



ENGINEERS
AUSTRALIA

Workforce Development Plan

2016 -2019

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In association with:



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Executive Summary

Engineers Australia has a national strategy to cultivate a network of high-level support among leaders in industry, academia and government to create momentum on engineering issues. Tasmanian engineers work in a global environment and are deeply integrated into sophisticated supply chains. Importantly, engineering is a critical enabling profession that fuels innovation.

The industry environment in which engineers operate is under pressure. A survey of businesses that use engineers was undertaken as part of this research and revealed that in the last three years 50% of those businesses have contracted and 90% have changed their business model.

The greatest issues and challenges for the engineering profession in Tasmania are:

- ***It is an international market***
 - The Tasmanian engineering profession is competing, collaborating and supplying services to an international field. This impacts on the skill set needed of engineers to survive and thrive in this market place.
- ***Supply chains are deeply integrated***
 - The engineering profession is integrated into sophisticated supply chains. This requires both broadening of the skills required of engineers but also a deepening of the skill set to play specialist roles within a supply chain. Such skill sets include project and contract management, and quality assurance.
- ***The para-professional is coming***
 - A new emerging skill set is emerging across engineering disciplines – a trades person of the ‘internet of everything’. From advanced manufacturing to renewable energy a ‘design thinking’, business savvy, quality focused para-professional is an emerging occupation.
- ***Job numbers declining in areas of future industry growth***
 - The cyclical nature of the demand for work of engineers means graduates have to hit the ground running. Demand for work has peaks and troughs as major projects are initiated and completed. Two of the top three declines in engineering employment are those tipped to grow the Tasmanian economy (professional and scientific services and education).
- ***Career pathways need work***
 - There is a recognised need to open the entry points to the profession and support an integrated career structure through to management roles. The current pathway from Science, Technology, Engineering and Mathematics (STEM) rich school experiences to post-PhD is well mapped at either end but poorly in the middle.
- ***It is still a male dominated workforce***
 - Significant work is in place in the school sector to support STEM learning and address major gender imbalances that flow ultimately through to the workforce. This work needs to be connected to the other education sectors to maximise its impact.
- ***Keep growing connections between industry and education***
 - There should be more communication between the engineering profession and all education sectors. There are gaps in education pathways and emerging skill requirements that need to be resolved.

Importantly, industry workforce development for the engineering profession is a collaborative exercise. Accordingly, this Workforce Development plan needs to be driven by industry in partnership with government and the education sector.

The key recommendations arising from this Plan are outlined below.

Recommendations



IT IS RECOMMENDED THAT:

1. A plan is developed to build an understanding of the role of engineers in global supply chains.
2. Engineers Australia continues to support and promote initiatives to enhance career pathways and improve gender diversity in the industry. This should build on current initiatives to strengthen the focus on STEM in schools.
3. Engineering associate pathways be developed and supported in key industry sectors such as:
 - a. Advanced Manufacturing;
 - b. Information and Communications Technology (ICT); and
 - c. Agriculture.
4. Engineers Australia provide leadership on the role of engineering in fostering innovation in Tasmania.
5. Engineers Australia establishes and leads the governance arrangements to steer the implementation of this Workforce Development Plan. This will involve relevant education and industry stakeholders.

1. Introduction and overview

Engineers Australia is the national forum for the advancement of engineering and the professional development of its members. With over 100,000 members embracing all disciplines of the engineering team, Engineers Australia is the largest and most diverse professional body for engineers in Australia.

Engineering is a critical enabling profession that is embedded within all industry groups. Engineers encompass professional engineers, engineering technologists and engineering associates.

In 2014 Engineers Australia released its 2014–17 Strategic Plan. As part of developing this Plan, a new vision was developed:

Engineers Australia is the trusted voice of the profession. We are the global home for engineering professionals renowned as leaders in shaping a sustainable world.

As a means of giving practical direction to achieve this vision, seven top-level priority themes have been adopted:

1. Professional home for life – to build our body of knowledge and be the leading source of professional and career development for every Australian engineering professional no matter where in the world they are practising.
2. Connectivity and partnerships – to build a high profile with key stakeholders, leaders and decision-makers in the community.
3. The definitive voice of the profession – to provide trusted and highly respected leadership and advocacy for the engineering profession.
4. Professional credentials and currency – to sustain world-class engineering education qualifications and professional credentials.
5. International orientation – to be the gateway to international engineering practice in a global profession.
6. Tomorrow's engineers – to create awareness of the opportunities in engineering among young Australians and their influencers.
7. Business sustainability – to take a professional approach to member service, business processes, performance and accountability.

The Tasmania Division has approximately 1,300 members across the State ranging from students through to senior leaders in the profession and retired practitioners. In Tasmania, it is vital to:

- ensure the engineering workforce supports the transformation of the State's industry sectors; and
- prepare for the pressure of an aging workforce.

This Tasmanian Engineering Workforce Development Plan provides Engineers Australia and other key stakeholders in the Tasmanian engineering workforce with:

- a better understanding of the demographics of the current industry in Tasmania, the value of the sector to state growth and establishment of a strong and reliable data set to underpin future workforce analysis;
- a better understanding of the utilisation of skills in the workforce compared to the highest level of education, as well as identifying additional questions to understand the gap analysis between industry skills expectations and educational outcomes;

- increased engagement of industry with the education system; particularly to demonstrate the value of the system in supporting workforce development and addressing identified workforce skills issues;
- enhanced collaboration between industry and training/education in the delivery of industry demanded training; and
- better articulation of pathways and career opportunities to the potential engineering workforce.

Importantly, this Plan provides the means for industry, government and education and training leaders and decisions makers to understand the critical workforce issues facing the engineering profession. The Plan outlines a number of industry-owned strategies and action plans to provide for a stable and well-trained workforce to meet the demands of Tasmania's changing and growing economy as it heads toward a sustainable population of 650,000 by 2050.

1.1 METHODOLOGY

This project involved three main methods of research:

1. an extensive literature search of reports and statistics;
2. interviews and an education focus group to fill gaps in information and validate key issues; and
3. an online survey of employers.

