

A large industrial robotic arm is shown in a factory setting, performing a welding task. The robot is orange and blue, with a welding torch at its end. Bright sparks are flying from the point of contact between the torch and the metal workpiece. The background is slightly blurred, showing other industrial equipment and a bright light source.

IBSA Manufacturing Digital Skills Cross Sector Project Case for Change November 2017

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Prepared on behalf of the Digital Skills Project Reference Group for the Australian Industry Skills Committee (AISC)

Digital Skills Cross Sector Project Case for Change, November 2017

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Contents

Administrative information	1
Executive summary	4
The case for change	7
Industry support for change	13
Impact of change	14
PRG Signoff	18
Attachment A: Members of the Project Reference Group	19
Attachment B: Training Package components to change	20
Attachment C: Stakeholder Consultation Method and Scale	35
Attachment D: Supporting Research	38

Administrative information

Name of Cross Sector Project

Digital Skills

Name of lead Skills Service Organisation (SSO)

Innovation and Business Skills Australia (IBSA) Manufacturing

Project webpage address

A project page for the Digital Skills cross sector project was established on the IBSA Website to provide all IRCs and interested stakeholders with information on the activities. The webpage link is provided below:

<https://www.ibsa.org.au/consultation-project/coding-skills-cross-sector-project/>

Members of Project Reference Group (PRG)

A Project Reference Group (PRG) was established in July 2017 to oversee this project and consists of Industry Reference Committee (IRC) members and subject matter experts as provided in Attachment A.

This Digital Skills Cross Sector Project *Case for Change* was reviewed and approved by the project Reference Group in November 2017.

Name of training package(s) and qualifications, skill sets and units of competency (if known) impacted by proposed cross sector training product components

This Digital Skills Cross Sector project, by design, looked across a number of manufacturing and related Training Packages to identify qualifications, skill sets and units of competency impacted by digital analytic/diagnostic skills, additive manufacturing (3D printing) skills, and programming/coding skills.

A list of the Training Packages included in the scope of the project and a description of the review and analysis process is detailed in the section outlining the Project Scope.

Stakeholder feedback identified a need to strengthen specific digital skills in specific existing qualifications/units. Analysis identified that many units are currently being used in a cross sector manner. Stakeholders did not identify a need for more units, skill sets or qualifications. The Training Package components to be reviewed and changed are detailed in Attachment B and include the following:

Qualifications

MSA07 Manufacturing Training Package

- MSA30208 Certificate III in Manufacturing Technology
- MSA40108 Certificate IV in Manufacturing Technology
- MSA50108 Diploma of Manufacturing Technology
- MSA60108 Advanced Diploma of Manufacturing Technology

MEM05 Metal and Engineering Training Package

- MEM30505 Certificate III in Engineering - Technical
- MEM30705 Certificate III in Marine Craft Construction
- MEM40311 Certificate IV in Advanced Jewellery Manufacture
- MEM50105 Diploma of Engineering - Advanced Trade
- MEM50311 Diploma of Jewellery and Object Design
- MEM60211 Advanced Diploma of Jewellery and Object Design

These qualifications are currently being transitioned to the *2012 Standards for Training Packages* and will be available for review in relation to *Digital Skills* in July 2018.

The Project Reference Group noted the need for a timely response to the updating of Training Package components which contain digital skills and strongly encouraged that these qualifications be prioritised for updating once the transition work is complete.

One accredited course, Diploma of Applied Technologies, was identified during the project. It is currently a higher education diploma which is being re-accredited as a VET diploma. Details are included in the 'bottom-up' analysis section.

Units of Competency

Overall 211 Units of Competency containing Digital Skills in eight Training Package areas have been identified as requiring updating/alignment to emerging Industry 4.0 skill needs, as summarised in the table following and detailed in Attachment B.

Training Package	Number of Units of Competency To be strengthened / updated for Digital Skills
MEA Aeroskills	39
LMT07 / MST Textiles, Clothing and Footwear	11
MEM05 Metal and Engineering	104
MSA07 / MSM Manufacturing	8
MSL Laboratory Operations	3
PMA Chemical, Hydrocarbons and Refining	1
PMB Plastics, Rubbers and Cablemaking	5
ICP Printing & Graphic Arts	40
TOTAL	211

The Case for Change does not recommend the development of new units of competency however this may occur as a result of the subsequent training package development. This case for change proposes that all decisions on how units should be updated/aligned to Industry 4.0 or newly created, as a consequence of the training package development process, should be taken by the respective Industry Reference Committee. If agreed to by respective Industry Reference Committees, the work can be undertaken in a holistic, cross sector manner.

In addition 17 accredited units were identified which appear to potentially duplicate content of Training Package units. They are listed as an addendum to Attachment B.

Stakeholder Consultations

Stakeholder consultation was guided by the *Digital Skills Cross Sector Project Reference Group*. Feedback was considered from all stakeholders and in depth face to face and phone consultation occurred with key stakeholders. A list of stakeholders consulted is provided in Attachment C.

Supporting research

The Case for Change was developed having regard for the Training Package Development and Endorsement Process Policy and provides robust evidence to support AISC's decision making process.

Supporting research is provided in Attachment D.

Executive summary

As the Australian economy, and the broader global economy, are being impacted by a range of technological, economic and social forces – work is changing in profound ways and with it the skills workers require. To ensure the Australian vocational education and training (VET) system can deliver the skills businesses need as they respond to and look to benefit from these changes; the Australian Industry and Skills Committee (AISC) has commissioned a number of cross sector projects. These projects investigate the ways in which jobs and skills are changing to meet these shifting cross sectoral skill requirements.

Project Scope

IBSA Manufacturing was tasked with leading one of these cross sector projects. Initially the project scope was focused on examining whether coding/programming skills are included in manufacturing and related Training Packages, and to determine the scope and scale of change required to ensure the ongoing relevance of existing training products for a rapidly changing workplace.

The Industry Sectors and related Training Packages included in the scope of the project were:

- Aeroskills (MEA)
- Chemical, Hydrocarbons and Refining (PMA)
- Laboratory Operations (MSL)
- Manufactured Mineral Products (PMC)
- Manufacturing and Engineering (MEM)
- Manufacturing (MSA07 / MSM)
- Metal and Engineering (MEM05)
- Plastics, Rubber and Cablemaking (PMB)
- Printing and Graphic Arts (ICP)
- Textiles, Clothing and Footwear (LMT07 / MST)
- Information and Communications Technology (ICT) (for the purposes of determining if there were units and skill sets available to be imported into other Packages)

At the first meeting of the Project Reference Group – it was unanimously agreed that there were broader digital changes occurring in the workplace (and associated changes to the skills required by workers) that went beyond coding skills. After reviewing the Industry Skills Forecasts and Proposed Schedules of Work developed by the relevant Industry Reference Committees, a broader scope for the project was agreed and then further refined during the course of the project.

The 'digital skills' project focused on the following skills:

1. digital analytic/diagnostic skills – arising from the digital augmentation occurring in many industries where there is a need for people with the technical skills to analyse and respond to data provided by the machines in their workplace,
2. additive manufacturing (3D printing) skills, and
3. programming/coding skills.

