Manufacturing and Engineering Industry Reference Committee

Skills Forecast and Proposed Schedule of Work 2018-2022

MEM05 Metal and Engineering Training Package
MEM Manufacturing and Engineering Training Package
May 2018

IBSA MANUFACTURING

Administrative Information

Name of Industry Reference Committee (IRC):
Manufacturing and Engineering

Name of Skills Service Organisation (SSO):
Innovation and Business Skills Australia (IBSA Manufacturing)

About the Industry Reference Committee

The **Manufacturing and Engineering Industry Reference Committee** comprises twelve members and was constituted in November 2017.

The 2018 Industry Skills Forecast and Proposed Schedule of Work was reviewed and approved by the membership below:

Mr Ian Curry (Chair)
Mr Kristian Stratton
Mr Daniel Murray
Mr Luke Brown
Mr Adrian Boden
Mr Mark Burgess
Mr David Tiller
Mr Doug De Cean
Mr Michael Grogan
Mr Doug Searle
Mr Paul Baxter
Mr Shane Roulstone

Industry Reference Committee Signoff

The 2018 **Manufacturing and Engineering** IRC Skills Forecast and Proposed Schedule of Work was approved as the result of a properly constituted IRC decision.

IRC Chair: Mr Ian Curry

Date: May 2018

www.ibsa.org.au
manufacturing@ibsa.org.au

IBSA Manufacturing
Level 11, 176 Wellington Parade
East Melbourne, Victoria, 3002

Call (03) 9815 7099

This IRC Skills Forecast and Proposed Schedule of Work has been prepared on behalf of the Manufacturing and Engineering Industry Reference Committee for submission to the Australian Industry Skills Committee (AISC).

This document has been produced with the assistance of funding provided by the Commonwealth Government through the Department of Education and Training.

Contents

Executive Summary

The Industry Reference Committee (IRC) Skills Forecast and Proposed Schedule of Work identifies priorities for training package development work to meet the needs of industry. This document is based on research, analysis and consultations with IRC members and other stakeholders and provides evidence of current and emerging industry skills needs.

What is the Manufacturing and Engineering Industry?

The Manufacturing and Engineering industry covers a diverse range of businesses and occupations associated with designing, making, assembling, installing, maintaining and repairing manufactured products. Their coverage includes most of the sub-sectors or 'classes' within the following Australian and New Zealand Standard Industrial Classification (ANZSIC) subdivisions and groups:

- Primary metal and metal product manufacturing
- Fabricated metal product manufacturing – including key and lock manufacturing
- Other transport equipment manufacturing – including shipbuilding and boatbuilding
- Machinery and equipment manufacturing
- Other manufacturing – including jewellery and silverware manufacturing
- Repair and maintenance – including watch and clock service and repair, and key duplication.

The qualifications in the MEM Manufacturing and Engineering Training Package relate to the following broad areas:

- Engineering
- Boatbuilding and Shipbuilding
- Jewellery Manufacture
- Locksmithing
- Watch and Clock Service and Repair.

Critical Workforce Challenges and Opportunities

Critical workforce challenges and opportunities facing the manufacturing and engineering industry include:

- New Australian Defence Force projects that will be creating significant numbers of jobs and demand for engineering skills for the next 50 years
- Changing technology, which is impacting upon the ways in which work is conducted, providing new business opportunities, assisting businesses to increase their efficiency and productivity and driving a need for new combinations of skills
- Changing business models that are shifting focus from the manufacture of discrete products, to the provision of integrated service-product bundles
- An increasing focus on niche markets and the production of bespoke, high-quality products
- An ageing workforce and challenges in attracting new, highly capable entrants to the industry
- Declining employment in some areas of manufacturing, but growth and skill shortages in others.

Forecasting Skills Priorities

These workforce challenges and opportunities have implications for skill needs, which have informed the following skill development priorities:

- Welding
- Technician skills
- Trainer, Supervisor and Coordinator skills
- Non-destructive testing
- Planning, scheduling, logistics and supply chain management
- Maintenance and diagnostics skills
- Mechatronics
- Design and drafting skills
- Computer-aided manufacturing
- Additive manufacturing
- Jewellery manufacture business basics
- New industrial electrician requirements
- Composite materials
- Electroplating
- Mobile machinery and drones
- Hydraulic hose fabrication
- Underpinning skills (including mathematics, problem-solving, interpretation of supplied information, time-keeping, goal-setting, customer service skills, and project management skills).

Training Package Priorities

In response to these skill needs, the IRC has identified several training package priorities.

The Proposed Schedule of Work 2018–19 to 2021–22 was developed by the IRC, with support from IBSA Manufacturing, based on identified industry trends. The Schedule lists the priorities over the next four years, the rationale and proposed timeframes for these activities.

The items identified as critical for inclusion as a priority for the 2018–2019 schedule of work and a Case for Change included as part of this Skills Forecast are:

- **Welding skills:** the updating of units of competency, restructuring of qualifications and development of new training components to meet changes in welding standards, techniques, processes and procedures
- **Technician skills:** the updating of training components to meet emerging skills needs arising from converging technologies and advanced manufacturing processes and systems in technician and para-professional roles
- **Trainer, Supervisor and Coordinator skills:** the development of post-trade training components to meet the needs of higher level job roles with training, supervisory or coordination responsibilities.

Sector Overview

The MEM05 Metal and Engineering and MEM Manufacturing and Engineering Training Packages cover a diverse range of businesses and occupations associated with designing, making, assembling, installing, maintaining and repairing manufactured products. Their coverage includes some or most of the sub-sectors or 'classes' within the following ANZSIC subdivisions and groups:

- Primary metal and metal product manufacturing (ANZSIC subdivision 21)
- Fabricated metal product manufacturing – including key and lock manufacturing (ANZSIC subdivision 22)
- Other transport equipment manufacturing – including shipbuilding and boatbuilding (ANZSIC group 239)
- Machinery and equipment manufacturing (ANZSIC subdivision 24)
- Other manufacturing – including jewellery and silverware manufacturing (ANZSIC group 259)
- Repair and maintenance – including watch and clock service and repair, and key duplication (ANZSIC subdivision 94).

The manufacturing industry is the largest employer of people with skills developed through the MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages. Other industries, such as mining and resources, transport and construction also utilise these skills; however, due to the difficulty in separately identifying these roles within other industries, they are not included in this analysis.

One of the unique features of the MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages is their strong links to industrial relations (IR) arrangements and the central role they play in relation to award classifications and in some cases, licensing requirements. For this reason, licensing requirements and IR arrangements are vitally important considerations in relation to training package standards in these industry sectors.

Key features of these industry sectors are described below under the main groupings of qualifications within the training packages; namely:

- Engineering
- Boatbuilding and Shipbuilding
- Jewellery Manufacture, Locksmithing, and Watch and Clock Service and Repair.

Details of how these training package areas align with ANZSIC classifications can be found in **Appendix A**.

Engineering

Australia's manufacturing sector overall is growing. According to the PMI, March 2018 marked an eighteen-month period of expanding or stable conditions, and the longest run of continuous expansion since 2005.[1]

IBISWorld reports indicate that there are several areas in which revenue has particularly increased, mostly notably:

- 'Other metal container manufacturing', which has grown in response to demand from the food and beverage sector
- 'Metal roof and guttering manufacturing (except aluminium)', which has grown rapidly due to demand from the building and construction industry, and technological advancements
- 'Photographic, optical and ophthalmic equipment manufacturing', which has performed well because of demand for optical and ophthalmic equipment related to an ageing population
- 'Computer and electronic equipment manufacturing', where growth has occurred in niche markets producing specialised and high value-added products.

Modest annual growth of up to 2% is projected over the next five years for slightly more than half of the relevant ANZSIC classes, due to the expected recovery of local building and construction markets, demand for specialised and niche market products, and in areas related to maintenance and repair (except for products that are cheaper to replace than to repair).

However, many of the manufacturing sectors to which the MEM Manufacturing and Engineering and MEM05 Metal and Engineering qualifications relate are in decline in Australia. IBISWorld reports indicate annual decreases in revenue of up to between 1% and 12% over the last five years across many of the relevant ANZSIC classes.[2] This is largely due to competition from imported goods that can be manufactured more cheaply overseas, and to declining demand for related goods and services from the mining, automotive and construction industries.

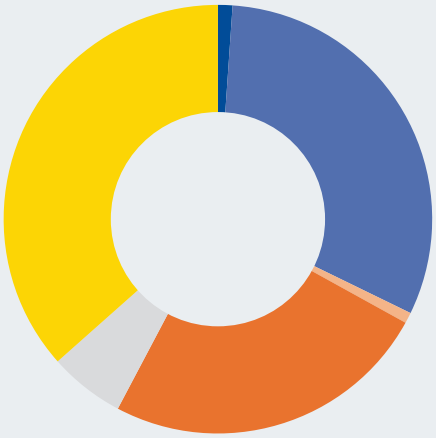
1 AiGroup, 2018, Australian Performance of Manufacturing Index, March 2018

2 IBIS World, 2017, IBISWorld Industry Reports for Primary Metal and Metal Product Manufacturing, Machinery and Equipment Manufacturing, Fabricated Metal Product Manufacturing, Primary Metal Product Manufacturing, Transport Equipment Manufacturing, Toy and Sporting Goods Manufacturing, Jewellery Manufacturing

Business Landscape

According to Australian Bureau of Statistics (ABS) data, there were over 41,000 businesses operating across the engineering sectors at the end of 30 June 2016. Figure 1 below shows the breakdown of these businesses according to the relevant ANZSIC codes.

Figure 1 – Number of engineering-related businesses operating at 30 June 2016



Primary metal and metal product manufacturing	451
Fabricated metal product manufacturing	12,857
Other transport equipment manufacturing (excluding shipbuilding and boatbuilding)	335
Machinery and equipment manufacturing	10,205
Other manufacturing (excluding jewellery and silverware manufacturing)	2,360
Repair and maintenance	15,098

Source: ABS, 2017, 8165.0 Counts of Australian Businesses, including Entries and Exits, Jun 2012 to Jun 2016

In the primary metal and metal product manufacturing, fabricated metal product manufacturing, and machinery and equipment manufacturing sectors, the largest proportion of businesses are small businesses – employing up to 20 people. In the other three sectors, the largest proportion of businesses are even smaller, and do not have employees.

Across all sectors, the majority of businesses are located in either NSW or VIC, followed by QLD and then WA.

Key Industry Stakeholders

Peak bodies in this sector are those related to manufacturing overall, including Ai Group and Manufacturing Australia, as well as those related to the individual sub-sectors.

Whilst most engineering-related businesses are small and micro, there are also many major companies operating in this space, including:

- ABB group
- BAE Systems Australia
- Baxter Healthcare
- BlueScope Steel Limited
- Bombardier Transportation
- Bradken
- Cochlear
- DuluxGroup
- Orora
- ResMed Holdings
- Thales Australia
- UGL
- VAE Rail Systems
- Valmont Group Holdings Limited.

Licensing and Regulation

The lack of a national licensing system means that the licensing requirements across the engineering trades vary considerably across jurisdictions. Examples of the variability include the following:

- in some jurisdictions, locksmiths are required to hold a licence, as are metal fabricators (but in other jurisdictions, these occupations are unlicenced)
- the Certificate III in Engineering – Industrial Electrician leads to a special class of license as an Industrial Electrician, and was developed for use in the mining and resources industries (it is currently only used in one jurisdiction)
- there are a number of certifications that may apply to welders, depending on the type of welding required and whether they need to meet Australian or international standards
- non-destructive testing (the only current skill set in the MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages) is governed and certified by the Australian Institute for Non-destructive Testing (AINDT).

Businesses in the manufacturing industry must also comply with federal, state and local government environmental standards, product safety standards and occupational health and safety regulations, as well as a wide range of sub-sector-specific regulations. An example of this is the specific regulations that apply to medical equipment and are administered under the Therapeutic Goods Administration.

Boatbuilding and Shipbuilding

The boatbuilding sector has been in decline in Australia over the past five years, and is projected to continue to decline, although not as rapidly, over the next five.[3] As the sector is largely dependent on new boat sales, it has been affected significantly by declining consumer demand for 'luxury' products. However, this has been offset somewhat by increased demand for the repair of existing boats, and for smaller, more affordable vessels.

A shortage of marina berths in densely populated areas has also been identified as a contributor to the lack of boat sales.

Unlike boatbuilding, the shipbuilding sector has experienced significant growth, over 5% annually, for the past five years and is projected to continue to grow over the next five.[4] Growth has been driven by demand from the Australian Defence Force, with planned projects for the Collins-class submarine replacement, Anzac-class frigate fleet replacement and Offshore Patrol Vessels continuing to drive demand over the coming years. In all, the Australian Government's Naval Shipbuilding Plan, which was released in 2017, is expected to lead to 5,200 new shipbuilding jobs and more than double that number in sustainment, in less than a decade.[5]

Although commercial shipbuilding is no longer viable on a large scale, due to cheaper overseas manufacturing environments, there are niche markets, such as high-speed catamarans, in which Australian manufacturers are competitive.

3 IBISWorld, 2017, IBISWorld Industry Report C2392: Boatbuilding and Repair Services in Australia

4 IBISWorld, 2017, IBISWorld Industry Report C2391: Shipbuilding and Repair Services in Australia

5 Australian Industry and Skills Committee
https://www.aisc.net.au/hub/contribute-skilling-australia%E2%80%99s-naval-shipbuilding-workforce

Business Landscape

According to ABS data, at the end of 30 June 2016 there were over 1,600 businesses operating in the Boatbuilding and Repair sector.[6] Only 2% of these were medium size (employing between 20 and 199 people), with the remainder small, or without employees. Businesses operating in this sector are concentrated in QLD (35%), followed by NSW (over 25%) and WA (over 15%).

By contrast, of the 429 businesses operating in the Shipbuilding and Repair sector, over 5% were medium and 2% large. The majority are located in NSW (nearly 30%) and QLD (27%), followed by WA (20%).

Key Industry Stakeholders

The three major companies in the boatbuilding sector – Riviera Australia, Telwater and Haines Marine Industries – are all based in QLD.

In the shipbuilding sector, the largest companies are those providing shipbuilding services for defence purposes as part of their operations – ASC Pty Limited, BAE Systems Australia Holdings Limited, Thales Australia Holdings Pty Limited, Austal and Civmec Construction and Engineering Pty Ltd. However, another significant player, Incat Tasmania Pty Ltd, manufactures catamarans.

Licensing and Regulation

Regulations in the shipbuilding industry are governed by the International Maritime Organisation and include matters relating to safety and environmental regulations, as well as maritime security and shipping efficiency.

The boatbuilding sector is governed by the Australian Maritime Safety Authority (AMSA), which covers issues to do with safety, stability and water-tight and weather-tight integrity.

As a result of wide variations in the certification requirements for welders performing repair and maintenance work on boats and ships, the International Institute of Welding (IIW) has created a set of uniform standards to which a large number of national welding associations, including the Welding Technology Institute of Australia (WTIA) subscribe.