Over 60 Tasmanian engineering stakeholders and businesses have contributed to this Plan. Its key findings were also presented at the Engineers Meet Parliament event in June 2016.

An important limitation of the Plan is its reliance on Australian Bureau of Statistics (ABS) Census data up to 2011. The next Census is due later in 2016 and the results of that Census will not be available until 2017 at the earliest.

2. The engineering profession

2.1 ENGINEERING IS A GLOBAL PROFESSION

The global market presents a multitude of new opportunities for the engineering profession to expand business and expertise and to collaborate on projects across borders. Conversely competing for domestic work against international and national players has raised the quality requirement of engineering services. This has three consequences for skills development:

1. a deepening of skills required to integrate service offering into supply chains;
2. a broadening of the skills base as teams collaborate on projects; and
3. a modification of the business model as competition increases and niche, lean, adaptive models prevail.

Nationally, the engineering profession is increasing its reliance on a migrant workforce. Between the years 2000 and 2015, the permanent migration of engineers increased at an annual rate of 16.6%, increasing to 18.9% in the 2014-15 period. Throughout this time, the only fall in migration rates was in 2010 in response to the Global Financial Crisis (GFC). The 2014-15 year had the highest record of permanent migration of engineers. Of these permanent migrants:

- 7.3% were associate engineers (holding a Cert III or equivalent);
- 5.15% were engineering technologists (holding a Diploma, Associate Degree, or equivalent); and
- 87.5% were professional engineers (holding a Bachelor's Degree or higher).²

The engineering profession is subject to fluctuations in work availability as projects are started and completed. Temporary migrant engineers have been required to meet the varying demands of the labour market, as it is not possible to respond to sudden changes with the existing domestic supply of engineers.³ Though skilled migration is an extremely efficient solution for short-term supply and demand issues, work by the former Australian Workforce and Productivity Agency questioned whether it should be used to supplement long-term employment, as it reduces job availability for domestic engineers.⁴

² 'The Engineering Profession: A Statistical Overview' (2015, 12th edn.), Engineers Australia, viewed 10 February 2016, p 59.
³ Engineering Workforce Study (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 98.
⁴ Engineering Workforce Study (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 98.

2.2 ENGINEERS START AT SCHOOL

The skill sets required by engineers in today's economy are delivered initially by the schools sector and then by further education in the Vocational Education and Training (VET) sector and the Higher Education sector. Further, ongoing professional development of engineers is supported by courses offered through Engineers Australia.

The importance of STEM education has been highlighted, particularly through the media, noting that innovation in the economy requires a greater emphasis on these subjects to keep up with the global workforce.⁵ Importantly, STEM education is a critical building block for entry into the engineering profession.

Across all education sectors, participation in STEM is in decline.⁶ Nationally, rates of participation in Year 11-12 Chemistry and Physics declined between 2000 and 2012, to below 18% of students.⁷ Within the same year group, participation in Advanced Mathematics fell below 10%, while Intermediate Mathematics remained at 20%.⁸

The participation rates in STEM in high schools is not helped by the lack of understanding among students of the diverse role of engineers nationally and the career paths available.

Within the VET sector, national enrolments in Certificate III and IV engineering-related studies have been increasing strongly. These courses suffered severe reductions in 2010 due to the GFC, with employers forced to reduce the number of traineeships offered. Enrolment rates have improved dramatically since 2011, but are yet to reach the same levels recorded in the 2008-2010 period.⁹

At a national level, commencement of Diplomas and Higher Diplomas rose sharply between 2007 and 2012, increasing by 207 students (5%).¹⁰ Of all students studying VET courses in Engineering and Related Technologies in 2010, 20.5% were from rural or remote areas.¹¹

Between 2006 and 2012, domestic commencement and completion of engineering related undergraduate degrees in Australia was markedly lower than that of international students, and increased at a much slower rate. By comparison, the growth of domestic student enrolment and completion of Higher Degrees was greater than that of international students (see Table 1).¹²

TABLE 1: RATES OF INCREASE IN ENGINEERING HIGHER EDUCATION (2006-2012)¹³

	Commencement	Completion
Domestic Undergraduate Degrees	32%	7.8%
Domestic Higher Degrees	69.4%	43%
International Student Undergraduate Degrees	33.3%	50%
International Student Higher Degrees	50%	34%

5 'Getting Not So Serious About STEM', The Mercury, viewed 19 February 2016 at < www.themercury.com.au/news/getting-not-so-serious-about-stem/news-story/6cd6603986ec1fa245a40885abf8f680>.

6 Australian Academy of Science in 'The Engineering Profession: A Statistical Overview' (2015, 12th edn.), Engineers Australia, viewed 10 February 2016, pp 24-25.

7 *ibid.*

8 *ibid.*

9 Engineering Workforce Study (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 41.

10 "NCVER, 2013, VOCSTATS, Students and courses" in "Engineering Workforce Study" (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 42.

11 Engineering Workforce Study (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 76.

12 Engineering Workforce Study (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 39.

13 "Department of Education, Higher education statistics" in "Engineering Workforce Study" (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 39.

Engineers Australia currently offers a range of continuing professional development courses online to target four areas of skills. These courses are:

- ***Project Management***
 - The Fundamentals of Project Management
 - Mastering Complex Projects: Leadership
- ***Risk Management***
 - Effective Risk Management: Risk, Reason and Reward
 - Mastering Complex Projects: Risk
 - The Fundamentals of Project Management
 - The Professional Engineers Act – Your Obligations
- ***Technical Engineering***
 - From Design to Construction: Melbourne Star Observation Wheel
 - The Professional Engineers Act – Your Obligations
 - Engineering Frontiers: Conversations with Engineering Leaders
 - Code of Ethics
- ***Career Development***
 - Career Development
 - Engineering Your Career – Part 3 Early Career Advice
 - Engineering Your Career – Part 4 Next Steps
 - Engineering Frontiers: Conversations with Engineering Leaders

2.3 A MALE DOMINATED PROFESSION

Gender inequality is a systemic issue within the engineering profession nationally, with males being majorly overrepresented in this workforce. Research has suggested that girls in compulsory education are primarily motivated by a combination of role models and hands-on participation in activities, whereas boys associate predominantly with a role model alone.¹⁴ For this reason an increase in events targeting female students to promote engagement and mentoring may increase female participation in engineering.