The content of the Training Packages listed above was analysed through a detailed search of the full content of each Training Package using the following search terms:

- Digital
- Code
- Coding
- Program
- Programming
- Additive
- CAD
- CAM
- CAE
- 3D (and 3-D).

The search identified a large number of units containing content relevant to the scope of the project. Other units referencing concepts including basic digital literacy, digital media, digital files, and various codes (in the form of standards) were excluded.

Stakeholder Feedback

Few of the more than 40 individuals involved in the project consultations identified a need for specific changes to Training Packages to meet current or future digital skills needs. Those that did have feedback on Training Package content made reference to the need to make sure that that content was up-to-date in today's rapidly changing work environment. No-one involved in the consultations identified any gaps that needed to be filled (or where they did, later analysis identified units which were available). The Training Package analysis undertaken during the project identified a wide range of Training Package components which contained specific digital skills relevant to the scope of this project. A number of units of competency in these Training Packages were already being used in a cross sector manner.

Many of those involved in the consultations raised the issue of skills needs in an Industry 4.0 environment (Industry 4.0 is also referred to as the fourth industrial revolution and relates to the profound changes occurring in manufacturing and related industries as a result of digitisation). They

questioned if and how Training Packages could meet the needs of this new industrial revolution and what would happen to Australian manufacturing if they were unable to do so.

A number of participants pointed out the very short amount of time required to get new courses accredited in the university sector (a matter of weeks) versus the time needed to get courses accredited or Training Packages changed in the VET sector. People also pointed to the need for critical thinking, problem solving and other skills that went ‘beyond the technical’ during the consultations when they discussed future skill needs in manufacturing and related industries.

Supporting Evidence

Research was undertaken to support the project and found a paucity of evidence on the specific digital skills needed in manufacturing and related industries. Instead, there was a wide range of research on the changes occurring as a result of Industry 4.0, including how other countries are changing their VET systems to try and accommodate these changes (see Attachment D).

Summary of proposed changes

There are three direct Training Package changes proposed as a result of this project and a recommendation to undertake further cross sector work:

1. The four Manufacturing Technology qualifications in the MSA07 Training Package should be reviewed and updated.
2. The six qualifications in the MEM05 Training Package which focus on CAD/CAM skills should also be reviewed and updated.
3. The 211 ‘digital skills’ units from Training Packages identified in this analysis should be reviewed and updated – with a priority given to those which have not had substantial changes made to them for five or more years.
4. IBSA Manufacturing leading a new cross-sector project which examines the skill needs of Industry 4.0 and the potential impact on Training Packages – with Manufacturing as the pilot for any possible changes. The research should consider, amongst other things, how Training Packages can be updated and maintained in a timely manner given the pace of change in the world of work as a result of digitisation; the inclusion of core skills such as creative thinking, critical thinking, problem solving and other higher order core skills; and the need for specific ‘working in Industry 4.0’ units.

The following recommendation sits outside the scope of this Case for Change however industry stakeholders involved in the consultations did want the AISC to consider:

5. Encouraging States and Territories and the Commonwealth to consider making the Diploma of Applied Technologies available as a subsidised program/eligible for VET Student Loans (once it is accredited by the Victorian Registration and Qualifications Authority (VRQA)).

Finally the development of this Case for Change identified some apparent duplication between accredited units and those available in Training Packages which should be investigated further with the VRQA.

The Case for Change

Current and emerging developments in skill needs – top down analysis

The World Economic Forum's 2016 *Future of Jobs* survey¹ determined that 35 percent of the skills deemed important in today's workforce will have changed in four years. The fourth industrial revolution is characterised by a range of new technologies that are merging the physical, digital and biological worlds and will bring "*change at a speed, scale and force unlike anything we have ever seen before*".²

According to the AIIA, major technologies impacting the manufacturing sector include Artificial Intelligence (AI), the Internet of Things (IoT), general automation, robotics and augmented reality.³

When manufacturing executives were asked to identify the top-five impacts of digital technologies to 2020⁴, they identified that:

1. as more tasks are automated, work will become more strategic
2. we will work faster
3. work will require greater technical expertise
4. interpersonal relationships at work will be more valuable, and
5. jobs and the required skills will change significantly.

These observations were consistent across the research. In examining the impact of additive manufacturing/3D printing Brown and Satyavolu for Cognizant's *Centre for the Future of Work*⁵, outline its potential to rapidly change the manufacturing sector – from "legacy industrial models" to "what you want, when you want it" manufacturing. Despite the impact 3-D printing will have, in their survey of 500 senior manufacturing executives, approximately 70 percent of respondents did not focus on a need for 3-D printing skills when asked about the impact of digital change. Instead they identified how 3-D printing is boosting the need for innovation skills. Specifically they identify that this will mean, less emphasis on discrete manufacturing equipment installation (and skills), and more focus on whether the new equipment will improve new digital business approaches.

¹ World Economic Forum (2016) *Future of Jobs*, <https://www.weforum.org/>

² World Economic Forum <https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab>

³ AIIA (2017) *Skills for Today. Jobs for Tomorrow* https://www.aiia.com.au/_data/assets/pdf_file/0020/81074/JOBS-FOR-TOMORROW-FINAL.pdf

⁴ Brown, R. H. & Satyavolu, P (2017) *The Work Ahead: Designing Manufacturing's Digital Future report* (p.4) The Centre for Work, Cognizant. <https://www.cognizant.com/whitepapers/the-work-ahead-designing-manufacturing-s-digital-future-codex2391.pdf>

⁵ Brown, R. H. & Satyavolu, P. (2017) *The Work Ahead: Designing Manufacturing's Digital Future report* (p.4) The Centre for Work, Cognizant. <https://www.cognizant.com/whitepapers/the-work-ahead-designing-manufacturing-s-digital-future-codex2391.pdf>

In their examination of skill needs in the aerospace sector, rather than focussing on explicit technical and digital skills, Lappas and Kourousis ⁶ note that employees need a plethora of skills, like “the ability to respond creatively to complex problems, effective communication, team working and the use of technology to create new knowledge”. They also raise concerns about whether an ‘industrial-age curriculum’ can fully equip students for work in an ‘information-age society’.

Skills needs shared by multiple sectors and industries - ‘bottom up’ analysis

The digital skills contained in the Training Packages which were the focus of this Digital Skills Cross Sector project were analysed, along with units in related accredited courses. The analysis identified 10 qualifications, one skill set, one accredited course, 17 accredited units, and 211 Training Package units of competency which contain relevant digital skills.