6 Source: ABS, 2017, 8165.0 Counts of Australian Businesses, including Entries and Exits, Jun 2012 to Jun 2016

Jewellery Manufacture, Locksmithing and Watch and Clock Service and Repair

Revenue in the Jewellery and Silverware Manufacturing sector has grown by about 2% over the past five years, as significant declines in gold and silver prices have made jewellery more affordable. There has also been a particular increase in demand for handmade and custom-made jewellery.[7]

IBISWorld reports indicate that growth is likely in areas where more complex and sophisticated technology is creating niche markets requiring more sophisticated tools, equipment and expertise.[8]

By contrast, the watch and clock service and repair sector is shrinking, despite reports of demand growing in Australia by over 10%.[9] Globally there has been a decline in demand for Swiss watches (as opposed to digital watches), whereas Australia has experienced growth; and there has been a specific resurgence of interest in vintage watches. A decline in the supply of skilled watch and clock makers and repairers (see the Challenges and Opportunities section for further details), combined with challenges in gaining access to spare parts from watch manufacturers, is leading to a decline in the availability of services.

Business Landscape

According to ABS data, at the end of 30 June 2016 there were over 1,300 businesses operating in the Jewellery and Silverware Manufacturing sector.[10] More than 60% of these businesses did not have employees, with just 1% classed as medium and the remainder small. The large majority are located in NSW (nearly 40%), followed by VIC (25%) and QLD (nearly 20%).

It is not possible to identify the numbers of Locksmithing and Watch and Clock Service and Repair businesses within current data.

7 IBISWorld, 2017, IBISWorld Industry Report C2591: Jewellery Manufacturing in Australia

8 IBISWorld, 2017, IBISWorld Industry Report O7712: Investigation and Security Services in Australia

9 Watch and Clockmakers of Australia http://www.wca.org.au/watchmakers-of-australia

10 Source: ABS, 2017, 8165.0 Counts of Australian Businesses, including Entries and Exits, Jun 2012 to Jun 2016

Key Industry Stakeholders

The Jewellers Association of Australia is the peak industry body for the jewellery manufacture sector.

The locksmithing sector is represented by the Master Locksmiths Association of Australasia Limited and the Locksmiths Guild of Australia.

Watch and Clockmakers of Australia is the peak industry association for watch and clock service and repair.

Whilst most businesses in this sector are small and micro, there are a few medium-size players, including:

- Pallion Group Pty Limited
- Michael Hill International Limited
- Wallace Bishop Pty Ltd.

Licensing and Regulation

In the major Australian states (NSW, QLD, VIC and WA), security licences are now required for certain aspects of locksmith work.

Training Snapshot

The MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages attract the highest number of enrolments of any training package managed by IBSA Manufacturing. Nearly 56,000 learners were enrolled in MEM Manufacturing and Engineering and MEM05 Metal and Engineering qualifications in 2016, which is almost half of the enrolments across all IBSA Manufacturing training packages.

Learner Training Profile[11]

In 2016, a learner enrolled in a qualification from the MEM Manufacturing and Engineering or MEM05 Metal and Engineering Training Package was more likely to be:

Enrolled in a Certificate III level qualification

- Studying in Queensland
- Aged 19 years or younger
- Male
- Not an apprentice or trainee
- Enrolled with a public training provider.

Over the period 2014–2016:

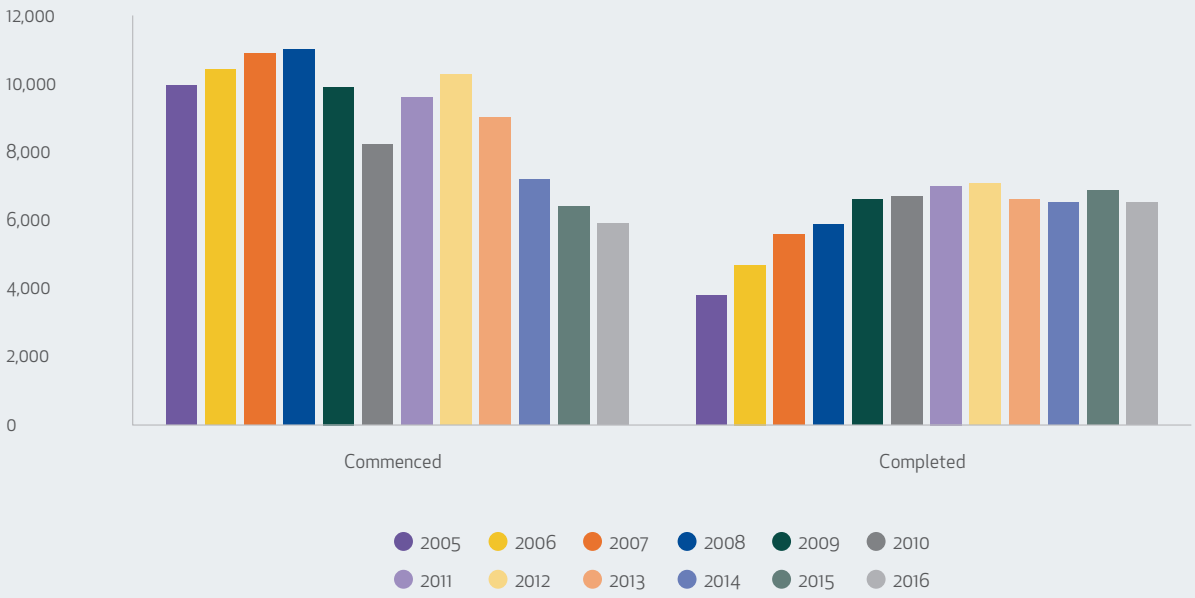
- QLD has consistently had the highest proportion of learners, accounting for nearly a third of enrolments, while NSW and WA accounted for slightly more than 20% and slightly less than 20% respectively
- Learners aged 19 years and under have consistently accounted for around half of all enrolments, highlighting the importance of the MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages in providing entry level qualifications for young people
- Males consistently accounted for around 95% of all enrolments.

All but four of the qualifications in the MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages are deemed a traineeship or apprenticeship pathway in at least one state or territory. The Certificate III in Engineering – Mechanical Trade, and Certificate III in Engineering – Fabrication Trade are the most common apprenticeship pathways, accounting for around 90% of government funded enrolments in these qualifications. Apprenticeships also account for more than 90% of the government funded enrolments in the Certificate III in Marine Craft Construction and Certificate III in Locksmithing.

Consultations indicated that there are some difficulties in recruiting apprentices to the industry. Figure 2 below shows that apprentice and trainee numbers have been declining significantly since 2012. However, completions have remained relatively stable over the same period.

11 VOCSTATS VET Provider Collection, extracted September 2017

Figure 2 – Apprenticeships and traineeships, commencements and completions, Certificate III or higher qualification, Engineering trades, Australia, 2005 to 2016 (year to March)



Source: NCVER, Apprentices and trainees, March 2016, cited in Australian Government Department of Employment, 2016, Labour Market Research – Engineering Trades

Training Delivery

As illustrated in Table 1 below, TAFE is the predominant provider of training in MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages, accounting for nearly two-thirds of all Vocational Education and Training (VET) delivery. In addition, almost two-thirds of all training is government funded.

Table 1 – Program enrolments in MEM Manufacturing and Engineering and MEM05 Metal and Engineering qualifications by Training Organisation type

Training Organisation Type	Total VET Enrolments 2015	Total VET Enrolments 2016	Percentage of enrolments that were Government Funded	
	2015	2016	2015	2016
TAFE	32,434	29,683	75%	76%
University	3,215	2,791	85%	83%
Enterprise provider	73	43	99%	100%
Private training provider	12,670	12,029	68%	62%
School	11,284	10,615	28%	31%
Community education provider	305	721	60%	63%
Totals	59,981	55,882	65%	64%

Source: NCVER VOCSTATS, Total VET Activity, extracted 20/9/2017

In the engineering area, as of March 2018:

- The Certificate I in Engineering and the Certificate II in Engineering Pathways were on the scope of significant numbers of schools, private providers and TAFE Institutes spread across the country (134 Registered Training Organisations [RTOs] had the Certificate I on scope and 102 had the Certificate II on scope)
- The Certificate III in Engineering – Industrial Electrician was only on scope of providers in WA, reflecting specific licensing arrangements in the state, while the Certificate III in Engineering – Composites Trade was only on scope of providers in VIC and WA. Not surprisingly, enrolments in these two qualifications are very low by comparison to most of the engineering qualifications
- The remaining Certificate II, III, IV, Diploma and Advanced Diploma level qualifications were on scope of providers spread across most of the country, predominantly by TAFE, but also by small numbers of private providers.

In the boatbuilding and shipbuilding area, as of March 2018:

- Training providers with qualifications in this area on scope were concentrated in QLD, although there were some providers, both public and private, with these qualifications on scope in NSW, VIC, WA and SA.

In the areas of jewellery manufacture, locksmithing and watch and clock service and repair, as of March 2018:

- TAFE was the only provider of training in jewellery related qualifications, with those providers with the Certificate III on scope spread across the country, but concentrated in NSW, VIC and SA at the higher levels qualifications
- Training in the locksmithing qualification was only delivered by TAFE Institutes in QLD, NSW, VIC and WA. All locksmithing apprentices in SA, NT and TAS attend TAFE in Victoria
- Watch and clock service and repair training was only delivered by two providers – one in Sydney and one in Perth.

Qualifications Available

The following qualifications and skill sets are included in the MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages:

Engineering

- MEM10105 Certificate I in Engineering
- MEM20105 Certificate II in Engineering
- MEM20205 Certificate II in Engineering – Production Technology
- MEM20413 Certificate II in Engineering Pathways
- MEM30305 Certificate III in Engineering – Fabrication Trade
- MEM30105 Certificate III in Engineering – Production Systems
- MEM31112 Certificate III in Engineering – Composites Trade
- MEM30405 Certificate III in Engineering – Electrical/Electronic Trade
- MEM30205 Certificate III in Engineering – Mechanical Trade
- MEM30505 Certificate III in Engineering – Technical
- MEM31215 Certificate III in Engineering – Industrial Electrician
- MEM40412 Certificate IV in Engineering Drafting
- MEM40105 Certificate IV in Engineering
- MEM50105 Diploma of Engineering – Advanced Trade
- MEM50212 Diploma of Engineering – Technical
- MEM60112 Advanced Diploma of Engineering
- MEM80112 Graduate Diploma of Engineering.

Boatbuilding and Shipbuilding

- MEM10205 Certificate I in Boating Services
- MEM20305 Certificate II in Boating Services
- MEM30905 Certificate III in Boating Services
- MEM30705 Certificate III in Marine Craft Construction
- MEM40205 Certificate IV in Boating Services.

Jewellery Manufacture, Locksmithing, and Watch and Clock Service and Repair

- MEM30605 Certificate III in Jewellery Manufacture
- MEM30805 Certificate III in Locksmithing
- MEM31010 Certificate III in Watch and Clock Service and Repair
- MEM40311 Certificate IV in Advanced Jewellery Manufacture
- MEM50311 Diploma of Jewellery and Object Design
- MEM60211 Advanced Diploma of Jewellery and Object Design.

Skill Sets

- MEMSS00001 Non-Destructive Testing – Level 2 NDT practitioners.

Current work is underway to ensure the qualifications from the MEM05 Metal and Engineering Training Package comply with current training package policy requirements and templates. This is referenced in the Training Product Review - Current Activities section of this report.

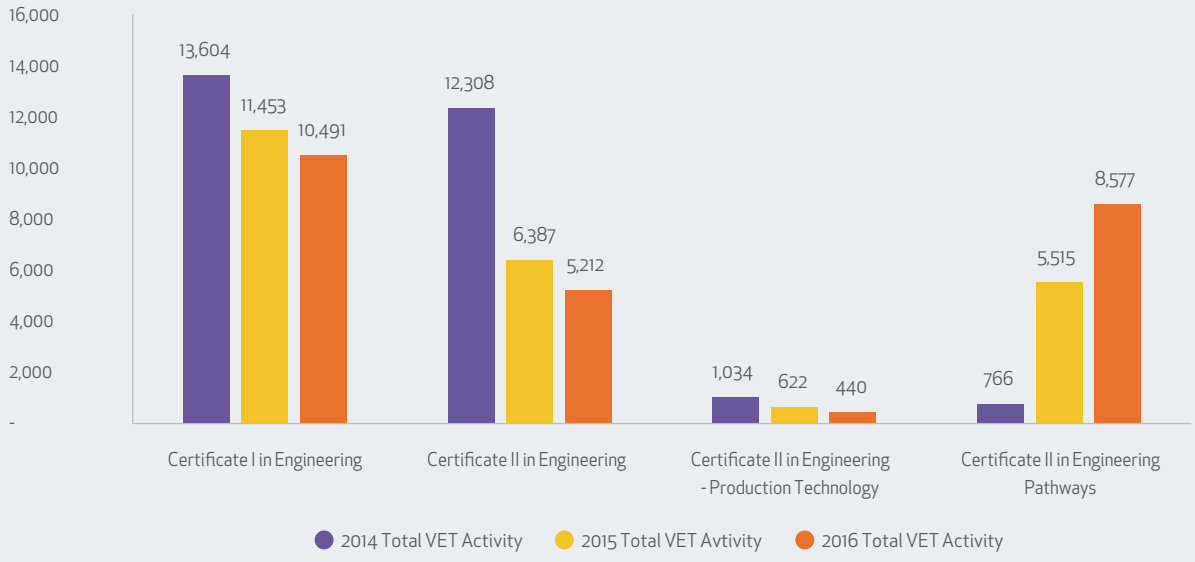
Qualification Uptake

Engineering

Enrolments in engineering qualifications account for 98% of all enrolments in the MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages. Trends in enrolments in these qualifications are illustrated in Figures 3–5 below. Amongst these qualifications:

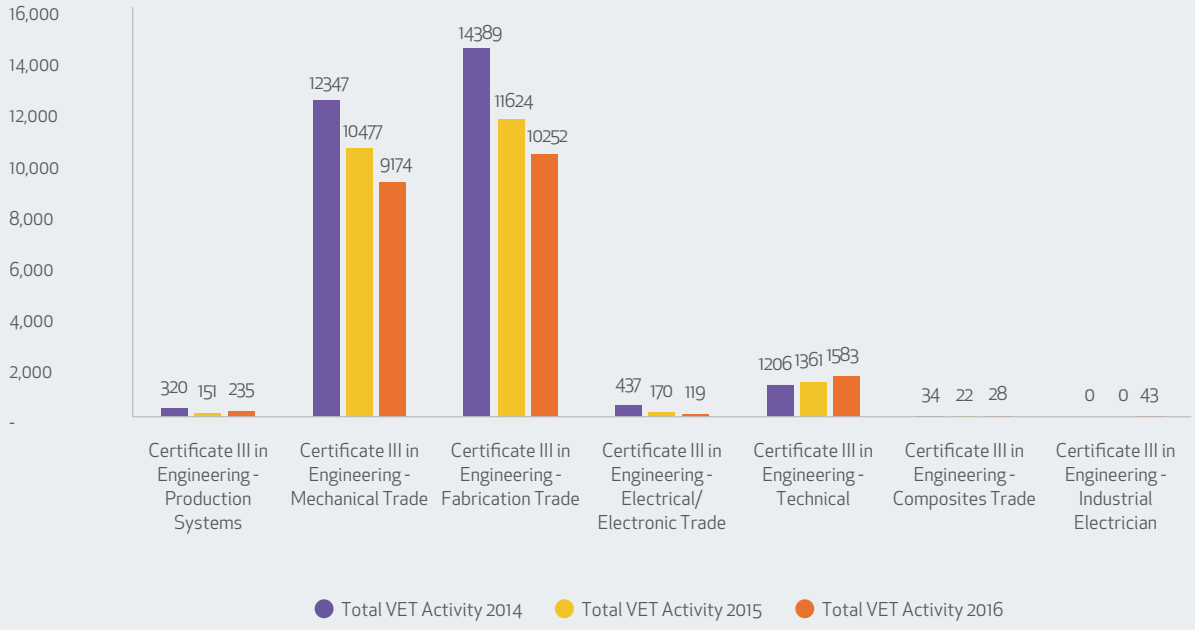
- Enrolment numbers have been in decline from 2014–16, except for:
    - Certificate II in Engineering Pathways, which has increased dramatically, with a corresponding decline in enrolments in the Certificate II in Engineering over this period. The trend for enrolments in these qualifications probably indicates that learners with no access to on-the-job learning are now being enrolled in the more appropriate 'pathways' qualification
    - Certificate III in Engineering – Technical, which has increased steadily over that period
    - Certificate IV in Engineering Drafting, which has likewise increased steadily.
- The qualifications experiencing the highest levels of demand in 2016 were:
    - Certificate I in Engineering (10,491 enrolments)
    - Certificate III in Engineering – Fabrication Trade (10,252 enrolments)
    - Certificate III in Engineering – Mechanical Trade (9,174 enrolments).
- By contrast, the following qualifications had much lower enrolment levels:
    - Certificate III in Engineering – Composites Trade (approximately 30 enrolments per year over the three years)
    - Certificate III in Engineering – Industrial Electrician (only 43 enrolments in 2016 – due to the specific licensing purpose of this qualification)
    - There have been no recorded enrolments in the Graduate Diploma of Engineering and only one private provider is currently registered to deliver it, and only in New South Wales, Victoria and Queensland.