A further element that negatively influences female participation in the engineering workforce is the requirement for ongoing professional development. Should women attempt to return to the workforce after extended leave (such as maternity leave), the issue of compulsory or vital professional development acts as a barrier to the women. An increase of flexibility in these programmes would be a major benefit for women returning to the workforce and therefore female retention.¹⁵

The average annual pay rate for women in the engineering workforce has been shown to be \$3,000 lower than men at the same level of work. This has been attributed to a possible lack of knowledge of what is a 'normal' pay rate within the engineering profession, or potentially the less aggressive negotiation of pay rates by women.¹⁶ Regardless of the cause, this systemic issue should be addressed to resolve possible disinclination by women to enter the engineering workforce.

Of the engineering organisations surveyed in the development of this plan, 79% stated that they would possibly be interested in participating in initiatives for improving the diversity of both culture and gender within their workforce. This demonstrates that there is a high level of interest in correcting the gender imbalance in the engineering profession.

¹⁴ "Engineering Workforce Study" (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 106.

¹⁵ Ibid p 116.

¹⁶ Engineering Workforce Study (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 117.

3. Engineering in Tasmania

The industries with the highest engineer employment rates are:

- Consulting and Professional Services (24.4%);
- Manufacturing (14.7%);
- Electricity, Gas, Water and Waste (12.1%);
- Public Administration (9.5%);
- Construction (6.5%);
- Transport (6.1%); and
- Education (5.2%).

The Tasmanian engineering profession underwent growth and losses within specific identifiable areas between 2006 and 2011. The areas of highest growth, in order of increase, were:¹⁷

- university lecturers and tutors;
- construction managers;
- chief executives and managing directors;
- ICT support technicians; and
- management and organisation analysts.

Five specific areas were identified as experiencing a net loss of workers with engineering qualifications. Ordered from the areas of highest loss, these were:¹⁸

- vocational education teachers;
- natural and physical science professionals;
- electronics engineers;
- safety inspectors; and
- actuaries, mathematicians and statisticians.

Despite the significant growth in the supply of engineers in Tasmania between 2006 and 2011,

the annual demand for engineers during the same period of time increased by only 3.9%. This was well below the national increase at the same time, which was at 5.5%. This was partially due to there being proportionally less full time employment and more part time employment in Tasmania than the national average.¹⁹

The Hobart region has the highest number of engineers with 1,620 engineers and 67.6% employed in their profession. The lowest unemployment was experienced in Launceston and the North East, with an unemployment rate of 3.1%.

It is clear the local demand for services industry is cyclical.²⁰

Tasmania's key commodity exports have remained weak in spite of favourable global economic conditions for the 2015-16 period. Partially, this is due to an increase in global supply and the rebalancing of the Chinese economy away from investment projects and towards service industries.²¹ Despite this, the Tasmanian economy itself has undergone continued improvements across the last 12 months with forecast growth for 2015-16 above the long-term trend of 2.5%.²²

Though the international and national factors do exert some influence on the local industry, regional factors and Government projects present the most immediate issues for the engineering workforce. There was a downturn in the market of engineering services in Tasmania in 2014 following the completion of several major civil projects, including the Brighton Transfer Hub and Bypass and the Kingston Bypass. However, there are currently several major State infrastructure developments that have the potential to temporarily boost the engineering market demand, including the relocation of the University of Tasmania STEM research and training facilities into the Hobart CBD,²³ the rehabilitation or replacement of the Bridgewater Bridge,²⁴ the development of a range of irrigation schemes across the State,²⁵ the upgrade

17 ABS Census data, 2006 and 2011.

18 ABS Census Data, 2006 and 2011.

19 Engineers Australia, 'The Engineering Profession in Tasmania' (2014), viewed 15 February 2016.

20 "Department of Education, Higher education statistics" in "Engineering Workforce Study" (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 39.

21 Department of Treasury and Finance, 'Tasmanian Economy', viewed 19 February 2016 at <[https://www.treasury.tas.gov.au/domino/df/df.nsf/LookupFiles/2015-16-BP1-2-Tasmanian-Economy.docx/\\$file/2015-16-BP1-2-Tasmanian-Economy.docx](https://www.treasury.tas.gov.au/domino/df/df.nsf/LookupFiles/2015-16-BP1-2-Tasmanian-Economy.docx/$file/2015-16-BP1-2-Tasmanian-Economy.docx)>.

22 Department of Treasury and Finance, 'Revised Estimates Report 2015-16', viewed 3 March 2016 at <[https://www.treasury.tas.gov.au/domino/df/df.nsf/LookupFiles/Revised-Estimates-MYFR-Report-2015-16.pdf/\\$file/Revised-Estimates-MYFR-Report-2015-16.pdf](https://www.treasury.tas.gov.au/domino/df/df.nsf/LookupFiles/Revised-Estimates-MYFR-Report-2015-16.pdf/$file/Revised-Estimates-MYFR-Report-2015-16.pdf)>.

23 The Mercury, 'Hobart City Heart Starter', viewed 17 February 2016 at <<http://www.themercury.com.au/news/opinion/hobart-city-heart-starter/news-story/fbb63f1f235e2906e9376602f43ec3d8>>.

24 Australian Infrastructure Plan - Infrastructure Priority List, Infrastructure Australia, February 2016, p 6.

25 *ibid.* p. 99.

of sewerage infrastructure in Hobart, Launceston and Devonport, and the planned University of Tasmania Arts Academy.²⁷

There has been a heavy reliance on government-funded projects within the Tasmanian engineering profession. The survey indicated that 80% of respondents were at least partially reliant on these projects for their workload. Of these responses, 59% were heavily dependent on government-funded projects which accounted for 80% or more of their work.