Qualifications

There are four manufacturing technology qualifications available in the MSA07 Training Package (which range from Certificate III to Advanced Diploma) and a more recently updated Certificate II qualification from the MSM Manufacturing Training Package. The Certificate II qualification has been specifically designed for a VET in Schools environment and was first implemented in 2016 therefore is not recommended for review as part of this project. The four qualifications from the MSA Training Package which are recommended to be aligned to Industry 4.0 requirements are:

- MSA30208 Certificate III in Manufacturing Technology
- MSA40108 Certificate IV in Manufacturing Technology
- MSA50108 Diploma of Manufacturing Technology
- MSA60108 Advanced Diploma of Manufacturing Technology

The Certificate III and IV qualifications were designed to be delivered through a one and two-year technology cadetship respectively (under a contract of training arrangement). They were first introduced in 2011 and offer cadets a number of streams to choose from. Some State governments provide funding for these qualifications as traineeships. They are recognised in Queensland as cadetships. The Diploma and Advanced Diploma were also introduced in 2011 and offer learners specialist streams. They are not offered as cadetships.

While all four qualifications have been updated since their introduction the changes made have been either to correct unit codes, replace imported units with newer equivalent units, or to amend unit

⁶ Lappas, I, & Kourousis, K, I. (2016). Anticipating the Need for New Skills for the Future Aerospace and Aviation Professionals. *Journal of Aerospace Technology and Management*, 8(2), 232-241. <https://dx.doi.org/10.5028/jatm.v8i2.616>

codes. These changes are important but signify that no substantive change to the content of these qualifications has been made since their introduction.

These qualifications are currently being transitioned to the *2012 Standards for Training Packages* and will be available for review in relation to *Digital Skills* in 2018. Given the pace of technological change, the need for existing workers to upgrade their technology skills as a result of Industry 4.0, and the need for new entrants to the labour market to have current technology skills it is recommended that these qualifications should be updated

CAD/CAM/CAE/3D printing/additive manufacturing

In addition to the specific manufacturing technology qualifications, there are six qualifications in the MEM05 Metal and Engineering Training Package which include skills related to additive manufacturing (CAD, CAM, CAE and 3-D printing). One has not been updated since 2005, others were last updated in 2012 and 2013. Given the significant advances being made in 3-D printing/additive manufacturing and the way it is already starting to transform the manufacturing sector – it is recommended that these qualifications should also be updated:

- MEM30505 Certificate III in Engineering - Technical
- MEM30705 Certificate III in Marine Craft Construction
- MEM40311 Certificate IV in Advanced Jewellery Manufacture
- MEM50105 Diploma of Engineering - Advanced Trade
- MEM50311 Diploma of Jewellery and Object Design
- MEM60211 Advanced Diploma of Jewellery and Object Design

These qualifications are currently being transitioned to the *2012 Standards for Training Packages* and will be available for review in relation to *Digital Skills* in 2018.

Skill sets

The ICPSS00002 *3D Print Fundamentals Skill Set* was first released in January 2016 and includes three units to assist learners to understand the basics of 3D printing. The Printing and Graphic Arts IRC have had a Case for Change to this skill set approved to enable them to improve the currency of the existing units in the skill set and add a new unit. The project will also consider the structure and purpose of the skill set. No further changes to this skill set are recommended as a consequence of this Cross Sector Project.

Accredited course

As part of the Commonwealth government's 'Apprenticeships Training – Alternative Delivery Pilots' AiGroup, Siemens and Swinburne University have developed two higher level apprenticeship courses in

Applied Technologies. They are designed to help new entrants to the labour market work in an Industry 4.0 environment. The apprenticeships are respectively at Diploma and Associate Degree level.

The diploma course is currently being considered by the VRQA for accreditation as a VET accredited course – enabling it to be taught more widely across the VET sector. The Victorian government has indicated it will add the course to its subsidised course list once it is accredited – making it more widely available to learners in Victoria. Once it is accredited as a VET diploma it is understood that it will be discussed with other State Training Authorities and the Commonwealth with a view to including it on other State government subsidised funding lists and thus also as a course eligible for VET Student Loans approval.

The course contains units specifically designed for new entrants to an Industry 4.0 work environment and has been well received by employers involved in the pilot. It is recommended that the AISC supports the intention that State Training Authorities and the Commonwealth recognise the course for funding/VET Student Loan eligibility purposes.

Training Package units of competency

This analysis also identified 211 units which are currently in use within the Training Packages which are the primary focus of the project, and which contain the set of digital skills which are within the scope of the project. A further seven units from the ICT Training Package contain skills relevant to the scope of the project.

A number of units, those with a more generic focus, are already being used in a cross-sector manner across multiple Training Packages. In addition, a total of 38 units contain more than one type of the digital skills relevant to the scope of this project and are used in multiple Training Packages. Other units are necessarily specific to the instruments they relate to (eg the various digital skills units in the MEA Aeroskills Training Package).

It is noteworthy that of the 211 units identified in this research, 35 have not been updated since they were first introduced in 2005, an additional 24 have not been updated since 2011 and 60 have not been updated since 2012. In addition, some of the updates to units with more recent release dates, have involved changes to update the unit content to meet nationally agreed standards, rather than to make substantive changes to the content of the units. This means that more than half of the digital units identified in this analysis were developed more than five years ago and many of those released more recently have not had substantive changes made to their content for some years. Given the nature and pace of technological change it seems appropriate that the content of the units identified here should be reviewed and potentially updated, with an immediate emphasis on those which have not been updated within the past five years.

Further analysis of other IRC Industry Skills Forecasts and Proposed Schedules of Work (and supported in some instances through observations made in the consultations) identifies the digital skills which

were the focus of this project are also applicable in the future skill needs of other industries which focus on 'making things'. They are:

- Agriculture
- Civil Infrastructure
- Construction
- Dental and other areas of the Health sector (eg Technicians Support Services)
- Food, Beverage and Pharmaceutical Manufacturing
- Furnishing
- Horticulture
- Meat Processing
- Pulp and Paper Manufacturing
- Timber Manufacturing

Opportunities for qualification design to promote occupation mobility, and for modernising sector / industry specific units, qualifications or skill sets

The four Manufacturing Technology qualifications (particularly those at Certificate III and IV level and able to be offered as cadetships) are an important pathway to support greater occupational mobility within the manufacturing sector (and related industries) and for workers from outside the manufacturing sector wanting to move into new technologically focused jobs within the industry. Updating these qualifications should be a matter of priority to support improved mobility.

In relation to the units available across the 10 Training Packages considered here – despite the number available the analysis showed little overlap. The largest number of units were those focused on digital analytic/digital diagnostic skills ie the skills to input, analyse and interpret data from machines and to use that information in a job role. While the project was clearly understood to be one focused on cross sector opportunities to align units and reduce any duplication, given the different machines learners are required to work with (eg in the aviation industry) it was not considered that the units as written were duplicative. No feedback was received during the consultations which indicated that units were duplicative or could be more broadly applied.

Of the units which incorporate **coding/programming skills** 15 are used in two Training Packages, five are used in three different Packages and one is used in four different Packages.

Of the units providing **additive manufacturing, CAD, CAM, CAE, or 3-D printing skills**, nine were used in two different Training Packages, one was use in three different Packages, two were used in four different Packages and one was used in five different Packages.

Of the units which included the specific **digital skills** which are the focus of this project, 16 were used in two different Training Packages, one was used in three different Packages, one was used in four different Packages, and one was used in seven different Packages.