Figure 3 – Enrolments in Certificate I and II level Engineering qualifications



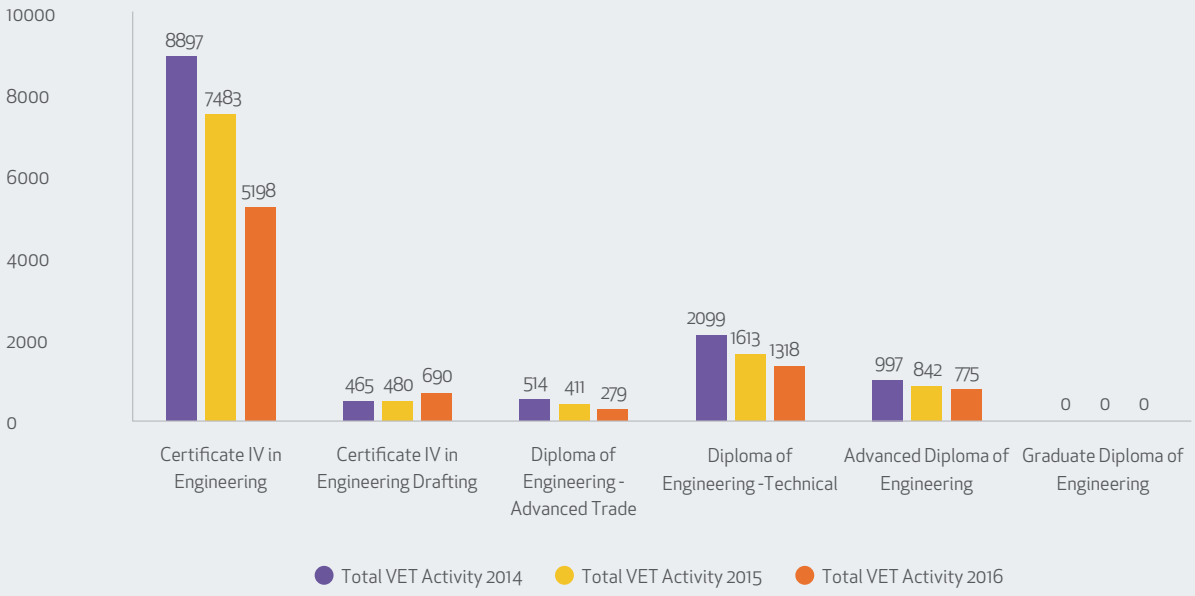
Source: NCVER VOCSTATS, Total VET Activity, extracted 18/9/2017

Figure 4 – Enrolments in Certificate III level Engineering qualifications



Source: NCVER VOCSTATS, Total VET Activity, extracted 18/9/2017

Figure 5 – Enrolments in Certificate IV and higher-level Engineering qualifications



Source: NCVER VOCSTATS, Total VET Activity, extracted 18/9/2017

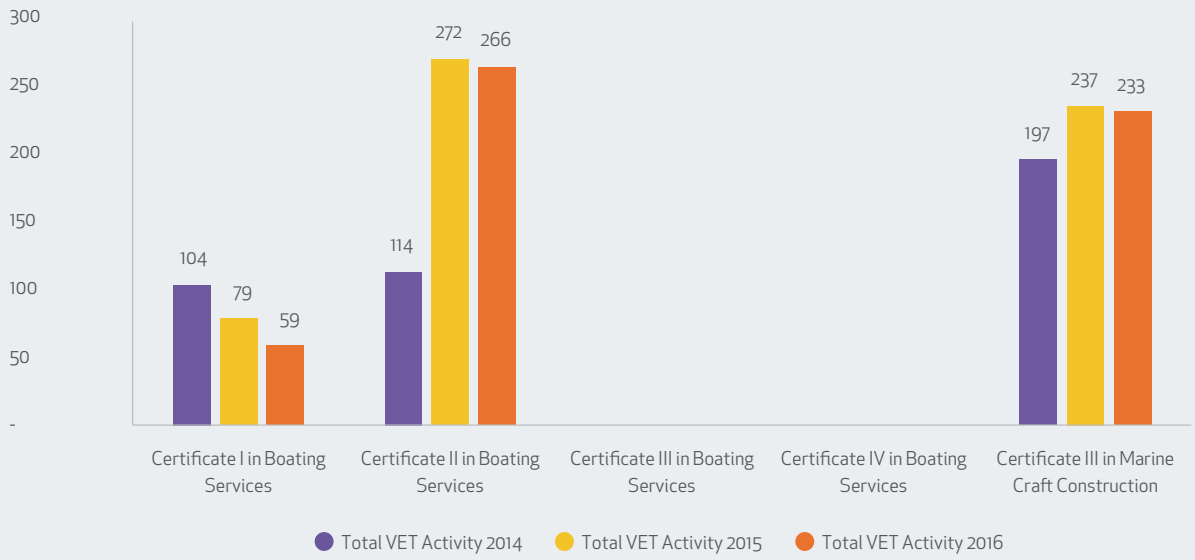
Boatbuilding and Shipbuilding

As illustrated in Figure 6 below, demand for the apprenticeship-based Certificate III in Marine Craft Construction has hovered around 200 enrolments from 2014–16.

Enrolments in the Certificate I in Boating Services declined each year between 2014–16. However, enrolments in the Certificate II have more than doubled during the same period – despite fewer than 20% of these places being government funded.

Introduced in 2005, the current Certificate III in Boating Services has had no recorded enrolments since 2010. The Certificate IV has not had any recorded enrolments. TAFE Queensland is the only training provider currently registered to deliver the Certificate III, but it is registered to deliver this qualification in all states and territories. There are no providers currently registered to deliver the Certificate IV.

Figure 6 – Enrolments in Boatbuilding and Shipbuilding qualifications



Source: NCVER VOCSTATS, Total VET Activity, extracted 18/9/2017

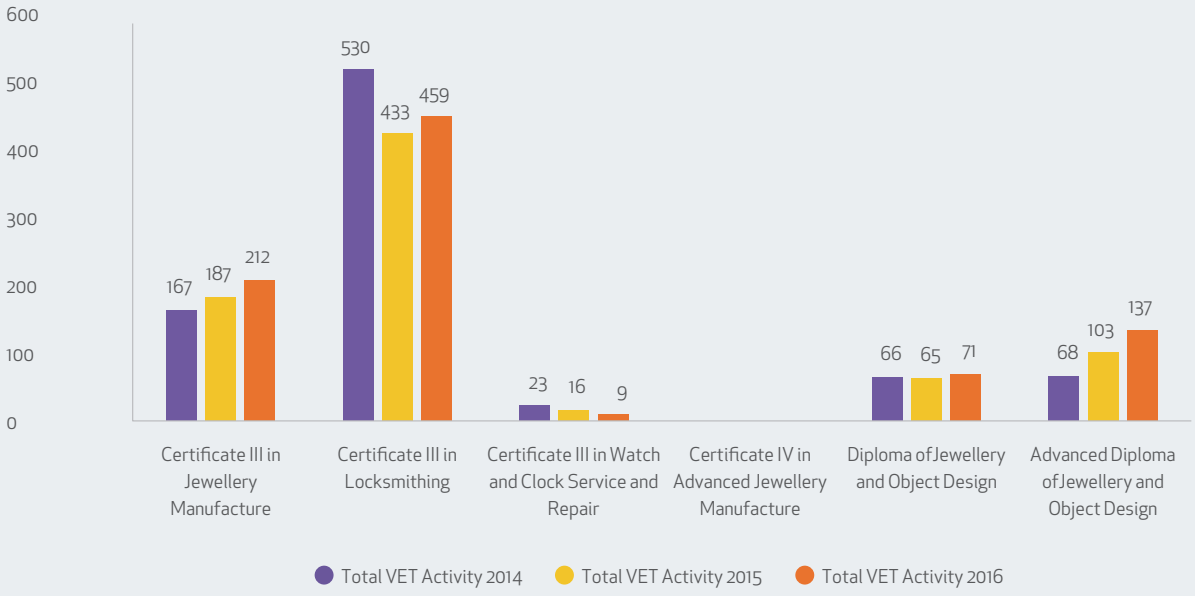
Jewellery Manufacture, Locksmithing, and Watch and Clock Service and Repair

Enrolments in jewellery related qualifications grew rapidly over the period 2014–16, particularly in the Advanced Diploma of Jewellery and Object Design, which has almost doubled over this period (see Figure 7). The exception is the Certificate IV in Advanced Jewellery Manufacture, which has had negligible enrolments since the introduction of the current qualification in 2011. There is currently only one provider registered to deliver this qualification (in NSW and ACT) and no available government funding.

Enrolments in the apprenticeship-based Certificate III in Locksmithing have fluctuated somewhat, but continue to attract more than 400 enrolments each year. Consultations suggested that this is a growing industry area and that changes being made to the current qualifications to bring them up-to-date with new technology and practices will see industry demand for these qualifications grow.

Enrolments in the Certificate III in Watch and Clock Service and Repair have been in continual decline since 2013. Despite its apprenticeship status and the availability of government funding, there have been fewer than 20 enrolments in 2015 and 2016. Consultations suggested that small and micro businesses, which comprise the majority of this sector, struggle to be able to send employees to training and prefer to do training on-the-job. There was also a suggestion that this qualification needs reviewing to bring it up-to-date with current practices.

Figure 7 – Enrolments in Jewellery Manufacture, Locksmithing, and Watch and Clock Service and Repair qualifications



Source: NCVER VOCSTATS, Total VET Activity, extracted 18/9/2017

A snapshot of enrolments in the MEM Manufacturing and Engineering Training Package is provided in **Appendix B**.

Challenges and Opportunities

For Industry and Employers

One of the biggest drivers of growth and change in engineering-related skills will be the Australian Defence Force projects that are starting to be rolled out and that will continue for the next 50 years. The projects include:

- Construction of 12 new submarines under the Future Submarines project, which is expected to begin in Adelaide in 2022 and continue through to the late 2040s. The project is anticipated to create an average of 2,800 direct jobs across the life of the project[12]
- Construction of the new fleet of Offshore Patrol Vessels, which will commence in 2018 at the Osborne Naval Shipbuilding Precinct, located in Adelaide. Construction of the 12 new vessels will create more than 400 direct jobs. The project will transfer to Perth in 2020, to enable the commencement of the Future Frigates project in Adelaide, creating a further 2,000 direct jobs
- The Land 400 project, which is expected to deliver 675 military vehicles over 15 years and require ongoing maintenance and support for those vehicles for up to 30 years. The successful tenderer, Rheinmetall, has committed to establish its headquarters and Military Vehicle Centre of Excellence in South East Queensland.[13]

These projects will have a massive impact on the industry, not only through the creation of direct employment, but also through the economic impact on the wider sectors involved in the project supply chains. The need for ongoing maintenance of the new vessels and vehicles, and the creation of new technology and skills, will flow on to other industries.

These projects will also contribute to the promotion of a new image of the modern manufacturing industry, which is now characterised by work environments that are pristine, highly controlled and technologically advanced. Many are also focused on continuous improvement and innovation, and staffed by increasingly highly skilled workers who are integrally involved in the process of improvement and innovation.

Conveying these messages about the changed and changing nature of manufacturing will help to attract new, highly capable entrants to the industry and ensure an ongoing supply of necessary skills in an ageing workforce.

Consultations suggest that part of the challenge in attracting new entrants to the industry is changing the language of the current training system which is still predominantly based on traditional impressions of manufacturing, and that adopting language that is appealing and reflective of modern work environments will be a key factor in attracting young people, and a more diverse cross-section of workers, to the industry.

While some parts of the manufacturing industry are in decline, overall the industry is experiencing growth.[14] Given that Australia is not in a position to compete with overseas markets in the manufacture of low-cost, mass-produced goods, the Australian businesses that are succeeding are those that are focused on niche markets and the production of bespoke, high-quality products. Some of these businesses may be 'high-tech', but many are also focused on non-

12 Defence Connect, November 2017, Size of Future Submarines revealed, accessed online at https://www.defenceconnect.com.au/maritime-antisub/1532-size-of-future-submarines-revealed

13 http://www.defenceindustries.qld.gov.au/land/project-land-400.html

14 AiGroup, 2018, Australian Performance of Manufacturing Index, March 2018

technological innovations such as new business models, innovative design and improved manufacturing methods.[15] Australia's Advanced Manufacturing Growth Centre also describes today's successful manufacturing businesses as being characterised by advanced knowledge, advanced processes and advanced business models.[16]

Changing business models are seeing businesses shift focus from the manufacture of 'widgets' to the development of integrated service-product bundles,[17] with those consulted citing many examples of businesses that have transformed themselves into producers of high-value added whole products, and services, not just component manufacturers.

At the same time, other businesses are turning to specialisations, as resourcing every part of the manufacturing process can be cost-prohibitive, and they are therefore increasing their level of collaboration with other businesses within the supply chain.

An increased focus on sustainability is driving innovation in product design and development, as well as a focus on continuous improvement of processes and practices to improve efficiency and productivity.

