubb, Australia's Chief Scientist, *Proof Committee Hansard*, 7 May 2012, p. 12.

71 Mr Simon Bartlett, Chairman of the Board, Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 25.

72 Mr Simon Bartlett, Chairman of the Board, Australian Power Institute, *Proof Committee Hansard*, 28 March 2012, p. 25.

73 Consult Australia, *Submission 66*; National Engineering Registration Board, *Submission 71*, Institute of Public Works Engineering Australia, *Submission 64*.

safeguard standards'.[74] Registration would also promote workforce mobility across Australia and continuing professional development requirements would ensure that engineers maintain and develop their skills. In the context of engineering disasters, discussed in chapter 4, a national registration scheme would also protect the professional standards of engineers.

5.81 In a study commissioned by the National Engineering Registration Board, ACIL Tasman forecast that a national registration scheme for engineers would deliver $7.4 billion in savings.[75] The key financial benefits include:

- a reduction in large engineering failures ($13.2 million a year)
- reduction in botched engineering projects ($207.08 million a year)
- benefits for migrant engineers ($29.91 million a year); and
- other efficiency gains (207.6 million a year).[76]

5.82 ANET advised that the cost impacts of national registration are minor as such a scheme would be largely funded by engineers and employers. [77] The committee notes that the Council of Australian Governments (COAG) is working toward national registration schemes for trades, as part of the National Partnership Agreement on a Seamless National Economy. [78] Further, COAG is currently considering national registration of a number of other occupations, including engineering.[79]

Committee view

5.83 The committee believes that it is important that the concerns of the engineering profession and trades are represented at the highest levels of government. The committee was interested to learn that the Australian Federal Parliament currently has three qualified engineers, and its alumni exceed 25 in number. [80] This is probably roughly proportional to the numbers of engineers in the community.

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74 Australian National Engineering Taskforce, *Submission 73*, p. 35.

75 National Engineering Registration Board, *Submission 71*, p. 2. ACIL Tasman was commissioned by the National Engineering Registration Board to perform quantitative economic analysis of the case for national registration.

76 National Engineering Registration Board, *Submission 71*, p. 2.

77 Australian National Engineering Taskforce, *Submission 73*, p. 36.

78 National Partnership Agreement, Seamless National Economy, part 1, item 4. Available online: http://www.federalfinancialrelations.gov.au/content/national_partnership_agreements/other.aspx (accessed 5 July 2012).

79 A COAG Taskforce is considering submissions that the engineering profession (and others) should be subject to national registration, COAG Communiqué, 13 April 2012, Canberra, http://www.coag.gov.au/coag_meeting_outcomes/2012-04-13/index.cfm (accessed 6 July 2012). See also the COAG Reform Council's report on the Seamless National Economy reforms, http://www.coagreformcouncil.gov.au/reports/competition.cfm (accessed 6 July 2012).

80 Mr Martin Lumb, Editor, Parliamentary Handbook, Parliamentary Library Briefing, 14 June 2012 and 15 June 2012.

5.84 Australia's Chief Scientist considers it one of his roles to promote science, technology, engineering and mathematics subjects to high school and primary school students. The committee notes that the decision to award the 2012 Young Australian of the Year to engineering student Ms Marita Cheng has already resulted in raising the profile of engineers in the community, especially amongst young women.[81] The committee also notes that one of the five experts appointed to the Prime Minister's Science, Engineering and Innovation Council has an engineering background. [82]

5.85 The committee believes that there is merit in working towards a national registration scheme for engineers, and is pleased that COAG is actively considering the expansion of national registration of occupations, including engineering, as part of the Seamless National Economy reforms. The committee considers that national registration of the engineering profession should be made a priority area for reform over the next decade.

Recommendation 12

5.86 The committee recommends that the government continues to work with the states and territories through the Council of Australian Governments to make a national registration scheme for engineers a priority area for reform over the next decade.

Conclusion

5.87 The engineering skills shortage in Australia can be attributed to a number of causes. One key stimulus is the departure during the 1990s of the public sector from engineering training and the failure of industry to resulting fill the gap. Graduate programs are thin on the ground, and graduate engineers are very employable in other sectors, which results in large numbers of engineering graduates choosing not to pursue engineering careers.

5.88 Although the numbers of international students studying engineering in Australian universities continues to increase, large numbers of these students return home after studying and many of those that remain struggle to find employment. The mining boom in Queensland and Western Australia has created further demand for engineers in those states, and prompted shortages in other industries that need engineering skills such as manufacturing and power. The low participation and retention rates of women have further contributed to this shortage, as has the numbers of experienced engineers approaching retirement.

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81 See the Australian of the Year website: http://www.australianoftheyear.org.au/recipients/?m=marita-cheng-2012 (accessed 8 June 2012).