The MEM Metal and Engineering Training Package contained the largest number of digital units. Many of the units in this Package have not been updated since 2005 and while they are the subject of a current Activity Order (to ensure they meet the 2012 Standards for Training Packages) – it is recommended that their content be updated and changes made to ensure the digital skills included in the units are current.

Industry drivers and how the proposed changes address identified cross sectoral skills needs

There are three drivers for the changes proposed in this Case for Change. They focus firstly on ensuring a cross sector approach to the recommendations, secondly ensuring that the current suite of digital skills being provided in Training Packages are contemporary and thirdly, that the sector has considered how it will meet the need for skills in a digitally integrated and rapidly changing Industry 4.0 environment.

While this project focused on the manufacturing, printing and related sectors, an analysis of all available IRC Industry Skills Forecasts and Proposed Schedules of Work identifies that there are other industries impacted by these changes and with similar skill needs. They are all involved in manufacture, production or construction processes.

Despite adopting a cross-sectoral approach to the project – the fact that (a) there are a number of units which are already being used in a cross sectoral manner, and (b) the specific machines used in different manufacturing and related industries – meant that the report makes no recommendations for new cross sectoral units to be created. However, undertaking training package development work in a holistic and cross sector manner could potentially identify similarities in units across training packages and lead to the development of units which could be used across sectors.

The steps outlined below aim to address the needs identified in the project, that is:

1. ensuring that existing units, skill sets and qualifications are current by updating the identified Training Package components (Attachment B)
2. providing other IRCs with similar digital skills in their Training Packages with advice on this project,
3. meeting with other IRCs and their SSOs to examine if the cross sectoral units already in use in the Training Packages which were the focus of this project can be used in their Training

Packages where a need for the same skills is identified⁷, and

4. ensuring the skill needs of the Australian manufacturing sector (and related industries) continue to be met in an Industry 4.0 environment by:
 - a. providing approval and funding for IBSA Manufacturing to undertake a cross-sector project focussed on determining how Training Packages can continue to meet the needs of the workforce in a rapidly changing Industry 4.0 environment, and
 - b. promoting the take-up of the soon-to-be accredited Diploma of Applied Technologies (higher level apprenticeship) as a means of meeting the skill needs of new entrants to the workforce going into Industry 4.0 workplaces.

NB: IBSA Manufacturing is currently working with the Furnishing IRC to identify similar digital skills in the MSF Furnishing Training Package. A separate 'Case for Change' will be submitted for this work.

Industry support for change

Consultations took place over a seven week period and involved face-to-face meetings and telephone interviews with representatives from small and medium businesses, national and global businesses, unions, training providers, industry peak bodies and other VET sector stakeholders. IBSA Manufacturing is grateful for the time taken by industry representatives to participate in the project and for the input they provided.

Participants were based in the inner city and outer suburbs of Sydney, Melbourne, Brisbane, Canberra, Adelaide, Perth; three were in regional areas of New South Wales and Victoria. Due to the time required to reach agreement on an expanded scope for the project it was not possible to also implement a wider survey to garner feedback. However input was received from multiple participants from all industry areas included in the project scope, and from those currently represented on the affected IRCs.

Specific details on the consultation participants are included at Attachment C.

Evidence of cross sectoral support, including impacted IRCs and other key stakeholders

All IRCs which are impacted by the recommendations included in this Case for Change were provided with advice on the project as it progressed and with an early copy of the anticipated recommendations

It should be reiterated that all decisions on how units should be updated/aligned to Industry 4.0 or newly created, as a consequence of the training package development process, will be taken by the

⁷ A number of the PRG representatives involved in this Case for Change project also sat on other Case for Change PRGs. In addition, staff from IBSA Manufacturing participated as observers on all other Case for Change projects and have provided formal and informal advice to other SSOs. As a consequence, there is a level of understanding of this digital skills project beyond just the industries included in the project scope. IBSA intends to build on this in continuing a cross sectoral approach to sharing the lessons of the project and offering support for the use of the already identified cross sectoral units from within the Training Packages which were part of this project scope – to other industry areas and Training Packages.

respective Industry Reference Committee. This Case for Change *does not propose* mandating any digital skills to be imposed on industries.

IRC feedback will be provided as a separate document.

Issues identified by stakeholders and how they will be addressed. In particular, highlight any issues that remain outstanding.

As noted earlier in this Case for Change – many of those involved in the consultations were more concerned with the impact of Industry 4.0 than specific changes to Training Packages. There were no issues identified by stakeholders in relation to the proposal to update the existing digital skills units and qualifications in the relevant Training Packages to ensure their currency.

Those participants who were familiar with the Diploma of Applied Technologies were positive about its potential to assist new entrants to the workforce in adapting to an Industry 4.0 environment. They were less clear about what options were available to them to upskill their existing workers for Industry 4.0.

There were no dissenting views from stakeholders to the approach outlined in this Case for Change.

Impact of change

Provide an analysis of the impact of the recommended changes on the vocational education and training system and relevant stakeholders (including employers, employees, students, registered training organisations, and government).

The implementation of the first three recommendations in this Case for Change represent ‘business as usual’ for the VET sector. That is, Training Package components will be updated to ensure their currency under the direction of the relevant Industry Reference Committee. In addition, an accredited course is being introduced which meets a need not yet included in a Training Package, and accredited units which duplicate units in Training Packages should not be re-accredited. As a consequence, the impact of the first three recommendations is considered to be positive but incremental –

learners will be taught more current skills and employers will receive the benefits of these skills, assisting them in improving their current operations.

The only potential negative impact on the system results from the fact that the first three recommendations in this Case for Change include many units and qualifications that are already undergoing an update to ensure they meet the 2012 Standards for Training Packages. This will create some duplication of activity for providers, regulators and students whereby some units and qualifications will be updated twice in a relatively short period of time.

The fourth recommendation in this Case for Change relates to the commissioning of a new project to explore how Training Packages can meet the needs of the Industry 4.0 work environment. The research should consider, amongst other things, how Training Packages can be updated and maintained in a

timely manner given the pace of change in the world of work as a result of digitisation; the inclusion of core skills such as creative thinking, critical thinking, problem solving and other higher order core skills; and the need for specific 'working in Industry 4.0' units. If the project is funded it is likely that it may result in recommendations which have a more substantial impact on the system. If it is not funded it is likely that the growth in accredited courses identified in Attachment D (at both the VET and higher education level) will continue as a means of meeting employer needs in a rapidly changing environment.

The research report at Attachment D canvases the major changes being made by the German, UK and Singaporean governments (amongst others) to their training systems, as a means of preparing their current and future workforces for Industry 4.0. The changes being made are not uniform (and it is not suggested that any of them specifically should be introduced here), however they are being introduced by other countries as a means of future proofing their manufacturing and related sectors by addressing the need (a) for different skills – beyond just the technical and (b) for the more timely delivery of new skills. It is suggested that Australia needs to ensure it also looks to future proof its manufacturing and related industries, and that there may be some lessons which can be learned from other advanced manufacturing countries.