The other major driver of change in the manufacturing and engineering industry is technology change. Global trends around automation, robotics, sensors, data analytics, advanced materials, additive manufacturing and augmented and virtual reality are impacting on the ways in which work is conducted, as well as providing new business opportunities and increased efficiency and productivity for businesses.

As routine, repetitive and predictable tasks become increasingly automated, skill demands will move to non-automatable tasks – particularly those involving problem-solving and interpersonal skills. The increased adoption of new technologies is also driving a need for new applications of existing skills and new combinations of skills, such as the combination of mechanical and electronic skills, particularly in the areas of maintenance and diagnostics, as well as in the field of mechatronics.

Supply-Side Challenges and Opportunities

Training in new technologies is increasingly being provided by product and equipment manufacturers. Whilst this may indicate a gap in the current training packages, those consulted urged caution about focusing training on proprietary products; and instead advised continuing to ensure that the broader skills required to use, monitor, control and maintain an ever-growing and changing range of products are being developed.

While some of those consulted cautioned about being overly focused on the jobs of the future at the expense of developing the skills that are needed in current jobs, others identified that a lack of qualified trainers is creating problems for the delivery of MEM Manufacturing and Engineering and MEM05 Metal and Engineering qualifications, particularly in regional areas and in content areas in which there is increased use of new technology.

Issues were also raised about the variable quality of delivery amongst training providers and a lack of government funding in some areas. The expense involved in providing training in many areas of manufacturing was acknowledged as a contributing factor to these issues, as well contributing to the lack of availability of training in some sectors.

15 Roy Green, 2015 in The Conversation, Australia's 'five pillar economy' – manufacturing, available online at https://theconversation.com/australias-five-pillar-economy-manufacturing-40639

16 Advanced Manufacturing Growth Centre, Advanced Manufacturing: A new definition for a new era

17 CSIRO, 2016, Advanced Manufacturing: A Roadmap for unlocking future growth opportunities for Australia

Training in watch and clock repair services is one area that is suffering, with only two training providers delivering training for the whole of Australia, and only one of these, TAFE NSW, offering apprenticeships in watch and clock repair. Due to the expense of running the apprenticeship course, the funded hours for the off-the-job training component have been reduced significantly, requiring employers to conduct much more of the training on-the-job. This change is evident in the declining numbers of enrolments and the declining numbers of watch and clock repairers across the country.

For Learners and Training Package Development

One of the major challenges for the MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Packages is that because of the significant IR implications of any changes to their content, the training package development and approval process is slower than in other industries.

Many of those consulted talked about the need for a major update for the packages to ensure that the content reflects current standards and practices. Some feedback described this issue in terms of a lack of 'job readiness' amongst graduates for current workplaces. This will require not only updating content, but also removing content that is now outdated.

Whilst there was agreement that for the most part many of the skills in the training package have not changed, the environment in which they are being applied has. This may require changes to the way in which skills are packaged, in addition to changes to their content.

New technology may not only have implications for training package development, it may also provide opportunities for new ways of learning. Augmented and virtual reality are being used to develop simulated learning environments in areas that are high-risk, involve extremely expensive equipment, or could potentially result in lengthy shutdowns in production.

Cross-Industry Challenges and Opportunities

The impact of automation, digitisation and robotics is also relevant to many other industry sectors, particularly within the manufacturing industry.

Employment and Skills Outlook

Employment Outlook

In line with the overall decline in Australia's manufacturing industry, ABS Census data shows that employment across most of the ANZSIC industry groups relevant to MEM Manufacturing and Engineering and MEM05 Metal and Engineering qualifications also declined in the ten years from 2006 to 2016 – in most cases by 30–60%. The two notable exceptions are Shipbuilding and Repair Services, which has grown by nearly 5%, and Repair and Maintenance, which has grown by 5% over the same period.

ABS Census data also shows that.

- while employment across all of the relevant industry groups is dominated by males (80–90% in most cases), the areas of Machinery and Equipment Manufacturing, and Other Manufacturing employ around 25–30% females, while Jewellery and Silverware Manufacturing employs almost equal proportions of males and females
- the manufacturing workforce is an ageing one, with most industry groupings showing decreases in the employment of young people, under the age of 30, and corresponding increases in the proportion of employees aged 50+
- Shipbuilding and Repair Services and Boatbuilding and Repair Services have slightly younger age profiles than the other industry groupings, with over 20% and 25% of employees (respectively) under 30 years of age in 2016. For all other industry groupings, this age group accounts for less than 20%
- Other Manufacturing, including Jewellery and Silverware Manufacturing, has a comparatively older workforce, with the proportion of employees aged 60+ close to 20%, compared with around 10% in other industry groupings
- workers in the Jewellery and Silverware Manufacturing area are much more likely to work part-time than those in other groupings, while those in the Shipbuilding and Repair Services area are much more likely to work more than 40 hours per week.

Department of Employment labour market projections (illustrated in Table 2 below) suggest that while in the majority of the relevant industry groupings employment will continue to decline, some will experience growth. Those experiencing growth are most notably Basic Ferrous Metal Product Manufacturing, Structural Metal Product Manufacturing and Other Manufacturing, which includes jewellery manufacture.

Table 2 – Employment growth and projections

ANZSIC Code	Industry	Employment level – May 2017	Projected employment growth – May 2017 to May 2022	
		('000)	('000)	(%)
212	Basic Ferrous Metal Product Manufacturing	2.4	0.1	4.8
214	Basic Non-Ferrous Metal Product Manufacturing	7.7	-0.5	-6.9
221	Iron and Steel Forging	0.1	0.0	-12.5
222	Structural Metal Product Manufacturing	33.8	4.8	14.3
223	Metal Container Manufacturing	9.0	-0.4	-4.5
224	Sheet Metal Product Manufacturing (except Metal Structural and Container Products)	1.1	-0.1	-12.5
229	Other Fabricated Metal Product Manufacturing	24.1	-3.0	-12.5
239	Other Transport Equipment Manufacturing	31.0	0.2	0.7
241	Professional and Scientific Equipment Manufacturing	18.8	0.1	0.3
242	Computer and Electronic Equipment Manufacturing	16.6	0.2	1.1
243	Electrical Equipment Manufacturing	11.1	-1.6	-14.6
244	Domestic Appliance Manufacturing	7.1	-0.6	-8.0
246	Specialised Machinery and Equipment Manufacturing	21.9	-0.3	-1.3
249	Other Machinery and Equipment Manufacturing	17.6	-0.2	-1.2
259	Other Manufacturing	14.0	0.3	2.5
942	Machinery and Equipment Repair and Maintenance	65.5	0.4	0.6
949	Other Repair and Maintenance	8.1	-0.4	-5.0

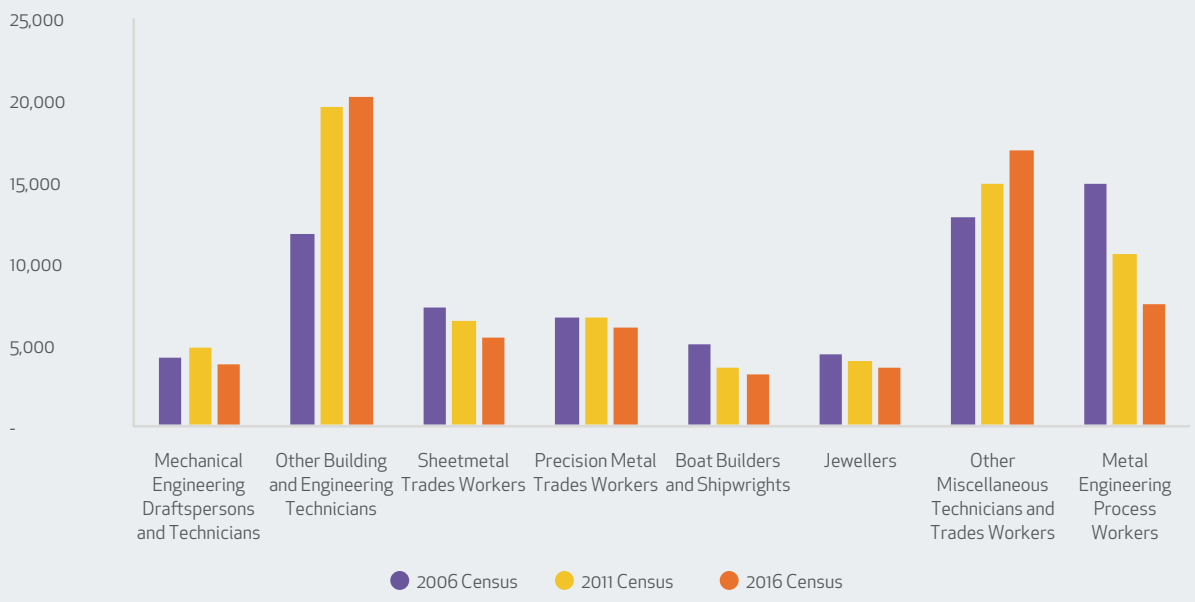
Source: Department of Jobs and Small Business Labour Market Information Portal (LMIP) Industry Employment Projections May 2017 – May 2022

Figure 8 below shows employment trends in the specific Australian and New Zealand Standard Classification of Occupations (ANZSCO) codes related to MEM Manufacturing and Engineering and MEM05 Metal and Engineering qualifications. Many of these occupations cut across the industry groupings described above; therefore, the patterns vary somewhat. This ABS data shows that over the period 2006 to 2016:

- most occupations have been in decline
- employment in Other Miscellaneous Technicians and Trades Workers has grown, but people working in composites trades, the only qualification related to this occupation, comprise only a small proportion of this occupational grouping
- employment growth was experienced in Other Building and Engineering Technicians occupations, which relate to engineering qualifications at the diploma and graduate diploma level. This may reflect the higher-level skill needs arising from technological developments in the manufacturing industry
- jewellery occupations have been in decline, which is contrary to ANZSIC data for the industry. This may reflect the fact that this occupational category does not include jewellery designers, which has experienced growth
- employment for Boat Builders and Shipwrights has also been in decline, but this is likely a reflection of the decline in the boating industry, which has not been sufficiently offset by the growth in the shipbuilding industry.

The occupational data once again shows the extent to which the industry is male-dominated, with males accounting for more than 90% of workers in each of the occupations, apart from Jewellers and Other Miscellaneous Technicians and Trades Workers.

Figure 8 – Employment in ANZSCO occupations related to MEM Manufacturing and Engineering and MEM05 Metal and Engineering qualifications



Source: ABS Census of Population and Housing; 2006, 2011 and 2016

Details of the alignment between MEM Manufacturing and Engineering and MEM05 Metal and Engineering qualifications and the ANZSCO occupation classifications can be found in **Appendix C**, and details of the alignment between ANZSIC industry classifications and the three key areas of MEM Manufacturing and Engineering and MEM05 Metal and Engineering qualifications can be found in **Appendix A**.

Workforce Supply Challenges and Opportunities

At a broad level, declining employment in manufacturing-related industries and occupations is likely to lead to job losses and a need for re-training and upskilling amongst affected workers.

However, at the same time, there are areas in which skill shortages are being experienced. For example, consultations identified that there is a critical shortage of welders in Victoria, which has led one private company (Bombardier Transportation) to gain accreditation to train and certify welders for the rail industry. The issue is being exacerbated by the fact that existing manual welders are being upskilled to run robot welding equipment, which is creating demand for new manual welders. Structural Steel and Welding Trades Workers are also listed as a state-wide shortage in NSW and ACT, and ABS data shows that 25% of Structural Steel and Welding Trades Workers worked more than 48 hours in the week prior to the 2016 census, which may also be an indicator that demand for skills is outstripping supply.

There are also national skill shortages for Sheetmetal Trades Workers, as well as for Locksmiths.

The impact of automation, robotics and digitisation on employment is predicted to be significant across all industries globally, and particularly so in the manufacturing industry. Predictions suggest that many workers will need to switch occupations, or to develop new skills and capabilities to adapt to the rise of more sophisticated machines, or to develop skills that cannot be easily automated, such as social and emotional skills, creativity and higher-level cognitive capabilities.[18] However, as many of those consulted pointed out, the changing nature of the manufacturing industry may not so much require new skills, but the application of existing skills in new ways and in relation to new types of equipment and technology.

It has also been identified that within the manufacturing and engineering sector, there are currently no appropriate qualifications or skill sets for workers who are moving from technical positions into higher level supervisory or training roles and in need of upskilling.

18 McKinsey and Company, 2017, Jobs Lost, Jobs Gained: Workforce transitions in a time of automation. Available online at https://www.mckinsey.com/global-themes/future-of-organizations-and-work/what-the-future-of-work-will-mean-for-jobs-skills-and-wages

Skills Outlook

A number of current and emerging skill needs have been identified through trend analysis and consultations.

Over the longer term, technology changes may require a new understanding of the ways in which skills can be applied, as well as new combinations of skills, particularly in the areas of mechanical and electronic skills. Consultations indicated that activity in this space, especially in the field of mechatronics, is occurring outside of the current training packages and that the mechanical engineering sector is at risk of being 'left behind'.

Demand for higher level skills and qualifications is also likely to increase as the level of adoption of new technology increases and as workers are displaced from disappearing job roles.

Other areas in which technology is resulting in changing work practices that may impact on skills demands in the shorter term are:

- Design and drafting skills
- Non-destructive testing
- Locksmithing.

New standards and work practices in the area of welding are also likely to impact on skill demands in the shorter term, particularly in relation to the new Australian Defence Force projects.

Adapting to changing technology and work practices requires strong underpinning skills in communication, problem-solving and other Science, Technology, Engineering and Mathematics (STEM) skills. Consultations indicate that there is a need for a much greater focus on the development of underpinning generic skills amongst learners in the manufacturing and engineering industry. This includes basic language, literacy and numeracy skills, as well as higher level communication and mathematical skills and other STEM skills needed to adapt to the increasing use of automation and robotics.

Supervisory and training skills, including communication and other interpersonal skills, are needed for those moving beyond technical roles; and these need to be aligned with relevant IR classifications.

Changing business models are also increasing the need for workers to not only have the appropriate technical skills, but to combine these with an understanding of different aspects of business and supply chain operations. For some sectors within manufacturing and engineering in which sole-traders predominate, such as jewellery manufacturing, the development of business skills in addition to the relevant technical skills is essential.

Changes to business models in the industry also increase the need for skills in:

- Collaboration, as more businesses specialise and need to collaborate with other businesses in the supply chain to remain competitive
- Innovation and continuous improvement, to increase productivity and efficiency and to identify and develop new niche markets
- Customer engagement, to facilitate whole product and integrated product-service business strategies.

Key Generic Workforce Skills

IRC members ranked the importance of key generic workforce skills for people undertaking qualifications from the MEM Manufacturing and Engineering and MEM05 Metal and Engineering Training Package as indicated in the right-hand column of the table below. Where there were only certain parts of the skill grouping that were considered important, these parts have been bolded. Several skill areas were given equal rankings.

IRC members noted that literacy skills were as important as the skills ranked in first and second place, and were a particular issue from a health and safety perspective.