This level of reliance on government-funded projects is a point of concern, particularly as the Tasmanian economy continues to recover after a period of weak economic activity. This situation may ameliorate over the medium term as current indications are that business confidence is high and private investment is growing strongly, with a number of significant commercial construction projects underway, particularly in the south of the State.²⁸ Growth risks remain, as the Tasmanian Government observes that:

While the short-term outlook for private investment is positive, the level of activity in a small economy such as Tasmania can be affected by the timing of major projects. For some major private projects in Tasmania, the timing is uncertain.²⁹

Specific industries that employ engineers have been recognised for their potential for future positive growth in the engineering workforce.

Manufacturing shows major potential, particularly as an increased emphasis is being placed on the implementation and development of technical skills and identifying the market for highly skilled engineers.³⁰

Though projected to have a slower rate of increase, construction has been identified as likely to have a slow but steady and regular growth throughout the long-term future. Civil and heavy residential construction are the areas of highest positive growth within the construction industry.³¹

In the civil construction sector, a sector summary prepared by industry in conjunction with the Tasmanian Department of State Growth examined opportunities and limitations for the State's engineering profession.³² This summary raised concerns regarding the retention of a skilled workforce throughout periods of high and low demand, an issue that is mirrored at a national level.

Research undertaken by the former Australian Workforce and Productivity Agency identified the industry of Professional, Scientific and Technical Services as paramount to every other engineering profession for future growth.³³ This industry sector was identified to having double the growth of any other engineering industry.

The Construction and Property Service Industry Skills Council (CPSISC) has further identified the Professional, Scientific and Technical Services, Education, and Construction industries as having the highest growth in the demand for engineers.³⁴

The Tasmanian engineering workforce has trended against national projections since the GFC, experiencing lower levels of growth when compared to national levels of economic improvement.³⁵ There are some indications that there may be limited capacity within the local workforce to support significant growth. While vacancies in engineering in Tasmania declined significantly in the 12 months to March 2014, they have gradually increased since then. Engineers Australia reports that there were 11 vacancies in December 2015, increasing to 14 in March 2016.³⁶

26 Ibid, p 102.

27 The Mercury, viewed 04 March 2016 at <<http://www.themercury.com.au/entertainment/tasmanian-taxpayers-chip-in-15m-to-build-utas-arts-academy/news-story/b3ee9cc8de0ae2b8ced3676367478f14>>.

28 The Budget 2016-17, Budget Paper No. 1, Tasmanian Government, pp 24-32.

29 The Budget 2016-17, Budget Paper No. 1, Tasmanian Government, p 29.

30 Engineering Workforce Study (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 24.

31 Ibid, pp 25-26.

32 Department of State Growth (TAS), 'Sector Summary 2014', viewed 15 February 2016 at <http://www.stategrowth.tas.gov.au/_data/assets/pdf_file/0011/89579/Building_Construction.pdf>.

33 Engineering Workforce Study (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 25.

34 Ibid.

35 Department of State Growth (TAS), 'Sector Summary 2014', viewed 15 February 2016 at <http://www.stategrowth.tas.gov.au/_data/assets/pdf_file/0011/89579/Building_Construction.pdf>.

36 Engineers Australia, Public Affairs Note. Engineering Vacancy and Migration in Tasmania March 2016 Update.

3.1 THE LOCAL WORKFORCE

In 2011 Tasmania had 4,111 engineers, an increase of 22% (757) since 2006.³⁷ Only 65.7% were employed in engineering related fields; and 3.8% were unemployed.

The distribution of engineers in Tasmania is extremely varied. Hobart has the highest number of engineers and with 67.6% working within the profession, the highest level of participation within the engineering profession.

Comparatively, the lowest number of engineers is in the South East, which has the highest level of trained engineer unemployment at 5.1% and only 61.9% of trained engineers working within the engineering profession. The lowest levels of trained engineer unemployment were recorded in Launceston and the North East where the rate of unemployment was at 3.1%.³⁸

Women make up only 6.6% of the total workforce numbers.³⁹

There are further recruitment difficulties in the areas of Civil Engineering professionals (specialising in large-scale structural work), Electrical Engineering (specialising in engineering design and consultation) and Mechanical Engineering (specialising in engineering design and consultation and scientific research).⁴⁰

A local government employment study⁴¹ identified the engineering profession as one of five areas that are projected to have the highest loss of employees through turn-over, retirement and resignation.

The study predicted that the number of engineers employed would decline by 59% between 2014 and 2020 due to low levels of regionally delivered TAFE and other engineering courses.

The highest levels of growth in the Tasmanian engineering profession in the period 2006-2011 were experienced by university lecturers and tutors, with an increase of 259 workers. The greatest loss for the engineering profession was from the VET sector, reducing by 160 workers.⁴² Details on further increases and losses experienced in Tasmania over

this period can be found in Appendix B.

Multiple factors have combined in Australia to cause the reduction in growth for the engineering sector. Disengagement by civil construction professionals from professional development and training has also been significant. Many of these professionals stated that they had attempted to access these courses, but were unsure how to access them or where to start looking.⁴³

The post GFC business climate for engineers remains challenging. Businesses responding to the survey cited increased financial pressures with contract-based work mostly being undertaken for lower prices and with shorter timeframes. Several businesses stated that they have been exploring technological and process improvements to increase efficiency and mitigate reduced revenue.

Businesses stated they experienced significant difficulties attracting graduate workers due to salary constraints and competition from better opportunities elsewhere. Tasmanian engineers receive 10-20% lower remuneration than other cities interstate.⁴⁴

Relevant skills were identified as a major issue in recruitment for businesses, with particular interest in proven academic ability, contract management and project management experience. Practical skills and experience are in high demand, with some concerns raised that graduates do not necessarily have these when starting employment, requiring further training and development. One respondent stated:

“Due to the size of many organisations there isn't always the opportunity to gain a lot of experience in one organisation. Historically, [we] did send

37 Engineers Australia, 'The Engineering Profession in Tasmania 2014', viewed 15 February 2016.

38 *ibid*

39 *ibid*

40 Engineering Workforce Study (2014), Australian Workforce and Productivity Agency, viewed 14 April 2016, p 22.

41 Local Government Association of Tasmania (2014), 'Tasmanian Local Government Workforce Report 2014', viewed 2 May 2016.