The fifth recommendation suggests that the AISC should lend its support to efforts to encourage State Training Authorities and the Commonwealth to follow the lead of the Victorian government and provide funding to students wishing to enrol in the soon to be accredited Diploma of Applied Technologies. This course is having a positive impact – it has been well received by those employers currently using it and it includes a specific focus on Industry 4.0 skills for new entrants to the workplace.

Identify the risks of not implementing the changes.

The risks of not updating the proposed units and qualifications are that Australian businesses will become less competitive and learners will find it harder to gain employment.

The risk of not funding the proposed cross sector project on Industry 4.0 is that Australian manufacturing and related industries will rapidly lose their ability to compete. A growth in accredited courses at both the VET and higher education level will result in an inconsistent national approach to training in this important area.

The risk of not encouraging States and the Commonwealth to provide funding support for the Diploma of Applied Technologies is that employers in States outside Victoria will be unable to access the Industry 4.0 skills on offer.

Provide advice about how the proposed changes advance the project's priorities.

This Cross Sector project was an opportunity to identify if generic cross sector units or skill sets were needed to address gaps or reduce duplication in the digital skills included in Training Packages. The evidence is that units and qualifications need updating and some units are already being used in a cross

sector manner across different Training Packages. As such there was no need identified for additional units to meet specific needs.

Provide estimated timeframes for implementing the proposed changes to training package(s).

The proposed changes will initially primarily impact the manufacturing industry sectors and involve the updating of qualifications and units across 10 training packages. Discussions will also be undertaken with other SSOs and the IRCs they support about how existing cross sector units in the Training Packages examined here may assist in their demand for digital skills.

Training package development work to accommodate this updating activity - it is proposed that an initial 3-month scoping phase is conducted, followed by a 12-month development phase. The development phase will include extensive cross industry consultation and validation to ensure the updated training components meet industry needs.

It is estimated that the Industry 4.0 research project proposed here would take six months to complete and would involve national and international⁸ consultations, as well as more detailed desktop research.

It is also proposed that the research findings form the basis of a national conference for those in the affected industries. High profile international speakers could describe the impacts on their businesses.

Provide advice on any linkages with other cross-sector projects.

During the course of the project IBSA Manufacturing engaged extensively with all of the other cross-sector projects as they touch on skills needs across all industries including the manufacturing sectors.

This digital skills cross sector project is more closely linked to the following projects impacted by technological disruption:

- Automation
- Big data
- Cyber security
- Consumer engagement through social media

Further work needs to be undertaken to analyse the cross over between the recommended changes across the projects. And, as noted above, IBSA Manufacturing intends to engage with other SSOs and IRCs which have already identified a need for similar digital skills to determine if existing cross sector units can meet the needs they have identified.

⁸ The international consultations are envisaged as using digital technology rather than face-to-face meetings given the time and costs that would otherwise be involved.

Implementing the COAG Industry and Skills Council (CISC) reforms for training packages

This Case for Change has the potential to address the following CISC reforms which the Council agreed to ensure training products best fit the needs of industry.

Ensure obsolete and superfluous qualifications are removed from the system

The proposed update of 211 units across a number of training packages is likely to identify superfluous or obsolete units of competency.

Ensure that 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 course choices

Expectations for industry contextualisation in delivery and assessment of digital skills will be clearly articulated in respective Companion Volumes. This information will also be collated and available for Training Providers wanting to implement digital skills across a number of areas.

Ensure that the training system better supports individuals to move easily from one related occupation to another

Addressing the issue of transferable skills is also a concern for industry. This Case for Change proposes the update of a number of qualifications which will explore the potential for broader credentials and provide an opportunity to address this issue.

The commissioning of a new project to explore how national Training Packages can meet the needs of the Industry 4.0 work environment will further identify transferrable skills for individuals.

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

The update of units across a number of training package areas in a coordinated way has the potential to identify and create additional generic units that can be owned and used by multiple industry sectors, and support individuals to move easily from one related occupation to another.

Foster greater recognition of skill sets

While this Case for Change does not propose the development of skill sets the need for specific, targeted skill clusters may emerge during the training package development and review process.

Ensure that new training courses can be developed as quickly as industry needs them and be available to support niche skill needs

The commissioning of research into Industry 4.0, and further training package development work, will ensure the national training system can respond to employer needs in a rapidly changing environment.

Project Reference Group Signoff

This Case for Change was agreed to by the Digital Skills Cross Sector Project Reference Group

Name of Chair

Michael Grogan

Signature of Chair

Via email 1 December 2017

Date

1 December 2017

Attachment A: Members of the Project Reference Group

Industry Reference Committee (IRC) (or Subject matter expert)	Name	Organisation
Aerospace IRC	David Peterson (IRC Nominee)	Civil Aviation Safety Authority
Information and Communications Technology (ICT) IRC	David Sweeney	Telstra
Manufacturing & Engineering IRC	Michael Grogan (Chair)	Advanced Manufacturing Growth Centre
Printing & Graphic Arts IRC	Julie Hobbs	Design Institute of Australia (DIA)
Process Manufacturing, Recreational Vehicles and Laboratory IRC	Nigel Haywood	(formerly) National Energy Resources Australia
Textiles, Clothing & Footwear IRC	Leon Drury (Deputy Chair)	NSW Industry Training Advisory Board (NSW ITAB), Manufacturing Skills Australia
Australian Information Industry Association (AIIA) (Subject Matter Expert)	Mark Walker	ICM Consulting
Innovative Manufacturing CRC (Subject Matter Expert)	Nico Adams DPhil(Oxon)	Innovative Manufacturing CRC
Swinburne Institute of Technology (Subject Matter Expert)	Shanti Krishnan	Swinburne University of Technology