	Combined Manufacturing IRCs		Manufacturing and Engineering IRC
1	Design mindset/Thinking critically/Systems thinking/ Solving problems skills	1	Design mindset/Thinking critically/Systems thinking/ **Solving problems skills**
2	Technology use and application skills	1	Technology use and application skills
3	Learning agility/Information literacy/Intellectual autonomy and self-management skills	2	Science, Technology, Engineering and Mathematics (STEM) skills
4	Communication/Collaboration including virtual collaboration/Social intelligence skills	2	**Learning agility/Information literacy**/Intellectual autonomy and self-management skills
5	Science, Technology, Engineering and Mathematics (STEM) skills	3	Language, Literacy and Numeracy (LLN) skills
6	Language, Literacy and Numeracy (LLN) skills	4	**Communication/**Collaboration including virtual collaboration/Social intelligence skills
7	Data analysis skills	4	Managerial/Leadership skills
8	Managerial/Leadership skills	5	Data analysis skills
9	Customer service/Marketing skills	6	Environmental and Sustainability skills
10	Environmental and Sustainability skills	7	Customer service/Marketing skills
11	Entrepreneurial skills	7	Financial skills
12	Financial skills	7	Entrepreneurial skills

Key Drivers for Change and Proposed Responses

The challenges and opportunities and the employment and skills outlook described in this report indicate the need for skill development solutions. A number of these are outlined in the table below.

Key Driver for Change	Priority Skills	Proposed Response
Major projects		
New Australian Defence Force projects	Welding Planning, scheduling, logistics and supply chain management	There is an urgent need for the review of welding competencies and qualifications to bring them into line with international welding standards and to ensure they meet the need for the increasing demand for welding skills, particularly at higher levels. Consideration should also be given to the skills needed for planning, scheduling, logistics and supply chain management as part of the schedule of work and as the details of the new Defence Force projects are determined.
Technology		
New and converging technologies	Technician skills Maintenance and diagnostic skills Mechatronics Computer-aided manufacturing Additive manufacturing Non-destructive testing Design and drafting skills Industrial instrumentation Composite materials Mobile machinery and drones	Each of these skill areas to be reviewed as part of the proposed schedule of work. However, technician skills are in particular demand due to the rapid uptake of new and converging technologies and advanced manufacturing processes. They are therefore considered a priority for training package development work.

Key Driver for Change	Priority Skills	Proposed Response
Gaps in training package coverage		
Need for upskilling in particular occupations	Trainer, Supervisor and Coordinator skills Hydraulic hose fabrication Electroplating	The lack of sector-specific training products for workers moving into trainer, supervisor and coordinator roles has been an issue for some time and needs to be urgently addressed. Consideration will be given to the need for skill sets in hydraulic hose fabrication and electroplating as part of the proposed schedule of work.
Business practices		
Changing business models and practices	Business skills for jewellery manufacture	To be included as part of the proposed schedule of work.
Generic skills		
Increasing demand for underpinning generic skills	Mathematics Problem-solving (including advanced problem-solving and analytical problem-solving models) Interpretation of supplied information Time-keeping Goal-setting Customer service skills Project management skills	The need for greater focus on these underpinning generic skills should be monitored as part of training package work over the next few years.

Training Product Review – Current Activities

2017–18 Activities

In 2017 IBSA Manufacturing was commissioned to progress the transition of components in the following training packages to the 2012 Standards for Training Packages and into the MEM Manufacturing and Engineering Training Package:

- MEM05 Metal and Engineering Training Package
- CUV11 Visual Arts, Crafts and Design Training Package
- LMT07 Textiles, Clothing and Footwear Training Package
- MSA07 Manufacturing Training Package.

This work includes the review and transition of 720 units and 41 qualifications in 3 releases.

Release 1.0 was completed by Manufacturing Skills Australia in April 2015, with minor upgrades in June 2015 and May 2016.

Release 2.0 Training Package review and development work involved:

- 18 Qualifications:
    - 14 existing MEM05 Metal and Engineering qualifications
    - 4 new qualifications that were previously specialisations embedded in other MEM05 Metal and Engineering qualifications.
- 448 units:
    - Transitioning from MEM05 Metal and Engineering with consolidation of some previous foundation and core units and proposed modifications to Locksmithing units.

The Case for Endorsement was submitted to the Department in late 2017; a decision is expected in mid-2018.

Release 3.0 involves training package review and development work of:

- 23 Qualifications:
    - 14 existing MEM05 Metal and Engineering qualifications
    - 4 Manufacturing Technology qualifications from MSA07
    - 3 Cotton Ginning and 1 TCF Mechanic from LMT07
    - 2 Opal Cutting and Polishing qualifications from CUV11 (recommended for deletion)
- 272 units from the CUV11, LMT07 and MSA07 training packages.

The Final Case for Endorsement is scheduled to be submitted in late 2018.

AISC Cross-Sector Projects

The AISC identified a number of emerging cross-sectoral themes in previous IRC Skills Forecasts. The AISC sought to strategically address these common skills issues and commissioned nine cross-sector projects. The aim of the projects is to address changing skills needs across industries in a coordinated and efficient way and, where opportunities exist, to create flexible and transferable training package components that will benefit industry, learners and the broader VET sector.

There are five cross-sector projects that will potentially directly impact upon the Manufacturing and Engineering Training Packages.

1 The **Digital Skills** Cross-Sector Project, initially focused on the need for coding skills in manufacturing and related training packages, was subsequently expanded to focus on a broader set of skills related to coding and programming, CAD/CAM/CAE, and additive manufacturing/3-D printing, as well as the digital analytical and diagnostic skills needed to analyse and respond to data provided by machines in the workplace. Outcomes of the project may result in recommendations for updated content for up to 151 units of competency in the Manufacturing and Engineering Training Packages.

2 The **Automation Skills** Cross-Sector Project focused on current and emerging developments in automated processes. These were reviewed as part of the project to determine the cross-sector skills required to use robotics, drones and remote operation systems. Outcomes of the project may result in recommendations for updated content for at least six units of competency in the Manufacturing and Engineering Training Packages.

3 The **Environmental Sustainability** Cross-Sector Project focused on identifying environmental sustainability skills that are shared by multiple industry sectors and recommended training package developments and modifications that will enable the use of training products across multiple industries, thus reducing duplication and enhancing skill transferability. Outcomes of the project may result in recommendations for at least one unit of competency from the Manufacturing and Engineering Training Packages to be reviewed, with potential for replacement by a cross-industry unit.

4 The **Supply Chain** Cross-Sector Project investigated cross-sector skills to support industries seeking to increase efficiencies and meet consumer demands to become more competitive across supply chains. Outcomes of the project may result in recommendations for at least three units of competency from the Manufacturing and Engineering Training Packages to be reviewed or redeveloped to make them more suitable for cross-industry use and included in cross-industry skill sets.

5 The **Teamwork and Communication** Cross-Sector Project is proposing to develop five new units of competency that might be able to be used across all training packages and could potentially be used to replace four units of competency from the Manufacturing and Engineering Training Packages.

Training Product Review – Priorities 2018–2022

Following consideration and analysis of the industry challenges and opportunities, the current and emerging skills needs and the key drivers for change, the Manufacturing and Engineering IRC have identified a number of areas for training product development. These training priorities are outlined in the IRC Skills Forecast and Proposed Schedule of Work 2018–19 to 2021–2022 table, which lists the priorities for the next four years. This table also provides a rationale for the priorities, proposed scope and timeframes for these activities.

Items Identified as Time-Critical and to be Considered by the AISC as Part of the 2018 Industry Skills Forecast and Proposed Schedule of Work

The IRC identified the following training priorities as critical and requests their inclusion as a priority for the 2018–2019 schedule of work:

- **Welding:** Review of units of competency, restructuring of qualifications and development of new qualifications and standards to meet changes in welding standards, procedures and applications
- **Technician skills:** Review and update or develop new training package components that reflect requirements for application of emerging technologies and advanced manufacturing processes
- **Trainer, Supervisor and Coordinator:** Develop post-trade training components to meet the needs of higher level job roles with training, supervisory or coordination responsibilities.

A Case for Change has been prepared and included a part of this document. The Case for Change provides further information on the industry imperatives, consultation plan and proposed scope of the project.

Items Identified as Priorities Over the Next Three Years

The IRC identified the following training priorities for consideration over the next three years.

2019–20

- **Non-destructive testing:** Review of current units of competency and qualifications and development of new qualifications and standards to ensure adequacy in reflecting contemporary non-destructive testing hierarchies and emerging forms of testing, such as thermal imaging, and work organisation, with particular application to marine standards and standards related to heavy engineering applications, including resources, infrastructure and renewable energy.
- **Planning, scheduling, logistics and supply chain management:** New qualifications and standards associated with training package gaps to cover engineering and technical work associated with:
    - planning and scheduling
    - supply chain management
    - logistics
    - quality systems management, including through the supply chain
    - configuration management.
- **Maintenance and diagnostics skills:** Scoping of skills required to reflect advances in maintenance techniques, including higher level maintenance techniques for fitting trades, and identification of training products to underpin diagnosis, fault-finding and maintenance and repair in fields exposed to converging technologies. To include development of new hydraulic and pneumatics qualifications, units and skill sets.
- **Mechatronics:** Scoping of skill implications of growth in mechatronics, including explicit approaches to integrated mechatronic systems, for metals and engineering standards and training package components.
- **Design and drafting skills:** Review adequacy of content in design and drafting skills where there is a construction and civil component, such as residential building units, reinforced concrete units and 3-D solid modelling units, with reference to architecture, structure and MEP (mechanical, electrical and plumbing) design and drafting and reinforced concrete detailing. Also review Certificate IV requirements to improve flexibility.

2020–21

- **Computer-aided manufacturing:** Consideration of additional content relating to code files used in computer-aided manufacturing.
- **Additive manufacturing:** Review relevant current units of competency to ensure they adequately reflect the increasing use of additive manufacturing techniques in conjunction with existing trade skills. In particular:
    - IT and computer skills, including use of 3-D printing software
    - Units covering 3-D printing and reverse engineering at trade and post-trade level
    - 3-D printing skill set covering CAD, set up and run 3-D printing machine, scanning, and prototyping with investment casting.
- **Certificate III in Jewellery Manufacture:** Expand qualification to include coverage of business basics.
- **Certificate III in Watch and Clock Service and Repair:** Update or create new content to reflect current industry practice.
- **Certificate IV in Engineering:** Update industrial instrumentation content to reflect new industrial electrician requirements.
- **Composite materials:** Update or create new content to reflect current practice in composite repairs, timber vessel repair and infusion.

2021–22

- **Electroplating:** Examine the need for a skill set or qualification in electroplating.
- **Mobile machinery and drones:** Review current units of competency to ensure coverage of licence requirements for operating, driving and piloting artificially intelligent mobile machinery and drones.
- **Hydraulic hose fabrication:** Develop a skill set for hydraulic hose fabrication.
- **Underpinning skills:** Review coverage of relevant underpinning skills in units of competency, including mathematics, problem-solving (including advanced problem-solving and analytical problem-solving models), interpretation of supplied information, time-keeping, goal-setting, customer service skills and project management skills.

Proposed Schedule of Work 2018–19 to 2021–22

Manufacturing and Engineering Industry Reference Committee (IRC)

MEM Manufacturing and Engineering Training Package

Contact details: Ian Curry, IRC Chair

Date submitted to Department of Education and Training: May 2018

Year	Items to be included in National Schedule of Work
2018–19	**Welding, Technician and Trainer/Supervisor/Coordinator Skills** • **Welding:** Review of units of competency, restructuring of qualifications and development of new qualifications and standards to meet changes in welding standards, procedures and applications. • **Technician skills:** Review and update or develop new standards and training package components that reflect requirements for application of emerging technologies and advanced manufacturing processes. • **Trainer, Supervisor and Coordinator:** the development of post-trade training components to meet the needs of higher level job roles with training, supervisory or coordination responsibilities. **Rationale** See Case for Change below. **Training products impacted:** See Case for Change below. This project was identified as time-critical and that training package development work be approved as part of this submission. **Further information on the industry imperatives, consultation plan and proposed scope of the project is provided in the Case for Change following the proposed schedule of work.**

Year	Items to be included in National Schedule of Work

2019–20

New and converging technologies

To address skill needs arising from new and converging technologies, including those needed for Defence Force projects. This will include the following.

- **Non-destructive testing:** Review of current units of competency and qualifications and development of new qualifications and standards to ensure adequacy in reflecting contemporary non-destructive testing hierarchies and emerging forms of testing, such as thermal imaging, and work organisation, with particular application to marine standards and standards related to heavy engineering applications, including resources, infrastructure and renewable energy.
- **Planning, scheduling, logistics and supply chain management:** New qualifications and standards associated with training package gaps to cover engineering and technical work associated with:
  - planning and scheduling
  - supply chain management
  - logistics
  - quality systems management, including through the supply chain
  - configuration management.
- **Maintenance and diagnostics skills:** Scoping of skills required to reflect advances in maintenance techniques, including higher level maintenance techniques for fitting trades, and identification of training products to underpin diagnosis, fault-finding, maintenance and repair in fields exposed to converging technologies. To include development of new hydraulic and pneumatics qualifications, units and skill sets.
- **Mechatronics:** Scoping of skill implications of growth in mechatronics, including explicit approaches to integrated mechatronic systems, for metals and engineering standards and training package components.
- **Design and drafting skills:** Review adequacy of content in design and drafting skills where there is a construction and civil component, such as residential building units, reinforced concrete units and 3D solid modelling units, with reference to architecture, structure and mechanical, electrical and plumbing (MEP) design and drafting and reinforced concrete detailing. Also review Certificate IV requirements to improve flexibility.

Rationale

New and converging technologies are driving the need for new applications of existing skills and new combinations of skills (see discussion under the For Industry and Employers section.) Some of these skill applications are likely to be in demand as a result of Defence Industry projects and their flow-on effects will advantage the broader manufacturing and engineering industry.

Training products impacted:

A list of training package components impacted will be provided at a later date.

Year	Items to be included in National Schedule of Work

2020–21	**Gaps in technology use and business skills**
	
	To address skill gaps in the application of various technologies and business skills, including:
	
	• **Computer-aided manufacturing:** Consideration of additional content relating to code files used in computer-aided manufacturing.
	• **Additive manufacturing:** Review relevant current units of competency to ensure they adequately reflect the increasing use of additive manufacturing techniques in conjunction with existing trade skills. In particular:
	  • IT and computer skills, including use of 3-D printing software
	  • Units covering 3-D printing and reverse engineering at trade and post-trade level
	  • 3-D printing skill set covering CAD, set up and run 3-D printing machine, scanning, and prototyping with investment casting.
	• **Certificate III in Jewellery Manufacture:** Expand qualification to include coverage of business basics.
	• **Certificate III in Watch and Clock Service and Repair:** Update or create new content to reflect current industry practice.
	• **Certificate IV in Engineering:** Update industrial instrumentation content to reflect new industrial electrician requirements.
	• **Composite materials:** Update or create new content to reflect current practice in composite repairs, timber vessel repair and infusion.
	
	Rationale
	
	As a result of the emergence and application of new technology and new business models (see discussion under the Challenges and Opportunities and Workforce Supply Challenges and Opportunities sections), various skill gaps have been identified in current training products.
	