82 Commonwealth Scientific and Industrial Research Organisation, "Dr Cathy Foley: Chief, CSIRO Materials Science and Engineering", http://www.csiro.au/Organisation-Structure/Divisions/Materials-Science--Engineering/CathyFoley.aspx (accessed 12 June 2012).

5.89 While there may appear to be sufficient numbers of engineering graduates, many are compelled to opt out of engineering careers early on because industry tends to demand experienced engineers rather than new graduates. Others are lured by higher salaries in other sectors.

5.90 International experience demonstrates that government investment in education and training will not be enough to address skills shortages, and that stronger partnerships between educational bodies and industry will 'encourage more effective use of existing skills'.[83] The evidence throughout this report supports this conclusion.

Senator Chris Back

Chair

83 Skills Australia, *Submission 80*, p. 19.

Appendix 1

Submissions received by the Committee

1	Mr Frans Brouwer
2	Australia Wide Personnel
3	Mr Alastair Munro
4	Institute of Public Works Engineering Australia NSW Division
5	Auto Skills Australia
6	Mr Carl Johansson
7	Mr Manji Chhabhadia
8	Mr Henry Seccombe
9	Mr Tim Calver
10	Mr Philip Bell
11	Mr Ian Borthwick
12	Confidential
13	Mr Rodney Ziegelaar
14	Name Withheld
15	Mr Lewis Potterton
16	Re-Engineering Australia Foundation Ltd
17	Educational Testing Service

18 Name Withheld

19 Master Builders Australia Limited

20 Name Withheld

21 Australian Constructors Association

22 The Australian Power Institute

23 Ms Maria Silva

24 Mr Andrew Ruscoe

25 Manufacturing Skills Australia

26 National Committee on Engineering Design

27 The Warren Centre for Advanced Engineering

28 ASC Pty Ltd

29 Professor David Beanland, Professor Roger Hadgraft, Professor Aleksander Subic

30 Mr Geoffrey Stone

31 Mr James Trevelyan

32 Mr Russell Wade

33 Office of the Chief Scientist

34 JSM Appointments

35 Mr Mani Salmon

36 Mr Edward Heim

37 Consulting Surveyors National

38 Mr Luke Downing

39 Australian Institute of Traffic Planning and Management

40 Mr Conrad Drake

41 Mr Mahmood Al-Ibrahim

42 Chisholm Institute

43 South Australia Government

44 Mr Peter Doherty

45 The Chamber of Minerals and Energy of Western Australia

46 Association of Mining and Exploration Companies

47 Ausgrid

48 Mr Murray Mason

49 Mr David Patterson

50 Gerard Daniels

51 Mr Adrian Yong

52 Mr Jay Wickramatunga

53 Mr Michael Rice

54 Mr Colin Hackney

55 Australian Construction Industry Forum

56 Australian Technology Network of Universities

57 Local Government Managers Australia

58 Australian Industry Group

59 Australian Academy of Technological Sciences and Engineering

60 Australasian Railway Association

61 Roads Australia

62 Department of Infrastructure and Transport

63 Sinclair Knight Merz

64 Institute of Public Works Engineering Australia

65 Australian Council of Engineering Deans Inc

66 Consult Australia

67 Engineers Australia

68 Mr Greg McMahon

69 Association of Professional Engineers, Scientists and Managers, Australia

70 Name Withheld

71 National Engineering Registration Board

72 Name Withheld

73 Australian National Engineering Taskforce

74 Austroads Capability Taskforce

75 Hickory Group Pty Ltd

76 Energy Networks Association

77 General Electric

78 University of the Sunshine Coast

79 Institute of Public Works Engineering Australia WA Division

80 Skills Australia

81 NORTH Link

82 Mr Zaf Pavlic-Sahin

Additional Information received by the Committee

1 Document tabled by the Australian Institute of Traffic Planning and Management on the 27th of March 2012.

2 Document tabled by the Australian Association of Mining and Exploration Companies on the 27th March 2012.

3 Document tabled by the Australian Power Institute on the 28th March 2012.

4 Congestion figures requested at the hearing from the Department of Infrastructure and Transport report - Estimating urban traffic and congestion cost trends for Australian cities, received 19 April 2012.

Answers to Questions on Notice

1 Answer to question on notice from ETS TOEFL received 24 April, 2012.

2 Answer to question on notice from ETS TOEFL received 24 April, 2012.

3 Answer to question on notice from ETS TOEFL received 24 April, 2012.

4 Answer to question on notice from Institute of Traffic Planning and Management received on 19 April, 2012.

5 Answer to question on notice from Consult Australia received 26 April, 2012.

6 Answer to question on notice from Office of the Chief Scientist received 7 May, 2012.

7 Answer to question on notice from Department of Infrastructure and Transport received 4 June, 2012.

8 Answer to question on notice from Austroads received 5 June, 2012.

9 Answer to question on notice from Consulting Surveyors National received 5 June, 2012.

10 Answer to question on notice from Department of Industry, Innovation, Science and Research and Tertiary Education received 6 June 2012.