Attachment B: Training Package components to change

Lead SSO: IBSA Manufacturing

Date submitted: 1 December 2017

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Qualifications							
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSA30208 Certificate III in Manufacturing Technology		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSA40108 Certificate IV in Manufacturing Technology		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSA50108 Diploma of Manufacturing Technology		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSA60108 Advanced Diploma of Manufacturing Technology		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM05 Metal and Engineering Training Package		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM30505 Certificate III in Engineering - Technical		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM30705 Certificate III in Marine Craft Construction		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM40311 Certificate IV in Advanced Jewellery Manufacture		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM50105 Diploma of Engineering - Advanced Trade		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM50311 Diploma of Jewellery and Object Design		Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Units of Competency							
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA214 Inspect, test and troubleshoot aircraft basic communication and radio navigation systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA215 Inspect, test and troubleshoot advanced aircraft communications systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA216 Inspect, test and troubleshoot instrument landing systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA217 Inspect, test and troubleshoot fixed wing autopilot systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA218 Inspect, test and troubleshoot rotary wing autopilot systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA219 Inspect, test and troubleshoot aircraft pressurisation control systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA220 Inspect, test and troubleshoot aircraft primary radar systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA221 Inspect, test and troubleshoot aircraft secondary radar systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA227 Test and troubleshoot aircraft electrical systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA229 Test and troubleshoot aircraft radio frequency navigation and communications		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA230 Test and troubleshoot fixed wing aircraft automatic flight control systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA231 Inspect, test and troubleshoot rotary wing aircraft automatic flight control systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA232 Test and troubleshoot aircraft pulse systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA234 Inspect, test and troubleshoot aircraft global navigation systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA271 Lay out avionic flight management systems		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA279 Inspect, test and troubleshoot full authority digital engine control systems		Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA282 Repair or overhaul aircraft pulse system components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA283 Repair or overhaul aircraft display, control and distribution system components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA285 Repair or overhaul aircraft radio frequency communication and navigation system components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA288 Repair or overhaul aircraft audio and visual systems and reproducers		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA289 Maintain basic light aircraft avionic systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA291 Inspect, test and troubleshoot fixed wing single axis autopilot systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA313 Inspect, test and troubleshoot piston engine systems and components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA343 Remove and install avionic system components		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA360 Maintain aircraft diesel engines		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA389 Repair and/or overhaul propellers		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA703 Apply aeronautical modelling for computer aided engineering		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA704 Apply avionic modelling for computer aided engineering		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA705 - Apply basic scientific principles and techniques in aeronautical engineering situations		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA706 - Apply basic scientific principles and techniques in avionic engineering situations		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA711 Apply avionic analogue design techniques		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA712 Apply avionic digital design techniques		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA713 - Integrate aeronautical fundamentals into an engineering task		Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA714 Integrate avionic fundamentals into an engineering task		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA716 Evaluate avionic analogue systems		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA717 Evaluate avionic digital systems		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA725 Apply advanced scientific principles and techniques in avionic engineering situations		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEA726 Apply aircraft electrical system design techniques		Updated	Review and update
Aerospace	IBSA Manufacturing	MEA	Aeroskills	MEASS00326 LME056 Electrical/Instrument/Radio – B2 Licence Exclusion E34 Removal		Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	PMA	Chemical, Hydrocarbons and Refining	PMAOPS101 Read dials and indicators		Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	MSL	Laboratory Operations	MSL904001 Perform standard calibrations		Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	MSL	Laboratory Operations	MSL905002 Create or modify calibration procedures		Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	MSL	Laboratory Operations	MSL905003 Create or modify automated calibration procedures		Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	MSM	Manufacturing	MSMSUP406 Identify faults in electronic control		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSATCS301A Interpret architectural and engineering design specifications for structural steel detailing		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSATCS302A Detail bolts and welds for structural steelwork connections		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSATCS501A Detail standardised structural connections		Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSATCS502A	Detail structural steel members	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSATCS503A	Incorporate structural steel detailing into fabrication and construction project management	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSATCS504A	Detail ancillary steelwork	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MSA07	Manufacturing	MSATCM513A	Plan and complete metallurgical projects	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM04006B	Operate sand moulding and core making machines	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM04016C	Develop and manufacture precision models	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM05054A	Write basic NC/CNC programs for thermal cutting machines	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07006C	Perform lathe operations	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07007C	Perform milling operations	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07009B	Perform precision jig boring operations	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07018C	Write basic NC/CNC programs	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07019C	Program NC/CNC machining centre	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07020C	Program multiple spindle and/or multiple axis NC/CNC machining centre	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07022C	Program CNC wire cut machines	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07023C	Program and set up CNC manufacturing cell	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07039A	Write programs for industrial robots	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM07041A	Perform production machining	Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09005B	Perform basic engineering detail drafting	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09009C	Create 2D drawings using computer aided design system	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09010C	Create 3D models using computer aided design system	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09021B	Interpret and produce curved 3 dimensional shapes	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09022A	Create 2D code files using computer aided manufacturing system	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09023A	Create 3D code files using computer aided manufacturing system	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09155A	Prepare mechanical models for computer aided engineering (CAE)	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09156A	Prepare mechatronic models for computer aided engineering (CAE)	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09157A	Perform mechanical engineering design drafting	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09158A	Perform mechatronics engineering design drafting	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09201A	Work effectively in an engineering drafting workplace	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09204A	Produce basic engineering detail drawings	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09210A	Create 3 D solid models using computer aided design (CAD) system	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09211A	Produce drawings or models for industrial piping	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09215A	Supervise detail drafting projects	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09216A	Interpret and produce curved 3 D shapes and patterns	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09220A	Apply surface modelling techniques to 3 D drawings	Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM09221A Create 3 D model assemblies using computer aided design (CAD) system		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM10013A Install split air conditioning systems and associated pipework		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM10024 Install and troubleshoot luminaires and ancillary equipment		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM12001B Use comparison and basic measuring devices		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM12002B Perform electrical/electronic measurement		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM12003B Perform precision mechanical measurement		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM12004B Perform precision electrical /electronic measurement		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM12021B Program coordinate measuring machines		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM12022B Program coordinate measuring machines (advanced)		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM12023A Perform engineering measurements		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM14086A Apply mechatronic engineering analysis techniques		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM14087A Apply manufactured product design techniques		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM14088A Apply maintenance engineering techniques to equipment and component repairs and modifications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM14090A Integrate mechatronic fundamentals into an engineering task		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM14092A Integrate maintenance fundamentals into an engineering task		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM16008A Interact with computing technology		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18059B Modify electronic systems		Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18047B Diagnose and maintain electronic controlling systems on mobile plant		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18054B Fault find, test and calibrate instrumentation systems and equipment		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18057B Maintain/service analog/digital electronic equipment		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18058C Modify electronic equipment		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18059B Modify electronic systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18060B Maintain, repair control instrumentation single and multiple loop control systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18061B Maintain/calibrate complex control systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18062B Install, maintain and calibrate instrumentation sensors, transmitters and final control elements		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18065B Diagnose and repair digital equipment and components		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18066B Diagnose and repair microprocessor based equipment		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18067B Tune control loops multi controller or multi element systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18069B Maintain, repair instrumentation process control analysers		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18085A Install, service and repair domestic air conditioning and refrigeration appliances		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18108 Troubleshoot analog and digital electronic equipment		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM18109 Troubleshoot instrumentation systems and equipment		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM19024A Use CAD to create and display 3D jewellery and object models		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM19025A Create and present designs for jewellery and other 3D objects		Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM20001A Produce keys		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM20013A Service automotive transponder systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23003A Operate and program computers and/or controllers in engineering situations		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23004A Apply technical mathematics		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23064A Select and test mechatronic engineering materials		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23086A Apply scientific principles and techniques in avionic engineering situations		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23112A Investigate electrical and electronic controllers in engineering applications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23115A Evaluate fluid power systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23116A Evaluate programmable logic controller and related control system component applications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23117A Evaluate microcontroller applications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23122A Evaluate computer integrated manufacturing systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23126A Evaluate industrial robotic applications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23130A Coordinate servicing and fault finding of HVACR control systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23131A Evaluate rapid prototyping applications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23132A Evaluate rapid manufacturing processes		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23133A Evaluate rapid tooling applications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23134A Evaluate jigs and fixtures		Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23135A Evaluate moulding tools and processes		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23136A Evaluate stamping and forging tools		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23137A Evaluate rolling tools and processes		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23138A Evaluate suitability of materials for engineering related applications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23139A Design a basic single zone duct distribution system		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM23140A Determine operational parameters for building HVAC hydronic systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM234003A Design machines and ancillary equipment		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM234009A Design computer integrated manufacturing systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM234010A Design microcontroller applications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM234011A Design programmable logic controller applications		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM234014A Design a robotic system		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM234017A Design exhaust, ventilation and dust collection systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM234018A Design heating, ventilation, air conditioning and refrigeration control systems		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM234020A Coordinate small lot manufacture using rapid manufacture processes		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM234034A Manage heating, ventilation, air conditioning and refrigeration systems or projects		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM25002B Form and integrate fibre reinforced structures		Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM25011B Install marine systems		Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM25012B	Install and test operations of marine auxiliary systems	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM30027A	Prepare basic programs for programmable logic controllers	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM30031A	Operate computer aided design (CAD) system to produce basic drawing elements	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM30032A	Produce basic engineering drawings	Updated	Review and update
Manufacturing and Engineering	IBSA Manufacturing	MEM05	Metal and Engineering	MEM30033A	Use computer aided design (CAD) to create and display 3 D models	Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	PMB	Plastics, Rubber and Cablemaking	PMBPROD253	Operate an internal mill blender	Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	PMB	Plastics, Rubber and Cablemaking	PMBPROD308	Take a machine out of production	Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	PMB	Plastics, Rubber and Cablemaking	PMBPROD343	Shut down plant area	Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	PMB	Plastics, Rubber and Cablemaking	PMBPROD384	Operate multi axis router	Updated	Review and update
Process Manufacturing, Recreational Vehicles and Laboratory	IBSA Manufacturing	PMB	Plastics, Rubber and Cablemaking	PMBPROD385	Program computer controlled equipment	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF220	Produce basic converted or finished product	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF222	Set up and operate in line cutter	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF225	Set up machine for basic flat bed die cutting or embossing	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF228	Produce basic rotary die cut or embossed product	Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF231	Set up machine for basic flat bed cutting	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF232	Produce basic flat bed cut product	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF235	Set up machine for basic rotary cutting	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF236	Produce basic rotary cut product	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF241	Set up machine for basic single or continuous folding	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF242	Produce basic single or continuous folded product	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF243	Set up machine for basic collating or inserting (sheet/section)	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF244	Produce basic collated or inserted (sheet/section) product	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF245	Set up and produce hand collated or inserted product	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF261	Set up machine for basic adhesive, mechanical or thermal fastening	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF262	Produce basic adhesive, mechanical or thermal fastened product	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF281	Set up machine for basic laminating	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF282	Produce basic laminated product	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF305	Produce single faced web	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF307	Produce double faced web	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF309	Produce complex folded and glued cartons	Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF311	Prepare for cutting forme and stripper making	Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF320 Produce complex converted or finished product		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF327 Set up machine for complex rotary die cutting or embossing		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF328 Produce complex rotary die cut or embossed product		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF341 Set up machine for complex sequenced or multiple folding		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF342 Produce complex sequenced or multiple folded product		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF343 Set up machine for complex collating or inserting (sheet/section/reel)		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF344 Produce complex collated or inserted product		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF361 Set up machine for complex adhesive, mechanical or sewn fastening		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF381 Set up machine for complex laminating		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF382 Produce complex laminated product		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF391 Use electronic monitoring systems (converting and finishing)		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF392 Produce product on window gluer		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF406 Set up and load in line smart card machine		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF407 Operate a smart card machine and pack product		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF410 Set up machine for complex carton folding and gluing		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPCBF426 Produce complex flat bed die cut or embossed product		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPPRN395 Set up and produce 3D print		Updated	Review and update