	Training products impacted:
	
	A list of training package components impacted will be provided at a later date.

Year	Items to be included in National Schedule of Work
2021–22	**Skill sets, AI machinery/Drones and underpinning generic skills** To address the potential for products for upskilling in a number of occupations, as well as the need for underpinning generic skills: **Electroplating:** Examine the need for a skill set or qualification in electroplating. **Mobile machinery and drones:** Review current units of competency to ensure coverage of licence requirements for operating, driving and piloting artificially intelligent mobile machinery and drones. **Hydraulic hose fabrication:** Develop a skill set for hydraulic hose fabrication. **Underpinning skills:** Review coverage of relevant underpinning skills in units of competency, including mathematics, problem-solving (including advanced problem-solving and analytical problem-solving models), interpretation of supplied information, time-keeping, goal-setting, customer service skills, and project management skills. **Rationale** Underpinning generic skills are needed for adapting to changing technology and work practices, while changing technology is driving a need for upskilling of trade-qualified workers (see discussion under the Skills Outlook and Workforce Supply Challenges and Opportunities sections). **Training products impacted:** A list of training package components impacted will be provided at a later date.

2018–19 Case for Change

Manufacturing and Engineering Industry Reference Committee (IRC)

MEM Manufacturing and Engineering Training Package

Contact details: Mr Ian Curry, IRC Chair

Date submitted to Department of Education and Training: May 2018

Welding, Technician and Trainer/Supervisor/Coordinator Skills

Description: This project covers three key skill areas important to the manufacturing and engineering industries:

- **Welding skills:** The updating of units of competency, restructuring of qualifications and development of new training components to meet changes in welding standards, techniques, processes and procedures. This includes:
  - Development of new qualifications to meet the emerging needs of Welding Supervisor and Welding Inspection occupations in relation to international welding standards and weld procedure development
  - Restructuring the hierarchy of welding units of competency and qualifications leading to the higher-level welding processes and standards associated with advanced and coded welding standards
  - Updating units of competency and qualifications to ensure adequacy in meeting the needs of new welding applications such as continuous ship building, submarine manufacture and related heavy engineering applications, including infrastructure and renewable energy.
- **Technician skills:** The updating of training components to meet emerging skills needs.
  - **Stage 1** Consult industry stakeholders to identify potential gaps in training product content associated with emerging and converging technologies and advanced manufacturing processes and systems in technician and para-professional roles.
  - **Stage 2** Review and where necessary update units of competency and/or development of new training products that reflect skills requirements identified in Stage 1. Particular consideration to be given to the potential inclusion of an advanced manufacturing stream in an existing qualification or development of new training products that reflect emerging technologies and associated requirements (such as those associated with Industry 4.0).
- **Trainer/Supervisor/Coordinator skills:** The development of post-trade training components to meet the needs of higher level job roles with training, supervisory or coordination responsibilities.

Welding, Technician and Trainer/Supervisor/Coordinator Skills

Rationale:

Two key drivers of industry growth and change underpin this work:

- key **Government initiatives,** such as the new Australian Defence Force projects, which will have particular impact on Australia's shipbuilding and military vehicle manufacturing sectors, but also many implications for the broader manufacturing and engineering industries.
- **technology trends** around automation and digitisation (including those incorporated under Industry 4.0), use of advanced materials, and augmented and virtual reality, which are creating new ways of working and new business opportunities and models, as well as providing industry with opportunities to increase efficiency and productivity.

Changing work and career values are also posing a challenge for the industry, in terms of attracting new, highly capable entrants to the industry and ensuring an ongoing supply of skills in an ageing workforce. Highlighting the new opportunities arising from changing technology and industry practices, and ensuring training products keep pace with these changes, will assist in attracting new entrants to the manufacturing and engineering sector and in upskilling existing workers in the sector.

At the same time, the accelerating adoption of new technologies and convergence of technologies and practices from different sectors are driving a need for a new cross-disciplinary combination of skills.

In addition to these sector-wide drivers, there are a number of more specific drivers of the individual components of this work, each of which has been discussed in the Industry Skills Forecast.

Key drivers for welding skills:

- Defence Industry projects
- Welding skills shortages
- New welding processes and international standards, which are not yet addressed in current training products.

Key drivers for technician skills:

- Technology changes, which are requiring more advanced skills for operation and maintenance
- Emerging job roles requiring more advanced or new combinations of skills.

Key drivers for trainer/supervisor/coordinator skills.

- Gaps in training products associated with supervisory or training classifications and roles within the manufacturing and engineering sector
- No defined skill pathways for specific job roles with training, supervisory or coordination responsibilities.

The risks of not proceeding with this work include:

- Ongoing and increasing skill shortages in welding occupations
- A lack of supply of skills to meet the needs of Defence Industry projects
- Inability of businesses employing workers in manufacturing and engineering occupations to keep pace with changing technology and practices and remain competitive within national and global markets
- Increasing levels of training being conducted by equipment manufacturers without the underpinning broad skills and knowledge that is developed by the VET system. This will result in a narrowing of the sector's skills base and a lack of portability and transferability of skills for individuals.

All of these risks are highly significant in terms of both likelihood and impact, and when combined with evidence of skill shortages that are already occurring, highlight the time-critical nature of this work.

Welding, Technician and Trainer/Supervisor/Coordinator Skills

Ministers' Priorities Addressed:

This case for change addresses the following Ministers' Priorities:

Obsolete qualifications removed from the system

The proposed work will review existing qualifications and units of competency, which is expected to result in streamlining and rationalising of MEM Manufacturing and Engineering Training Package products.

More information about industry's expectations of training delivery is available to training providers to improve their delivery and to consumers to enable more informed choices

Updates to the Companion Volume after this work will provide training providers with clarity on vocational outcomes and pathways, and discussions with industry will provide the opportunity to promote vocational pathways.

The training system better supports individuals to move more easily between related occupations

Each of the skill areas covered by this work – welding skills, technician skills and trainer/supervisor/coordinator skills – are in demand across a range of industry sectors (not just in the manufacturing industry). Therefore, enhancement of skills in these areas will have a flow-on effect to the mobility, portability and transferability of skills within and across sectors.

Improved efficiency of the training system through units that can be owned and used by multiple industry sectors

Units of competency from the MEM Manufacturing and Engineering Training Package are frequently imported into other training packages due to their focus on key work roles that are undertaken across a range of industry sectors. For example, a search on a sample of 49 units of competency across the 7 nominated qualifications identified that these units are included in numerous qualifications and skills sets across 36 training packages, including the Agriculture, Horticulture and Conservation and Land Management, Creative Arts and Culture, Health, and Transport and Logistics Training Packages. Updating of these units to reflect changed technology and work practices is also likely to increase their relevance and value to other industry sectors. Any new units developed as part of this work are also highly likely to meet this priority.

Foster greater recognition of skill sets

Skill sets will be considered as part of this work, particularly in the areas of trainer/supervisor/coordinator skills, as they may provide a means of upskilling existing qualified workers.

Welding, Technician and Trainer/Supervisor/Coordinator Skills

Consultation Plan:

IBSA Manufacturing Training Development Projects follow the Training Package Development and Endorsement Process Policy and use a five-phase methodology. An IBSA Industry Manager will coordinate the project and work with the IRC.

Phase 1 – Initial research and analysis

Establishment of three Technical Advisory Committees (TACs) to validate the project scope and plan, to contribute to further industry assessment and to assist in determining industry needs and job role functional analysis.

The IRC will appoint the Technical Advisory Committees to inform this work and ensure that membership covers the technical skills and knowledge of the broad range of job roles covered by each component of this project. Industry and member associations, licensing and regulatory authorities will be included.

Proposed membership of the Welding Skills TAC will include representatives from:

- Welding Technology Institute of Australia
- Australian Industry Group
- Australian Manufacturing Workers Union
- Australian Institute for Non-Destructive Testing (AINDT)
- One or more welding practitioners
- One or more technical experts from organisations involved with the Defence Industry Projects (e.g. Naval Group, BAE Systems).

Proposed membership of the Technician Skills TAC will include representatives from:

- Australian Industry Group
- Australian Manufacturing Workers Union
- Advanced Manufacturing Growth Centre
- Specialist expertise will be sought/brought in where required.

Proposed membership of the Trainer/Supervisor/Coordinator Skills TAC will include representatives from:

- Australian Industry Group
- Australian Manufacturing Workers Union
- Specialist expertise will be sought/brought in where required.

Phase 2 – Draft 1 and public consultation

Develop first draft of training package components for feedback from the TAC and then the broader manufacturing and engineering industry and RTOs.

Phase 3 – Draft 2 and public consultation

Respond to feedback and develop second draft of training package components. Feedback to be sought from the broader manufacturing and engineering industry and RTOs.

Phase 4 – Approval process

Adjust training package components in response to further feedback and seek approval from respective committees, namely the TAC and IRC and consultation with state training authorities.

Welding, Technician and Trainer/Supervisor/Coordinator Skills

Phase 5 – Submission to Department

Submit to the Department of Education and Training for AISC approval.

Consultation Plan

IBSA will create a project web page to provide project updates, gather feedback from stakeholders and validate training package components.

Proposed consultations include:

- Industry representatives and employers to identify the industry and job requirements and trends and work opportunities, including:
  - Members of Australian Industry Group, Australian Manufacturing Workers Union, and Advanced Manufacturing Growth Centre
  - Welding Technology Institute of Australia and welding inspectors/supervisors
  - Department of Defence
  - Australian Institute for Non-Destructive Testing (AINDT)
  - Employers and contractors such as BAE Systems, Naval Group, Austral, and Thales.
- RTOs with these qualifications on scope and recent or current students, if accessible, to gain feedback on the qualifications and employment outcomes, including:
  - The Victorian VET Engineering Senate, which comprises both public and private providers
  - Public providers such as NSW TAFE, QLD TAFE, TasTAFE, TAFE SA and the TAFE division of Charles Darwin University in the Northern Territory, which also has regional reach
  - A number of private providers such as Hunter Valley Training and Hunter Trade College, ATEC in Adelaide
  - State industry advisory bodies that have contact with relevant industry stakeholders and both public and private providers
  - State training authorities to ensure all jurisdictions are engaged.

Scope of Project	
Timing	**Estimated Project Duration:** 12–18 months **Anticipated Start Date:** September 2018 **Anticipated Completion Date:** Case for Endorsement to be submitted to the Department between September 2019 and March 2020
Training Package	**Training Package to be developed/revised:** MEM Manufacturing and Engineering Training Package

Welding, Technician and Trainer/Supervisor/Coordinator Skills

Qualifications	**7 existing** qualifications to be redeveloped and updated: Welding / Technicians • MEM30305 Certificate III in Engineering – Fabrication Trade • MEM30505 Certificate III in Engineering – Technical • MEM40105 Certificate IV in Engineering • MEM50212 Diploma of Engineering – Technical • MEM50105 Diploma of Engineering – Advanced Trade • MEM60112 Advanced Diploma of Engineering • MEM80112 Graduate Diploma of Engineering. Subject to the analysis of contemporary and emerging work practices undertaken in Phase 1 of the project, this work may result in the development of: • a new qualification in welding supervision and inspection • new qualifications or new streams within existing technician qualification • a new qualification for trainer/supervisor/coordinator skills.
Skill Sets	Subject to the analysis of contemporary and emerging work practices undertaken in Phase 1 of the project, this work may result in the development of: • a new skill set for trainer/supervisor/coordinator skills • one or more new skill sets for technician skills.
Units of Competency	**233 existing units of competency** (as listed below) have been identified as relevant to welding and technician job roles and will be reviewed as part of this project. Subject to the analysis of contemporary and emerging work practices undertaken in Phase 1 of the project, this work may result in the redevelopment of a portion of these units and the development of a number of **new units of competency** to meet any skills gaps. Obsolete units will be deleted. • MEM04020 Supervise individual ferrous melting and casting operation • MEM04021 Supervise individual non-ferrous melting and casting operation • MEM05001 Perform manual soldering/desoldering – electrical/electronic components • MEM05002 Perform high reliability soldering and desoldering • MEM05004 Perform routine oxy fuel gas welding • MEM05005 Carry out mechanical cutting • MEM05007 Perform manual heating and thermal cutting • MEM05011 Assemble fabricated components • MEM05012 Perform routine manual metal arc welding • MEM05013 Perform manual production welding

Welding, Technician and Trainer/Supervisor/Coordinator Skills

- MEM05014 Monitor quality of production welding/fabrications
- MEM05015 Weld using manual metal arc welding process
- MEM05016 Perform advanced welding using manual metal arc welding process
- MEM05017 Weld using gas metal arc welding process
- MEM05018 Perform advanced welding using gas metal arc welding process
- MEM05019 Weld using gas tungsten arc welding process
- MEM05020 Perform advanced welding using gas tungsten arc welding process
- MEM05022 Perform advanced welding using oxy acetylene welding process
- MEM05023 Weld using submerged arc welding process
- MEM05024 Perform welding supervision
- MEM05025 Perform welding/fabrication inspection
- MEM05026 Apply welding principles
- MEM05041 Weld using flame powder spraying
- MEM05042 Perform welds to code standards using flux core arc welding process
- MEM05043 Perform welds to code standards using gas metal arc welding process
- MEM05044 Perform welds to code standards using gas tungsten arc welding process
- MEM05045 Perform pipe welds to code standards using manual metal arc welding process
- MEM05046 Perform welds to code standards using manual metal arc welding process
- MEM05047 Weld using flux core arc welding process
- MEM05048 Perform advanced welding using flux core arc welding process
- MEM05049 Perform routine gas tungsten arc welding
- MEM05050 Perform routine gas metal arc welding
- MEM05051 Select welding processes
- MEM05052 Apply safe welding practices
- MEM05053 Set and edit computer controlled thermal cutting machines
- MEM05054 Write basic NC/CNC programs for thermal cutting machines
- MEM05055 Weld using oxy fuel gas welding process
- MEM05056 Perform routine flux core arc welding
- MEM05057 Perform routine submerged arc welding
- MEM05058 Perform welds to code standards using oxy fuel gas welding process
- MEM09155 Prepare mechanical models for computer-aided engineering (CAE)
- MEM09156 Prepare mechatronic models for computer-aided engineering (CAE)
- MEM09157 Perform mechanical engineering design drafting