42 See Appendix B.

43 Skills Tasmania, 'Consultant's Report to the Civil Construction Industry Tasmania', viewed 15 February 2016 at <http://www.skills.tas.gov.au/employersindustry/workforceplans/Civil-Construction-Consultants_Report_to_Industry.pdf>.

44 Tasmanian State Government, 'Invest in Tasmania' (2015), viewed 10 June 2016.

graduates... for short period (five weeks – six months) to gain experience in various fields such as generation, protection, design and market operation. These graduates came back and became more valuable employees for their new skills and knowledge. It would be great if there was more opportunities for graduates to rotate to other businesses in Tasmania to upskill themselves”.

Further concerns were raised regarding the availability of ongoing professional development and workforce training. The most common barriers were the costs associated with providing such training, and the expenses associated with the transport required for such programmes.

Thirty-three of survey respondents identified as having an aging workforce without any plan for how to respond to this shift in workforce demographics.

4. Challenges and opportunities

4.1 A MORE NIMBLE WORKFORCE

The Tasmanian engineering profession is competing, collaborating and supplying services to an international field. This impacts on the skill set needed of engineers to survive and thrive in this market place. The profession is integrated into sophisticated supply chains. This requires both a broadening of the skills required of engineers and a deepening of the skill set to play specialist roles within a supply chain. Such skill sets include project and contract management, quality assurance and the ability to work in increasingly complex, and often, virtual team environments. Professional development support is currently available for all these skill sets except virtual team work.

The Australian Parliament is currently conducting an investigation into the future of Australian industry and its workforce, titled 'Innovation and Creativity: Workforce for the New Economy'.⁴⁶ During this investigation, Engineers Australia made a submission stating that failure to develop engineering capacities may result in a stall of innovation.⁴⁷ The submission further emphasised the issues faced by the lags of engineering workforce supply caused by the length of engineering education.⁴⁸ The investigation is currently ongoing, and is open for public submissions.

Recommendation: Develop a plan to build an understanding of the role of engineering global supply chains.

4.2 DECLINE IN PRE-TERTIARY STEM ENROLMENT

Australia's future domestic engineering capacity is dependent on the maintenance and improvement of the level of participation in STEM subjects at the pre-tertiary (Years 11 and 12) level to allow for entry into engineering courses. The study of STEM can be characterised as key enabling subjects required to support entry into post-secondary engineering education and training.

Since 2007, school retention rates between Year 10

to Year 12 have continued in an upwards trend at an average annual growth of 1.6% and the number of year 12 students in Australia has increased by 20.7% between 2000 and 2014. However, during the same period the participation in pre-tertiary STEM subjects has declined.⁴⁹

The key challenge is to increase pre-tertiary retention rates and arrest the falling participation in STEM subjects. Even in subjects such as chemistry, where the numbers of enrolment have increased, the overall trend of a reduction in participation levels poses concerning questions as to Tasmania's future domestic engineering capacity.

A recommendation relating to STEM is incorporated below.

4.3 GENDER IMBALANCE IN ENGINEERING EDUCATION

There are many more males in Year 12 studying engineering enabling subjects such as mathematics and science. Since 2009, an average of 15.4% of the students commencing entry level engineering courses have been women. To put the ratio into perspective, in 2012 there were 11,640 applications to study entry level engineering courses, 1,457 or 14.3% were women with the remaining 10,183 applications being made by men. One of the causative factors for the skewed gender ratio is the flow of women through enabling subjects that lead into engineering pathways. For instance:

- the 19,366 girls studying Chemistry accounted for 48.5% of the total participation;
- the 7,771 girls studying Physics accounted for 24.7% of the total participation;
- the 7,305 girls studying Advanced Mathematics accounted for 33.9% of the total participation; and
- the 15,076 girls studying Intermediate Mathematics accounted for 35.4% of the total participation.

⁴⁶ Viewed 28 April 2016 at <http://www.aph.gov.au/Parliamentary_Business/Committees/House/Education_and_Employment/Innovation_and_Creativity>.

⁴⁷ Engineers Australia (2016) Engineering Capacity Key to New Economy, viewed 28 April 2016 at <<http://newsroom.engineersaustralia.org.au/news/media-release/engineering-capability-key-to-the-new-economy>>.

⁴⁸ Engineers Australia (2016) Engineering Capacity Key to New Economy, viewed 28 April 2016.

⁴⁹ Engineers Australia, 'The Engineering Profession in Tasmania 2014', viewed 10 February 2016.

The low level of female applications to study entry-level engineering highlights the increasing importance of attracting girls to study pre-tertiary STEM subjects. It follows that increasing female participation in engineering enabling STEM subjects will assist in increasing the number of applications for placement in post-secondary engineering courses.

Recommendation: Engineers Australia continues to support and promote initiatives to enhance career pathways and improve gender diversity in the industry. This should build on current initiatives to strengthen the focus on STEM in schools.

4.4 ATTRACTING NEW ENGINEERS

4.4.1 PATHWAYS INTO ENGINEERING

There is a recognised need to open the entry points to the profession and support an integrated career structure through to management roles. The current pathway from STEM rich school experiences to post-PhD is well mapped at either end but poorly in the middle.

There are multiple pre-tertiary, tertiary and vocational pathways to becoming an engineer. These courses are offered by institutions such as Tasmanian secondary colleges (Years 11 and 12), TasTAFE and the University of Tasmania. Despite the number of courses offered, they are only run if there is sufficient enrolment to allow for a class. All engineering courses offered by these three organisations are listed below.

Tasmanian Colleges offer:⁵⁰

- Certificate I in Engineering
- Certificate II in Engineering

Courses offered by the Tasmanian Secondary College Registered Training Organisation (RTO) are all at Australian Qualifications Framework (AQF) Levels 1 – 2.

In addition to these courses, TasTAFE offers the following engineering courses:⁵¹

- Short Courses – Built Environment
- Short Courses – Metal Trades
- Cert II in Electrotechnology – Career Starter
- Cert II in Engineering Pathways
- Cert IV in Engineering – Drafting
- Diploma of Engineering – Technical

Reductions in levels of enrolment for 2016 have meant that only MEM40412 Certificate IV in Engineering – Drafting and two Certificate II courses were offered in Tasmania. Only five students undertook the Diploma of Engineering – Technical.⁵² In effect this means Tasmania has only a single path from School and University.