IRC name	SSO with responsibility for the IRC	Training package code	Training package name	Training product code (Qualification, skill set, unit of competency)	Training product name (Qualification, skill set, unit of competency)	Review status (New or updated)	Change required
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPPRP481 Design complex carton		Updated	Review and update
Printing and Graphic Arts	PwCs Skills for Australia	ICP	Printing and Graphic Arts	ICPPRP495 Manipulate 3D graphics files in preparation for 3D printing		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	LMT07	Textiles, Clothing and Footwear	LMTMF6002A Design, evaluate and make patterns for medical grade custom made footwear		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTFD5021 Conduct digital patternmaking and grading		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTFD5022 Develop digital costing markers		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTFD6007 Implement specialised patternmaking technologies		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTGN4009 Design production tooling		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTLG3001 Make a prototype		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTTD5004 Design and produce experimental textiles		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTTD5010 Produce computer aided textile design folios		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTTD6002 Apply electronic systems to textile design and production		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTTX3011 Set up, adjust and monitor a machine for TCF production		Updated	Review and update
Textiles, Clothing and Footwear	IBSA Manufacturing	MST	Textiles, Clothing and Footwear	MSTTX3012 Identify and deal with mechanical and low voltage electrical faults in textile		Updated	Review and update

Addendum: Units accredited by the VRQA which may need review:

- VBP240- Use extended features of CAD
- VBP241- Manage CAD systems
- VBP242- Manage CAD in a business
- VBP252- Apply computer aided manufacturing (CAM) processes
- VBP253- Apply computer aided manufacturing (CAM) 2D programming
- VBP254- Apply computer aided manufacturing (CAM) lathe programming
- VPAU541- Produce basic computer aided manufactured (CAM) signs - vinyl
- VU21160- Use extended features of CAD
- VU21161- Manage CAD systems
- VU21162- Manage CAD in a business
- VU21212- Apply computer aided manufacturing (CAM) processes
- VU21213- Apply computer aided manufacturing (CAM) 2D programming
- VU21214- Apply computer aided manufacturing (CAM) lathe programming
- VU21706- Create products using 3D printing
- VU21971- Produce 2-D architectural landscape drawings using CAD
- VU21986- Utilise 3D printing for plastic product manufacturing
- VU21987- Utilise 3D printing for plastic product prototyping

Attachment C: Stakeholder Consultation Method and Scale

Name and organisation of stakeholder	Stakeholder Type	State	Coverage	Detail method(s) and scale of consultation
Nico Adams (Innovative Manufacturing IRC)	PRG Member Industry subject matter expert	VIC	National	Face-to-face
Shanti Krishnan (Swinburne University of Technology)	PRG Member Registered Training Organisation Industry subject matter expert	VIC	VIC	Face-to-face
Ben Eade (Manufacturing Australia)	Industry Body / Member Organisation	VIC	National	Face-to-face
David Peterson (CASA)	PRG Member Industry subject matter expert	ACT	National	Face-to-face
Craig Robertson (TAFE Directors Australia)	Industry Body / Member Organisation	ACT	National	Face-to-face
Ron Jackson (TAFE Directors Australia)	Industry Body / Member Organisation	ACT	National	Face-to-face
Lyndell Manson (TAFE Directors Australia)	Industry Body / Member Organisation	ACT	National	Face-to-face
Mark Walker (ICM Consulting)	PRG Member Industry subject matter expert	NSW	NSW	Face-to-face
Leon Drury (NSW Industry Training Advisory Board (NSW ITAB), Manufacturing Skills Australia)	PRG Deputy Chair IRC Chair: Textiles, Clothing and Footwear IRC	NSW	National	Face-to-face
Robert Petherbridge (TAFE Queensland)	Registered Training Organisation	QLD	QLD	Face-to-face
Jenny Dodd (TAFE Queensland)	Registered Training Organisation	QLD	QLD	Face-to-face
Neil Miller (ACPET)	Industry Body / Member Organisation	QLD	National	Face-to-face