- MEM09158 Perform mechatronics engineering design drafting
- MEM09202 Produce freehand sketches
- MEM09203 Measure and sketch site information
- MEM09204 Produce basic engineering detail drawings
- MEM09205 Produce electrical schematic drawings
- MEM09206 Produce drawings for mechanical services
- MEM09207 Produce drawings for reticulated services
- MEM09208 Detail fasteners and locking devices in mechanical drawings
- MEM09209 Detail bearings, seals and other componentry in mechanical drawings
- MEM09210 Create 3-D solid models using computer-aided design (CAD) system
- MEM09211 Produce drawings or models for industrial piping
- MEM09212 Produce detailed drawings of steel to non-steel connections
- MEM09213 Produce schematic drawings for hydraulic and pneumatic fluid power systems
- MEM09214 Perform advanced engineering detail drafting
- MEM09215 Supervise detail drafting projects
- MEM09216 Interpret and produce curved 3-D shapes and patterns
- MEM09217 Prepare plans for pipe and duct fabrication
- MEM09218 Participate in drafting projects for building services
- MEM09219 Prepare drawings for fabricated sheet metal products
- MEM09220 Apply surface modelling techniques to 3-D drawings
- MEM09221 Create 3-D model assemblies using computer-aided design (CAD) system
- MEM09222 Interpret and maintain or restore original drawings
- MEM09223 Interpret architectural and engineering design specifications for structural steel detailing
- MEM09224 Detail bolts and welds for structural steelwork connections
- MEM09225 Detail standardised structural connections
- MEM09226 Detail structural steel members
- MEM09227 Incorporate structural steel detailing into fabrication and construction project management
- MEM09228 Detail ancillary steelwork
- MEM13010 Supervise occupational health and safety in an industrial work environment
- MEM14001 Schedule material deliveries
- MEM14002 Undertake basic process planning
- MEM14003 Undertake basic production scheduling
- MEM14085 Apply mechanical engineering analysis techniques

- MEM14086 Apply mechatronic engineering analysis techniques
- MEM14087 Apply manufactured product design techniques
- MEM14088 Apply maintenance engineering techniques to equipment and component repairs and modifications
- MEM14089 Integrate mechanical fundamentals into an engineering task
- MEM14090 Integrate mechatronic fundamentals into an engineering task
- MEM14091 Integrate manufacturing fundamentals into an engineering task
- MEM14092 Integrate maintenance fundamentals into an engineering task
- MEM15007 Conduct product and/or process capability studies
- MEM15008 Perform advanced statistical quality control
- MEM15010 Perform laboratory procedures
- MEM15011 Exercise external quality assurance
- MEM15012 Maintain/supervise the application of quality procedures
- MEM22001 Perform engineering activities
- MEM22002 Manage self in an engineering environment
- MEM22007 Manage environmental effects of engineering activities
- MEM22012 Coordinate resources for an engineering project or operation
- MEM22013 Coordinate engineering projects
- MEM22014 Coordinate engineering-related manufacturing operations
- MEM22015 Source and estimate engineering materials requirements
- MEM22017 Coordinate continuous improvement and technical development
- MEM22018 Coordinate sales and promotion of engineering-related products or services
- MEM23003 Operate and program computers and/or controllers in engineering situations
- MEM23004 Apply technical mathematics
- MEM23005 Apply statistics and probability techniques to engineering tasks
- MEM23006 Apply fluid and thermodynamics principles in engineering
- MEM23007 Apply calculus to engineering tasks
- MEM23008 Apply advanced algebra and numerical methods to engineering tasks
- MEM23063 Select and test mechanical engineering materials
- MEM23064 Select and test mechatronic engineering materials
- MEM23109 Apply engineering mechanic principles
- MEM23111 Select electrical equipment and components for engineering applications
- MEM23112 Investigate electric and electronic controllers in engineering applications

- MEM23113 Evaluate hydrodynamic systems and system components
- MEM23114 Evaluate thermodynamic systems and components
- MEM23115 Evaluate fluid power systems
- MEM23116 Evaluate programmable logic controller and related control system component applications
- MEM23117 Evaluate microcontroller applications
- MEM23118 Apply production and service control techniques
- MEM23119 Evaluate continuous improvement processes
- MEM23120 Select mechanical machine and equipment components
- MEM23121 Analyse loads on frames and mechanisms
- MEM23122 Evaluate computer integrated manufacturing systems
- MEM23123 Evaluate manufacturing processes
- MEM23124 Measure and analyse noise and vibration
- MEM23125 Evaluate maintenance systems
- MEM23126 Evaluate industrial robotic applications
- MEM23129 Evaluate thermal loads in heating, ventilation, air conditioning and refrigeration
- MEM23130 Coordinate servicing and fault finding of HVAC/R control systems
- MEM23131 Evaluate rapid prototyping applications
- MEM23132 Evaluate rapid manufacturing processes
- MEM23133 Evaluate rapid tooling applications
- MEM23134 Evaluate jigs and fixtures
- MEM23135 Evaluate moulding tools and processes
- MEM23136 Evaluate stamping and forging tools
- MEM23137 Evaluate rolling tools and processes
- MEM23138 Evaluate suitability of materials for engineering related applications
- MEM23139 Design a basic single zone duct distribution system
- MEM23140 Determine operational parameters for building HVAC/R hydronic systems
- MEM23141 Complete a building thermal performance survey
- MEM23142 Determine psychrometric processes and system performance
- MEM23143 Apply energy management principles
- MEM23144 Contribute to the design of a commercial refrigeration system
- MEM23145 Apply codes and regulations to air conditioning designs
- MEM23146 Contribute to the design of industrial refrigeration systems
- MEM23147 Contribute to the design of hydronic systems

- MEM23148 Develop energy management solutions
- MEM23149 Contribute to the design of commercial and industrial exhaust systems
- MEM23150 Contribute to the design of heating systems
- MEM23151 Commission and optimise performance of HVAC/R systems
- MEM23152 Apply principles of refrigeration food storage technology
- MEM23153 Contribute to the design of heat exchanger systems
- MEM23154 Analyse and service HVAC/R control systems
- MEM234001 Plan and manage engineering-related projects or operations
- MEM234002 Integrate engineering technologies
- MEM234003 Design machines and ancillary equipment
- MEM234004 Design for engineering-related noise and vibration mitigation
- MEM234005 Design hydrodynamic pumping systems
- MEM234006 Evaluate and select thermodynamic systems or sub-systems
- MEM234007 Design fluid power systems
- MEM234008 Design plant using computer simulations
- MEM234009 Design computer-integrated manufacturing systems
- MEM234010 Design microcontroller applications
- MEM234011 Design programmable logic controller applications
- MEM234012 Design integrated maintenance management systems
- MEM234013 Plan and design engineering-related manufacturing processes
- MEM234014 Design a robotic system
- MEM234015 Design hydronic heat exchanger systems
- MEM234016 Design refrigeration systems
- MEM234017 Design exhaust, ventilation and dust collection systems
- MEM234018 Design heating, ventilation, air conditioning and refrigeration control systems
- MEM234019 Apply finite element analysis in engineering design
- MEM234020 Coordinate small lot manufacture using rapid manufacture processes
- MEM234021 Apply statistics to technology problems
- MEM234022 Apply advanced calculus to technology problems
- MEM234023 Apply differential equations to technology problems
- MEM234024 Apply advanced mathematics in technology problems
- MEM234025 Apply numerical methods to technology problems
- MEM234026 Develop and coordinate engineering-related contingency plans

- MEM234027 Plan and manage materials supply for an engineering project or manufacturing operation
- MEM234028 Produce and manage technical documentation
- MEM234029 Produce and manage technical publications
- MEM234030 Provide specialised technical and engineering guidance to other technical employees
- MEM234031 Manage installation, commissioning or modification of machines and equipment
- MEM234032 Manage fluid power related technologies in an enterprise
- MEM234033 Lead engineering-related quality operations in an enterprise
- MEM234034 Manage heating, ventilation, air conditioning and refrigeration systems or projects
- MEM234035 Maintain and apply technical and engineering skills
- MEM24001 Perform basic penetrant testing
- MEM24002 Perform penetrant testing
- MEM24003 Perform basic magnetic particle testing
- MEM24004 Perform magnetic particle testing
- MEM24005 Perform basic eddy current testing
- MEM24006 Perform eddy current testing
- MEM24007 Perform ultrasonic thickness testing
- MEM24008 Perform ultrasonic testing
- MEM24009 Perform basic radiographic testing
- MEM24010 Perform radiographic testing
- MEM24011 Establish non-destructive tests
- MEM24012 Apply metallurgy principles
- MEM30005 Calculate force systems within simple beam structures
- MEM30006 Calculate stresses in simple structures
- MEM30007 Select common engineering materials
- MEM30008 Apply basic economic and ergonomic concepts to evaluate engineering applications
- MEM30009 Contribute to the design of basic mechanical systems
- MEM30010 Set up basic hydraulic circuits
- MEM30011 Set up basic pneumatic circuits
- MEM30012 Apply mathematical techniques in a manufacturing, engineering or related environment
- MEM30013 Assist in the preparation of a basic workplace layout
- MEM30014 Apply basic just in time systems to the reduction of waste
- MEM30015 Develop recommendations for basic set up time improvements
- MEM30016 Assist in the analysis of a supply chain

Welding, Technician and Trainer/Supervisor/Coordinator Skills

- MEM30017 Use basic preventative maintenance techniques and tools
- MEM30018 Undertake basic process planning
- MEM30019 Use resource planning software systems in manufacturing
- MEM30020 Develop and manage a plan for a simple manufacturing related project
- MEM30021 Prepare a simple production schedule
- MEM30022 Undertake supervised procurement activities
- MEM30023 Prepare a simple cost estimate for a manufactured product
- MEM30024 Participate in quality assurance techniques
- MEM30025 Analyse a simple electrical system circuit
- MEM30026 Select and test components for simple electronic switching and timing circuits
- MEM30027 Prepare basic programs for programmable logic controllers
- MEM30028 Assist in sales of technical products/systems
- MEM30029 Use workshop equipment and processes to complete an engineering project
- MEM30031 Operate computer-aided design (CAD) system to produce basic drawing elements
- MEM30032 Produce basic engineering drawings
- MEM30033 Use computer-aided design (CAD) system to create and display 3-D models
- MEM48001 Test the mechanical properties of materials
- MEM48002 Monitor ferrous melting and casting processes
- MEM48003 Monitor basic non-ferrous melting and casting processes
- MEM48004 Interpret basic binary phase diagrams
- MEM48005 Demonstrate basic knowledge of casting operations
- MEM48011 Apply basic chemistry principles to metallurgy
- MEM48012 Calculate and predict chemical outcomes in metallurgical situations
- MEM48015 Select metal forming process
- MEM48016 Select metal joining process
- MEM48020 Recommend ferrous and non-ferrous metals or alloys for an application

Appendix A: Industry Classifications

For the purposes of analysing the business landscape, the following industry classifications have been used.

ANZSIC Classifications

ANZSIC Code 3-digit classification	ANZSIC Code 4-digit classification	Related MEM Manufacturing and Engineering Training Package areas
212 Basic Ferrous Metal Product Manufacturing	2122 Steel Pipe and Tube Manufacturing	Engineering
214 Basic Non-Ferrous Metal Product Manufacturing	2141 Non-Ferrous Metal Casting	Engineering
214 Basic Non-Ferrous Metal Product Manufacturing	2142 Aluminium Rolling, Drawing, Extruding	Engineering
214 Basic Non-Ferrous Metal Product Manufacturing	2149 Other Basic Non-Ferrous Metal Product Manufacturing	Engineering
221 Iron and Steel Forging	2210 Iron and Steel Forging	Engineering
222 Structural Metal Product Manufacturing	2221 Structural Steel Fabricating	Engineering
222 Structural Metal Product Manufacturing	2222 Prefabricated Metal Building Manufacturing	Engineering
222 Structural Metal Product Manufacturing	2224 Metal Roof and Guttering Manufacturing (except Aluminium)	Engineering
222 Structural Metal Product Manufacturing	2229 Other Structural Metal Product Manufacturing	Engineering
223 Metal Container Manufacturing	2231 Boiler, Tank and Other Heavy Gauge Metal Container Manufacturing	Engineering
223 Metal Container Manufacturing	2239 Other Metal Container Manufacturing	Engineering
224 Sheet Metal Product Manufacturing (except Metal Structural and Container Products)	2240 Sheet Metal Product Manufacturing (except Metal Structural and Container Products)	Engineering
229 Other Fabricated Metal Product Manufacturing	2291 Spring and Wire Product Manufacturing	Engineering

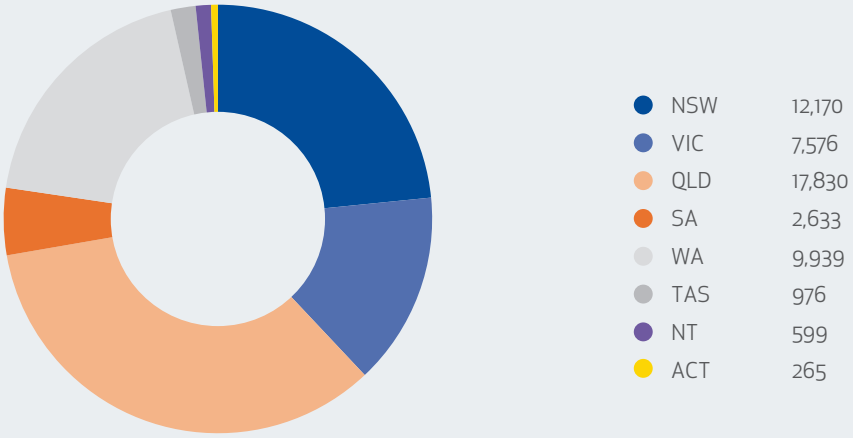
ANZSIC Code 3-digit classification	ANZSIC Code 4-digit classification	Related MEM Manufacturing and Engineering Training Package areas
229 Other Fabricated Metal Product Manufacturing	2292 Nut, Bolt, Screw and Rivet Manufacturing	Engineering
229 Other Fabricated Metal Product Manufacturing	2293 Metal Coating and Finishing	Engineering
229 Other Fabricated Metal Product Manufacturing	2299 Other Fabricated Metal Product Manufacturing nec	Engineering Locksmithing
239 Other Transport Equipment Manufacturing	2391 Shipbuilding and Repair Services	Shipbuilding
239 Other Transport Equipment Manufacturing	2392 Boatbuilding and Repair Services	Boatbuilding
239 Other Transport Equipment Manufacturing	2393 Railway Rolling Stock Manufacturing and Repair Services	Engineering
239 Other Transport Equipment Manufacturing	2399 Other Transport Equipment Manufacturing nec	Engineering
241 Professional and Scientific Equipment Manufacturing	2411 Photographic, Optical and Ophthalmic Equipment Manufacturing	Engineering
241 Professional and Scientific Equipment Manufacturing	2412 Medical and Surgical Equipment Manufacturing	Engineering
241 Professional and Scientific Equipment Manufacturing	2419 Other Professional and Scientific Equipment Manufacturing	Engineering
242 Computer and Electronic Equipment Manufacturing	2421 Computer and Electronic Office Equipment Manufacturing	Engineering
242 Computer and Electronic Equipment Manufacturing	2422 Communication Equipment Manufacturing	Engineering
242 Computer and Electronic Equipment Manufacturing	2429 Other Electronic Equipment Manufacturing	Engineering
243 Electrical Equipment Manufacturing	2432 Electric Lighting Equipment Manufacturing	Engineering
243 Electrical Equipment Manufacturing	2439 Other Electrical Equipment Manufacturing	Engineering
244 Domestic Appliance Manufacturing	2441 Whiteware Appliance Manufacturing	Engineering