Currently, nine programs are offered by the University of Tasmania via the School of Engineering and ICT that are accredited by Engineers Australia.⁵³ These courses are:

- Bachelor of Engineering (Biomedical Engineering) (Honours)
- Bachelor of Engineering (Civil and Environmental Engineering) (Honours)
- Bachelor of Engineering (Computer Systems Engineering) (Honours)
- Bachelor of Engineering (Electronics and Communication Engineering) (Honours)
- Bachelor of Engineering (Electrical Power Engineering) (Honours)
- Bachelor of Engineering (Geotechnical Engineering) (Honours)
- Bachelor of Engineering (Mechanical Engineering) (Honours)
- Bachelor of Engineering (Mechatronics) (Honours)
- Master of Professional Engineering (Civil and Structural)

Three University of Tasmania programs offered via the Australian Maritime College (and via co-operative education) are also accredited by Engineers Australia:

- Bachelor of Engineering (Naval Architecture) (Honours)
- Bachelor of Engineering (Ocean Engineering) (Honours)
- Bachelor of Engineering (Marine and Offshore Engineering) (Honours)

Despite this, engineering courses by the University represent only a minor amount of the national activity.⁵⁴

In 2011, course commencements in the University of Tasmania accounted for only 0.23% of the national total, with Tasmanian enrolments in the same year representing only 0.17% of the national total.

⁵⁰ Tasmanian Secondary Colleges RTO Executive Officer, contacted 2 May 2016.

⁵¹ TasTAFE, viewed 19 May 2016 at <http://www.tastafe.tas.edu.au/>.

⁵² Information provided by TasTAFE on 19 April 2016.

⁵³ Engineers Australia (27 Jan 2016) "Engineers Australia Accredited Website" Programs accredited by Engineers Australia, viewed 28 April 2016.

⁵⁴ Engineers Australia, "The Engineering Profession in Tasmania 2014", viewed 10 February 2016.

Similarly, course completion within Tasmania was only a portion of 0.19% of the national total, illustrating the low levels of graduate engineers sourced within the State.

The University of Tasmania has also established a number of other engineering qualifications:

- Associate Degree in Engineering (Mechanical)
- Associate Degree in Engineering (Civil)
- Associate Degree in Engineering (Electrical)
- Advanced Diploma of Marine Engineering
- Bachelor of General Studies (Engineering Pathway)

4.4.2 PARA PROFESSIONALS

A new emerging skill set is emerging across engineering disciplines – a trades person of the ‘internet of everything’. From advanced manufacturing to renewable energy a ‘design thinking’, business savvy, quality focused para-professional is an emerging skill set in demand.

During consultations and through the industry survey it was clear that the ‘hands on’ engineer is both prized and increasingly in demand. Respondents statements included:

“Focus on the para professional before we have none left!”

“Qualified technical officers are impossible to find! Bring back the associate degrees and other courses to train the para professional.”

Projections by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) have suggested a shift of traditional job roles, with robotics replacing workers to undertake routine tasks and more specialised post trade roles emerging.

Upskilling is critical to ensure that new roles can be filled, while retraining must be used to stay ahead of new architectural and engineering technologies.⁵⁵

Work is currently underway in the University sector to attempt to fill this gap⁵⁶ and in the Advanced Manufacturing sector⁵⁷ a project has been commissioned to better define the skill sets and pathways of this emerging occupation.⁵⁸

Recommendation: Engineering associate pathways be developed and supported in key industry sectors such as:

- a. **Advanced Manufacturing;**
- b. **ICT; and**
- c. **Agriculture.**

4.5 A BETTER CONNECTED WORKFORCE

The demand for work of engineers is cyclical and heavily reliant upon government priorities and infrastructure requirements. Demand for work has peaks and troughs as major projects are initiated and completed. Two of the top three declines in engineering employment are those tipped to grow the Tasmanian economy (professional and scientific services and education). Engineering is a critical enabling profession that fuels innovation and yet, as noted in this Plan, the profession faces a range of systemic challenges that will require long term and sustained effort to redress.

Recommendation: Engineers Australia provide leadership on the role of engineering in fostering innovation in Tasmania.

55 CSIRO, ‘Tomorrow’s Digitally Enabled Workforce’, viewed 3 March 2016 at http://www.csiro.au/~media/D61/Files/16-0026_DATA61_REPORT_TomorrowsDigitallyEnabledWorkforce_WEB_160204.pdf?la=en.

56 Engineering Pathways for Regional Australia, Funding Agreement between the Commonwealth and the Department of Education ID13-2984, 2013.

57 Mapping the Connections – Enterprise Connect and University of Tasmania, 2012.

58 Advanced Manufacturing Mapping the Pathways Project, Skills Tasmania, 2016.

5. Next steps

Industry workforce development for the engineering occupation is a collaborative exercise. Accordingly, this workforce development plan needs to be driven by industry in partnership with government and the education sector.

Key outcomes sought by this Plan are improved education pathways in particular for para professional level occupations and improved responsiveness of the education sector to support engineering and its role in innovation. Steering the different sectors of education to achieve these outcomes will be challenging and require strong industry leadership and Government support.

Recommendation: Engineers Australia establishes and leads the governance arrangements to steer the implementation of this Workforce Development Plan. This will involve relevant education and industry stakeholders.

5.1 ACTIONS

1. Secure a Ministerial launch of this Plan and challenge the Government to establish an Innovation Council.

2. Investigate best options for developing 'virtual team work' resources. This could commence with a review and gap analysis of current available resources and then a project to fill gaps.

3. Establish a workforce development committee chaired by Engineers Australia and include all education sectors, Department of State Growth including Skills Tasmania. The committee's brief would be to:

- steer the implementation of this workforce development plan;
- strengthen career pathways;
- improve gender diversity; and
- share knowledge and strengthen partnerships.