Appendix 2

Witnesses who appeared before the Committee

Parliament House, Perth, WA
27 March 2012

BENNISON, Mr Simon, Chief Executive Officer, Association of Mining and Exploration Companies

CAMPBELL-FRASER, Mr Bruce, Executive Officer, People Strategies, Chamber of Minerals and Energy of Western Australia

FITZHARDINGE, Mr Christopher Berkeley (Chris), former WA Division President, Engineers Australia

FROMM, Mr Justin Graham, Senior Policy Officer, Association of Mining and Exploration Companies

HARDWICKE, Ms Leanne, Director, WA Division, Engineers Australia

JACKSON, Mr Brent, Director, National and International Policy, Engineers Australia

MALE, Dr Sally Amanda, Private capacity

MASTERS, Mr John David, Managing Director, JSM Appointments

TREVELYAN, Professor James Philip, Private capacity

WOOLDRIDGE, Mr Craig, National Vice President, Australian Institute of Transport Planning and Management

Parliament House, Brisbane, QLD
28 March 2012

ANDERSON, Mr Kirby, Policy Leader, Energy Infrastructure (Australia-New Zealand), GE Energy

BARTLETT, Mr Simon, Chairman, Australian Power Institute

BARTLETT, Professor John, Executive Dean, Faculty of Science, Health, Education and Engineering, University of the Sunshine Coast

COOK, Ms Helen Marie, Associate Director, Client Relations (Australasia), ETS TOEFL

GRIFFIN, Mr Michael, Chief Executive Officer, Australian Power Institute

LOCKE, Mr Erik, Consultant, Association of Professional Engineers, Scientists and Managers Australia 38

MOTTO, Ms Megan, Chief Executive, Consult Australia

PAVLIC-SAHIN, Mr Zdravko (Zaf), Association of Professional Engineers, Scientists and Managers Australia

PORTER, Professor Mark, Professor of Engineering, University of the Sunshine Coast

PRESTON, Ms Verena, Director, Global Consulting Practices, Worley Parsons

RUSSELL, Mr Jonathan William, Senior Policy Adviser, Consult Australia

WALTON, Mr Chris, Chief Executive Officer, Association of Professional Engineers, Scientists and Managers Australia

Parliament House, Canberra, ACT
7 May 2012

BEANLAND, Emeritus Professor David George, Private capacity

BEITZ, Ms Sue, Head of Secretariat, Skills Australia

BEYNON, Professor John Howard, President, Australian Council of Engineering Deans

BONDAREW, Dr Veronica, Chief Executive Officer, Consulting Surveyors National

CHUBB, Professor Ian, Australia's Chief Scientist, Office of the Chief Scientist

DI IULIO, Mr Paul, National President, Institute of Public Works Engineering Australia

DINGELDEI, Mr Phillip, Chairman, Consulting Surveyors National

FINDLAY, Ms Donna, Policy Director, Roads Australia

HADGRAFT, Professor Roger, Private capacity

HOUSLEY, Mr Ian, Manager, Remote Offices—Mining and Metals, Sinclair Knight Merz

HUGHES, Dr Michael, Director of Science, Office of the Chief Scientist

JAGGERS, Mr Andrew, Executive Director of the Nation Building, Infrastructure and Investment Division, Department of Infrastructure and Transport

KING, Professor Robin William, Executive Officer, Australian Council of Engineering Deans

LILLY, Ms Megan, Director, Education and Training, The Australian Industry Group

LUCKHURST, Mr Adam, General Manager, Industry Skills and Productivity Branch, Department of Industry, Innovation, Science, Research and Tertiary Education

MANN, Ms Elise, People Manager, Australia and New Zealand, Sinclair Knight Merz

MARLER, Mr Ian, Vice Chairman, Consulting Surveyors National

MOODY, Mr Ross Victor, National Executive Officer, Institute of Public Works Engineering Australia

NUGENT, Mr Brendan, Director, Business Strategy and Performance, Transport for New South Wales; and Member, Capability Task Force, Austroads

REEVE, Mr Dan, Capacity Chapter Member, Roads Australia

SHREEVE, Mr Robin, Chief Executive Officer, Skills Australia

WALTERS, Mr Greg, State Manager, South Australia, Sinclair Knight Merz

WHITE, Ms Linda, General Manager, Industry Workforce Branch, Department of Industry, Innovation, Science, Research and Tertiary Education

WILLIAMS, Mr Neil, Executive Director of the Nation Building, Infrastructure and Investment Division, Department of Infrastructure and Transport

WREN, Mr Gordon, Executive Member, Consulting Surveyors National

Appendix 3

A

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.*