ANZSIC Code 3-digit classification	ANZSIC Code 4-digit classification	Related MEM Manufacturing and Engineering Training Package areas
244 Domestic Appliance Manufacturing	2449 Other Domestic Appliance manufacturing	Engineering
246 Specialised Machinery and Equipment Manufacturing	2461 Agricultural Machinery and equipment manufacturing	Engineering
246 Specialised Machinery and Equipment Manufacturing	2462 Mining and Construction Machinery Manufacturing	Engineering
246 Specialised Machinery and Equipment Manufacturing	2463 Machine Tool and Parts Manufacturing	Engineering
246 Specialised Machinery and Equipment Manufacturing	2469 Other Specialised Machinery and Equipment Manufacturing	Engineering
249 Other Machinery and Equipment Manufacturing	2491 Lifting and Material Handling Equipment Manufacturing	Engineering
249 Other Machinery and Equipment Manufacturing	2499 Other Machinery and Equipment Manufacturing nec	Engineering
259 Other Manufacturing	2591 Jewellery and Silverware Manufacturing	Jewellery
259 Other Manufacturing	2592 Toy, Sporting and Recreational Product Manufacturing	Engineering
259 Other Manufacturing	2599 Other Manufacturing nec	Engineering
942 Machinery and Equipment Repair and Maintenance	9421 Domestic Appliance Repair and Maintenance	Engineering
942 Machinery and Equipment Repair and Maintenance	9422 Electronic (except Domestic Appliance) and Precision Equipment Repair and Maintenance	Engineering
942 Machinery and Equipment Repair and Maintenance	9429 Other Machinery and Equipment Repair and Maintenance	Engineering
949 Other Repair and Maintenance	9499 Other Repair and Maintenance nec	Watch and Clock Service and Repair Locksmithing

Appendix B: Training Package Enrolment Snapshot

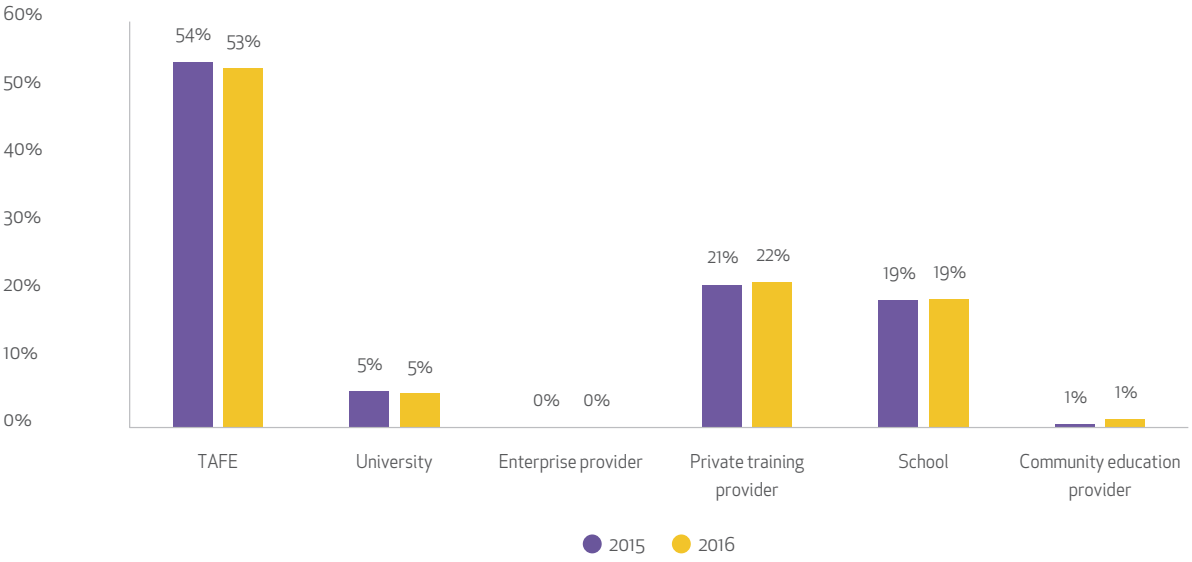
Program enrolments in MEM Manufacturing and Engineering qualifications by State/ Territory of student residence

2016 Total VET Activity



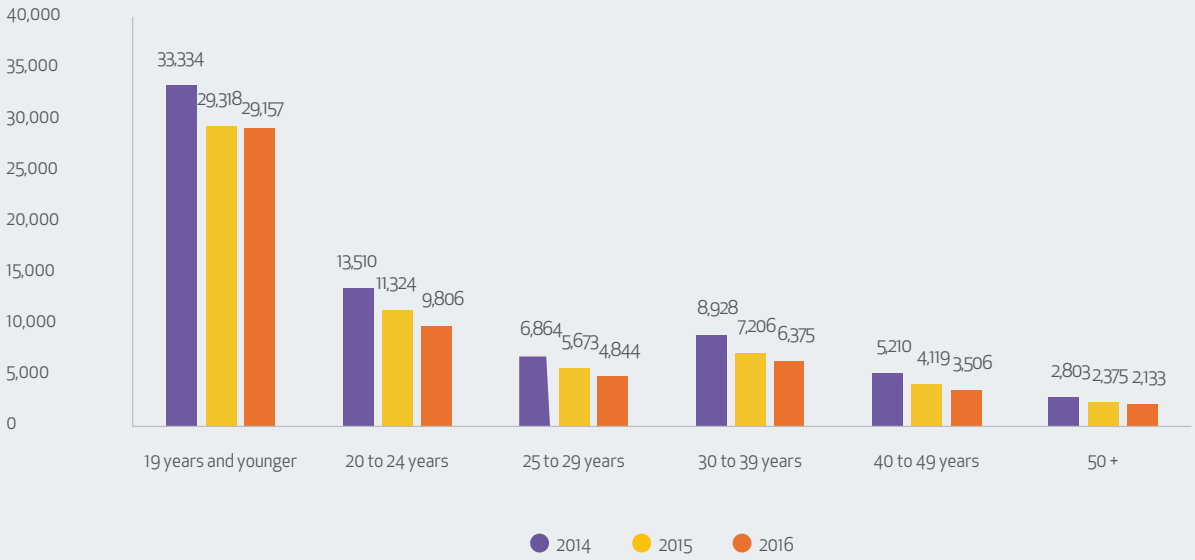
Program enrolments in MEM Manufacturing and Engineering qualifications by Training Organisation Type

Percentage of 2015–2016 Total VET Activity



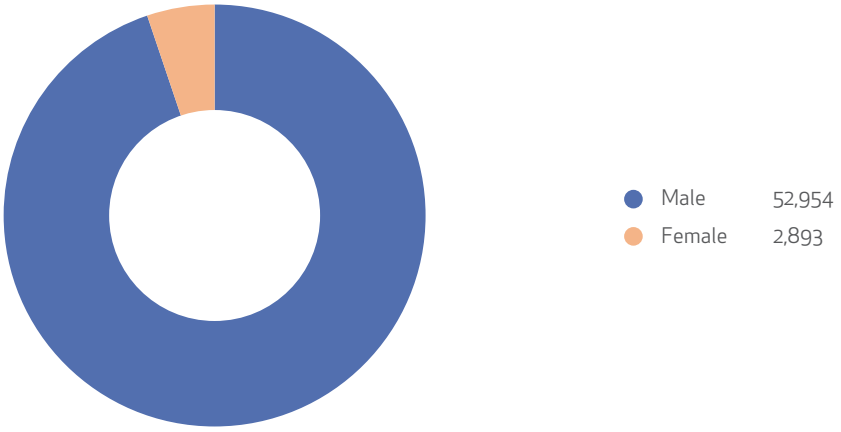
Program enrolments in MEM Manufacturing and Engineering qualifications by Age Group

2014–2016 Total VET Activity



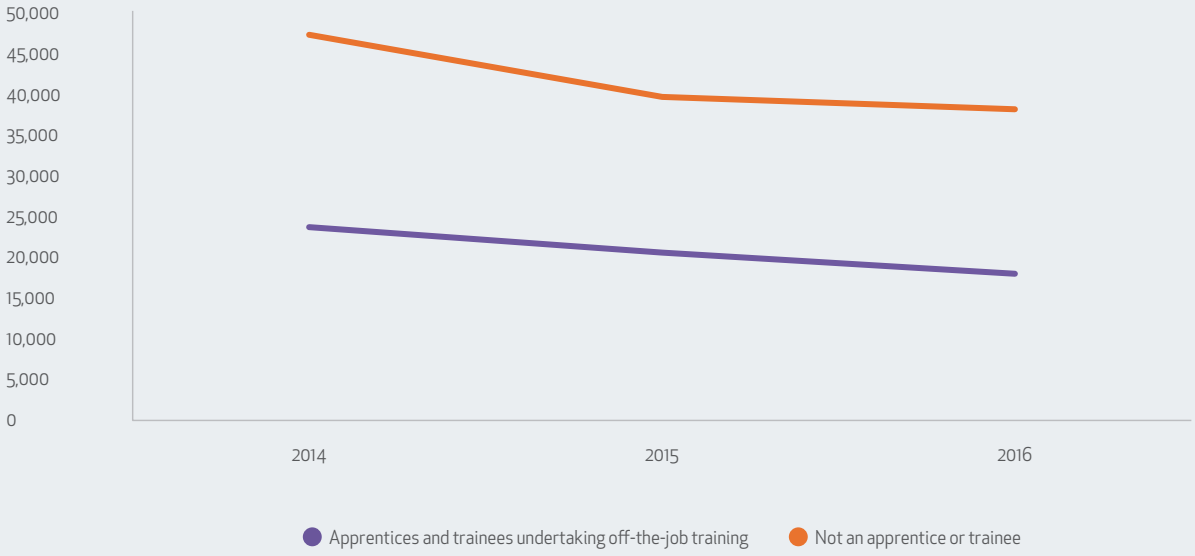
Program enrolments in MEM Manufacturing and Engineering qualifications by Sex

2016 Total VET Activity



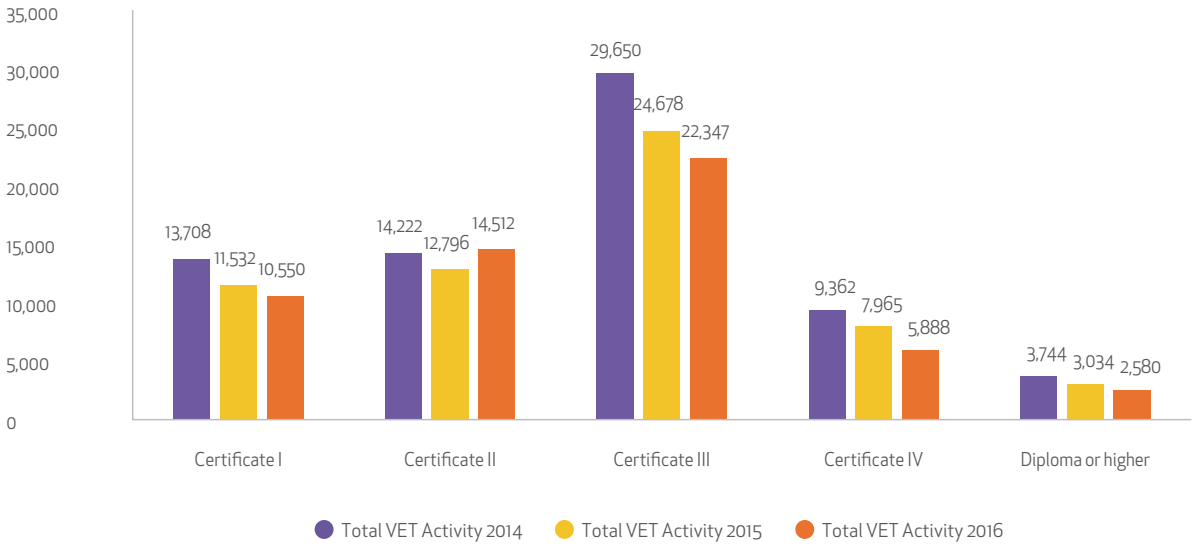
Program enrolments in MEM Manufacturing and Engineering qualifications by Apprentice/Trainee status of student

2014–2016 Total VET Activity



Program enrolments in MEM Manufacturing and Engineering qualifications by qualification level

2014–2016 Total VET Activity



All data in this Appendix is sourced from the VOCSTATS VET Provider Collection. 2016 Government Funded and Total VET Activity Program enrolments extracted September 2017

VOCSATATS data are 'randomly' adjusted by small amounts by a data perturbation tool to avoid the release of confidential data. Hence numbers are only approximate. The perturbation impact is negligible for most practical purposes. The effect can be significant and must be considered when interpreting small numbers.

Appendix C: Occupation Classifications

For the purposes of analysing employment trends, the following occupation classifications have been used.

ANZSCO Classifications

ANZSCO 3- or 4-digit classification	ANZSCO 6-digit classification	Related MEM Manufacturing and Engineering Training Package qualifications
8391 Metal Engineering Process Workers	839111 Metal Engineering Process Worker	Certificate I in Engineering Certificate II in Engineering Certificate II in Engineering – Production Technology Certificate II in Engineering Pathways
3991 Boat Builders and Shipwrights	399111 Boat Builder and Repairer	Certificate I in Boating Services Certificate II in Boating Services
322 Fabrication Engineering Trades Workers		Certificate III in Engineering – Production Systems
323 Mechanical Engineering Trades Workers		Certificate III in Engineering – Mechanical Trade Certificate IV in Engineering
3222 Sheetmetal Trades Workers	322211 Sheetmetal Trades Worker	Certificate III in Engineering – Fabrication Trade
340 Electrotechnology and Telecommunications Trades Workers		Certificate III in Engineering – Electrical/Electronic Trade
3125 Mechanical Engineering Draftspersons and Technicians		Certificate III in Engineering – Technical Certificate IV in Engineering Drafting

ANZSCO 3- or 4-digit classification	ANZSCO 6-digit classification	Related MEM Manufacturing and Engineering Training Package qualifications
3994 Jewellers	399411 Jeweller	Certificate III in Jewellery Manufacture Certificate IV in Advanced Jewellery Manufacture Diploma of Jewellery and Object Design Advanced Diploma of Jewellery and Object Design
3991 Boat Builders and Shipwrights	399112 Shipwright	Certificate III in Marine Craft Construction
3233 Precision Metal Trades Workers	323313 Locksmith	Certificate III in Locksmithing
3991 Boat Builders and Shipwrights		Certificate III in Boating Services Certificate IV in Boating Services
3233 Precision Metal Trades Workers	323316 Watch and Clock Maker and Repairer	Certificate III in Watch and Clock Service and Repair
3999 Other Miscellaneous Technicians and Trades Workers	399999 Technicians and Trades Workers nec	Certificate III in Engineering – Composites Trade
3411 Electricians	341112 Electrician (Special Class)	Certificate III in Engineering – Industrial Electrician
312 Building and Engineering Technicians		Diploma of Engineering – Advanced Trade
3129 Other Building and Engineering Technicians	312911 Maintenance Planner	Diploma of Engineering – Technical
3125 Mechanical Engineering Draftspersons and Technicians	312512 Mechanical Engineering Technician	Advanced Diploma of Engineering
3129 Other Building and Engineering Technicians	312999 Building and Engineering Technicians nec	Graduate Diploma of Engineering