4. Develop a project concept to further develop associate pathways in Tasmania. Potential projects could be developed through a number of collaborations, such as:

- Engineering Pathways in Regional Australia Project;
- Sense-T;
- Tasmanian Minerals and Energy Council - Advanced Manufacturing project; and
- working with another industry association such as TaslCT, who have also identified the para professional as a sought after skill set.

APPENDIX A- SURVEY RESPONSES

An industry survey was made publically accessible on the Engineers Australia web site and three newsletter campaigns were also initiated. 47 responses were received from across the State.

Answer Choices-	Responses-
Accommodation & Food services	3 - 6.38%
Agriculture, Forestry & Fishing	9 - 19.15%
Aircraft and Aeronautical	0.00%
Biotechnology	1- 2.13%
Building & Construction	18 - 38.30%
Defence	5 - 10.64%
Education & Training	5 - 10.64%
Electricity, Gas, Water and Waste Services	20 - 42.55%
Health Care & Social Assistance	4 - 8.51%
Heating, Ventilation & Air Conditioning	4 - 8.51%
Information & Communications Technology	8 -17.02%
Infrastructure	18 - 38.30%
Manufacturing	10 - 21.28%
Mining	12 - 25.53%
Oil & Gas	6 - 12.77%
Process & Resources	4 - 8.51%
Professional, Scientific & Technical Services	19 - 40.43%
Public Administration & Safety	3 - 6.38%
Public Works	12 - 25.53%
Railways	5 - 10.64%
Retail Trade	1 - 2.13%
Roads	15 - 31.91%
Telecommunications	7 - 14.89%
Transport, Postal & Warehousing	5 - 10.64%
Water	18 - 38.30%
Wholesale Trade	2 - 4.26%
Total Respondents: 47	

The responses represented:

786 Professional Engineers
247 Engineering technologists
195 Engineering associates

APPENDIX B – HEAT CHART

This table shows changes in employed engineering occupations, sourced from the Australian Bureau of Statistics 2006 and 2011 Census of Population and Housing.

2011-2006	Agriculture, Forestry and Fishing	Manufacturing	Wholesale Trade	Accommodation and Food Services	Rental, Hiring and Real Estate Services	Professional, Scientific and Technical Services	Administrative and Support Services	Public Administration and Safety	Education and Training	Arts and Recreation Services	Total
Chief Executives and Managing Directors	11	0	2	5	-4	14	5	34	24	6	142
Construction Managers	4	2	0	0	4	11	0	13	0	0	144
Actuaries, Mathematicians and Statisticians	0	0	0	0	0	-6	0	-2	-5	0	-8
Management and Organisation Analysts	3	8	0	-4	2	22	-5	41	4	1	114
Electronics Engineers	0	-1	0	0	0	-3	0	-3	0	0	-13
Natural and Physical Science Professionals	-13	2	0	0	0	-41	0	-36	12	-5	-90
University Lecturers and Tutors	0	0	0	0	0	0	0	0	250	0	259
Vocational Education Teachers (Aus)/Polytechnic Teachers (NZ)	0	3	0	0	5	5	-10	-5	-150	0	-160
Safety Inspectors	0	0	0	0	0	2	0	-10	0	0	-8
ICT Support Technicians	0	-6	3	0	5	35	18	29	31	-1	116
TOTAL	-5	56	-9	17	9	503	19	355	272	58	

APPENDIX C – WORKFORCE CHALLENGES

Finding	Challenge	Priority Timeframe	Primary Stakeholders	Supporting Stakeholders
It is an international market	The Tasmanian engineering profession is competing, collaborating and supplying services to an international field. This impacts on the skill set needed of engineers to survive and thrive in this market place.	Medium	Engineers Australia	Industry University of Tasmania TasTAFE
Supply chains are deeply integrated	The engineering profession is integrated into sophisticated supply chains. This requires both broadening of the skills required of engineers but also a deepening of the skill set to play specialist roles within a supply chain. Such skill sets include project and contract management, and quality assurance.	High	Engineers Australia	Industry University of Tasmania TasTAFE
The para-professional is coming	A new emerging skill set is emerging across engineering disciplines – a trades person of the ‘internet of everything’. From advanced manufacturing to renewable energy a ‘design thinking’, business savvy, quality focused para-professional is an emerging occupation.	High	Engineers Australia	University of Tasmania TasTAFE
Job numbers declining in areas of future industry growth	The cyclical nature of the demand for work of engineers means graduates have to hit the ground running. Demand for work has peaks and troughs as major projects are initiated and completed. 2 of the top 3 declines in engineering employment are those tipped to grow the Tasmanian economy (professional and scientific services and education)	Medium	Engineers Australia	Industry Government
Career pathways need work	There is a recognised need to open the entry points to the profession and support an integrated career structure through to management roles. The current pathway from STEM rich School experiences to Post Phd is well mapped at either end but poorly in the middle.	Medium	Engineers Australia	Industry Education Providers
It is still a male dominated workforce	Significant work is in place in the school sector to support STEM learning and address major gender imbalances that flow ultimately through to the workforce. This work needs to be connected to the other education sectors to maximise its impact.	High	Engineers Australia	Industry Education sectors
Keep growing connections between industry and education	There should be more communication between the engineering profession and all education sectors.	Medium	Engineers Australia	Education sectors
Industry workforce development is a collaborative exercise	This plan needs to be driven by industry in partnership with Government and the education sector.	High	Engineers Australia	All stakeholders

APPENDIX D – LIST OF CONSULTATIONS

- Acutel Consulting
- Aldanmark Pty Ltd
- ASC Engineers
- Australian Maritime College
- Brookbank Estate
- Brookfield TGN Holdings (Tas Gas Networks)
- BT and Se Consultants Pty Ltd
- Central Coast Council
- Cromarty
- DA Electricity
- Department of Education – My Education, Southern Colleges, STEM Curriculum and Pathways
- EBSystems
- Elphinstone Pty Ltd
- Engineering Pathways for Regional Australia (UTAS Office of PVC Partnerships and Regional Development)
- Entura
- Fogarty Automotive Services
- Frontier Engineers
- Geoton Pty Ltd
- GHD
- Howarth Fisher & assoc
- Hydro Tasmania
- Jacobs
- Marcom Watson
- PFG Group Pty Ltd
- Pitt&Sherry
- Revolution Design Pty Ltd
- Rjk consulting engineers
- Royal Hobart Hospital
- SEMF
- Shaw Contracting (Aust) Pty Ltd
- Skills Tasmania
- Southern Prospect
- Stornoway
- Tasmanian Irrigation
- TasNetworks
- TasTAFE
- TasWater
- University of Tasmania – Faculty of Science, Engineering and Technology and School of Engineering and ICT
- Wellco Pty Ltd

APPENDIX E - DOCUMENTS AND SOURCES REVIEWED

Title	URL
State of the Engineering Profession 2016	http://www.engineersaustralia.org.au/sites/default/files/uploaded/the_state_of_the_engineering_profession_engineers_australia_2016.pdf
China Edges Closer to Leading World's New Industrial Revolution.	http://europe.chinadaily.com.cn/business/2016-01/26/content_23261111.htm
The Future of Jobs; Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution	http://www3.weforum.org/docs/WEF_FOJ_Executive_Summary_Jobs.pdf
Skill Shortages Report	http://www.skills.tas.gov.au/skillstas/policiesstrategies/Skill_Shortages_Report_-_Final.pdf
Create; vol. 2 no. 1 Feb 2016 (page 18)	N/A
BALT Lean Action Learning Program Round 2 Final Report	http://www.skills.tas.gov.au/employersindustry/workforceplans/BALT-lean-action-learning-program-round-2-final-report.pdf
Engineering Australia Policy Note; The Decline of STEM Studies in Year 12 and the Constraints to University Engineering Studies	https://www.engineersaustralia.org.au/sites/default/files/shado/Resources/stem_at_school_and_higher_education.pdf
Tasmanian Transport and Logistics Workforce Plan 2015-2018	http://www.skills.tas.gov.au/_data/assets/pdf_file/0008/123794/Tasmanian_Transport_and_Logistics_Industry_Workforce_Plan_2015-2018.pdf
ABS Census (2011) in State of the Engineering Profession 2016	http://www.engineersaustralia.org.au/sites/default/files/uploaded/the_state_of_the_engineering_profession_engineers_australia_2016.pdf
The Engineering Profession: A Statistical Overview (12th Edition, November 2015)	https://www.engineersaustralia.org.au/sites/default/files/shado/Resources/statistical_overview_2015.pdf
Sector Summary 2014	http://www.stategrowth.tas.gov.au/_data/assets/pdf_file/0011/89579/Building_Construction.pdf
Which Country has the Most Engineering Graduates?	http://www.weforum.org/agenda/2015/09/which-country-most-engineering-manufacturing-and-construction-graduates/
STEM and the Australian Curriculum: E is for Engineering	http://www.acara.edu.au/verve/_resources/CONASTA_conference_Julie_King_secondary_8_July_2014.pdf
China's Industrial Revolution is Happening in a New Planet	http://theconversation.com/chinas-industrial-revolution-is-happening-on-a-new-planet-18204
China's industrial Revolution	http://www.crccasia.com/news/chinas-industrial-revolution/
A System for Monitoring Shortages and Surplus in the Market for Skills (pages62-67)	http://www.skills.tas.gov.au/skillstas/industryresources/workforce-planning-and-development-resources/A_system_for_monitoring_skills_imbalance_and_surpluses_in_the_market_for_skills.pdf
Tasmanian Local Government Workforce Report (2012)	http://www.skills.tas.gov.au/skillstas/industryresources/government-and-community-safety/TasmanianLocalGovernmentWorkforceReport2012public.pdf
Career Mentor Program	http://www.utas.edu.au/students/careers/events-and-programs/career-mentor-program
School-based Apprenticeships and Traineeships	http://www.skills.tas.gov.au/apprenticeshipstraineeships/schoolbased

Title	URL
Vacancies Fact Sheet, Engineers Australia (Dec 2015)	https://www.engineersaustralia.org.au/sites/default/files/shado/Resources/vacancies_for_december_2015.pdf
Vacancies Fact Sheet, Engineers Australia (Nov 2015)	https://www.engineersaustralia.org.au/sites/default/files/shado/Resources/november_vacancies_fact_sheet.pdf
Consultant's Report to the Civil Construction Industry Tasmania	http://www.skills.tas.gov.au/employersindustry/workforceplans/Civil-Construction-Consultants_Report_to_Industry.pdf
myCPD	http://mycpd.engineersaustralia.org.au/
Engineering Education and the Supply of Engineers in Tasmania and the Territories	https://www.engineersaustralia.org.au/sites/default/files/shado/Resources/higher_education_tas_terr_2015.pdf
VET Articulation and Training	http://www.utas.edu.au/access-participation-and-partnerships/articulation-credit
UTAS; Admission Requirements	http://www.utas.edu.au/admissions/undergraduate/admission-requirements
TasTAFE; Diploma of Engineering - Technical	http://www.tastafe.tas.edu.au/courses/course/diploma-of-engineering-technical/
2013 Statistical Overview Tasmania	https://www.engineersaustralia.org.au/about-us/statistics
Higher Education in Tasmania and the Territories 2015	https://www.education.tas.gov.au/PublicDocument/DoE-AnnualReport-2014-2015.pdf
Skills Shortage List Tasmania 2015 (Published 2016)	https://docs.employment.gov.au/system/files/doc/other/skillshortagelisttas_4.pdf
Engineering Workforce Study (2014)	https://docs.education.gov.au/system/files/doc/other/engineering-workforce-study-june-2014.pdf
Australia to capitalise on China's shift away from manufacturing to consumption	http://www.abc.net.au/news/2016-04-13/china-shifts-from-manufacturing-to-consumption/7320066
Engineers Australia Accreditation Website (2016)	http://www.engineersaustralia.org.au/sites/default/files/160127_web_listing_-_combined_v12_updated_27_january_2016.pdf
Tasmanian Local Government Workforce Report 2014	Provided by LGAT to consultants
Linking qualifications and the labour market through capabilities and vocational streams, Australian Government, L Wheelahan, J Buchanan and S Yu, 2015	https://www.ncver.edu.au/wps/portal/vetdataportal