Name and organisation of stakeholder	Stakeholder Type	State	Coverage	Detail method(s) and scale of consultation
David Sweeney (Telstra)	PRG Member IRC Member: Information and Communications Technology (ICT) IRC	VIC	National	Telephone interview
Susan Carter (Siemens)	Industry Employer	VIC	International	Face-to-face
Steve Dowey (Suttons Tools)	Industry Employer	VIC	National	Face-to-face
Michael Grogan (Advanced Manufacturing Growth Centre)	PRG Chair IRC Chair: Textiles, Clothing and Footwear IRC	VIC	National	Face-to-face
Paul Mitchell (Printing Industry Association of Australia (PIAA))	Industry Body / Member Organisation	VIC	National	Face-to-face
Wendy Cooper (Milspec)	Industry Employer	VIC	National	Face-to-face
Matthew Twist (Laser Bond)	Industry Employer	NSW	National	Face-to-face
Tristan Opie (Opie Manufacturing Group)	Industry Employer	NSW	NSW	Face-to-face
Laszlo Magyar (Roblan Plastics)	Industry Employer	NSW	NSW	Face-to-face
Alex Hollingsworth (Rio Tinto)	Industry Employer	WA	International	Face-to-face
Graeme Young (Quality Press)	Industry Employer	WA	WA	Face-to-face
Karen Humphreys (TAFE NSW)	Registered Training Organisation	NSW	NSW	Telephone interview
Bill Hamill (Rural Industry Skills Training)	Registered Training Organisation	VIC	VIC	Telephone interview
Paul Kennett (Manufacturing and Engineering Skills Advisory Board)	Industry Body / Member Organisation	VIC	VIC	Face-to-face
Marcel Bick (CSIRO)	Industry subject matter expert	NSW	National	Telephone interview

Name and organisation of stakeholder	Stakeholder Type	State	Coverage	Detail method(s) and scale of consultation
Pat Burke (North Metropolitan TAFE)	Registered Training Organisation	WA	WA	Telephone interview
Bradley Burrows (North Metropolitan TAFE)	Registered Training Organisation	WA	WA	Written advice
Julie Hobbs (Design Institute of Australia and Future Now)	PRG Member IRC Member: Printing and Graphic Arts IRC	WA	National	Face to face
Ann-Marie Ryan (Future Now)	Industry Body / Member Organisation	WA	WA	Face to face
Nigel Haywood (National Energy Resources Australia)	PRG Member IRC Member: Process Manufacturing, Recreational Vehicles, and Laboratory IRC	WA	National	Telephone interview
Jan Newmarch (Box Hill Institute)	Registered Training Organisation	VIC	VIC	Face to face
Ian Curry (Australian Manufacturing Workers Union)	Industry Body / Member Organisation IRC Chair: Manufacturing & Engineering IRC	SA	National	Face to face
Chris Dean (TAFE SA)	Registered Training Organisation	SA	SA	Face to face
Tania Montesin (Asahi Beverages)	Industry Employer	NSW	International	Face to face
Megan Lilly (Ai Group)	Industry Body / Member Organisation	VIC	National	Face to face
Michael Taylor (Ai Group)	Industry Body / Member Organisation	VIC	National	Face to face
James Fazzino (Incitec Pivot)	Industry Employer	VIC	International	Face to face
Russell Burgess (Qantas)	IRC Chair: Aerospace IRC	NSW	National	Face to face
Prashanth Mysore (DASSAULT Systems)	Industry Employer	SA	International	Telephone interview

Attachment D: Supporting Research

Preparing for Industry 4.0 – will digital skills be enough?



Preparing for Industry 4.0 – will digital skills be enough?

November 2017

Claire Field and Maria Langwell
Claire Field and Associates

Contents

Introduction	3
The Need for Digital Skills in Priority Australian Manufacturing Sectors	3
Summary	8
Industry 4.0	8
Australia's preparedness for Industry 4.0.....	11
Lessons to be Learned from Other Countries	13
Germany	13
United Kingdom	14
Singapore	15
Other approaches	17
Challenges for the Australian VET Sector	18
Other initiatives	19
Conclusion.....	20

Introduction

This research arose from work commissioned by the Australian Industry and Skills Committee – in the form of a cross sector project looking at the need for digital skills in a range of manufacturing and related industries.

The project was managed by IBSA Manufacturing, a Skills Service Organisation,¹ which provides support to the following Industry Reference Committees (IRCs):

- Aerospace
- Furnishing
- Manufacturing and Engineering
- Process Manufacturing, Recreational Vehicles and Laboratory
- Sustainability
- Textiles, Clothing and Footwear

During the course of the project, national consultations were undertaken with more than 40 representatives from large (often multinational) businesses, small and medium businesses, unions, training providers and other VET sector stakeholders.

Many of the individuals involved in the consultations raised questions about how well the VET sector was prepared for the substantial digital changes impacting on the workforce and the manufacturing sector in particular. They questioned whether Training Packages were sufficiently flexible to meet the needs of the manufacturing sector as it responds to growing levels of digital disruption (or what has been termed the 4th Industrial Revolution, or Industry 4.0). The research undertaken to support the project, also identified a vastly greater number of reports and papers focussed on the challenge of upskilling workers for an Industry 4.0 environment, than in relation to the need for specific digital skills for manufacturing and related workers.

This report synthesises the research evidence – in relation to both digital skills and the broader challenges of skilling workers for the Industry 4.0 workplace.

The Need for Digital Skills in Priority Australian Manufacturing Sectors

In their industry skills forecasts and proposed schedules of work, the IRCs involved in the project identified an emerging need for three key digital skills in their industries. In summary, they are:

1. **Digital analysis/diagnosis** – arising from the digital augmentation occurring in many industries. The Aerospace; Manufacturing and Engineering; the PMA Chemical, Hydrocarbons and Refining; and the MSL Laboratory Operations skills forecasts all identify a need for people with the technical skills to *‘analyse and respond to data provided by the machines in their workplace’*. While some IRCs referred to these skills as digital literacy – to avoid confusion with other broader definitions of digital literacy, following the consultations, these digital skills have been identified as digital analysis and digital diagnosis skills.
2. **3D printing/additive manufacturing skills** – the need for these skills is specifically mentioned in the Manufacturing and Engineering; MSL Laboratory Operations; and the Printing and Graphic Arts skills forecasts; and

¹ For a description of IBSA Manufacturing’s work see: <https://www.ibsa.org.au/manufacturing-ssol/>

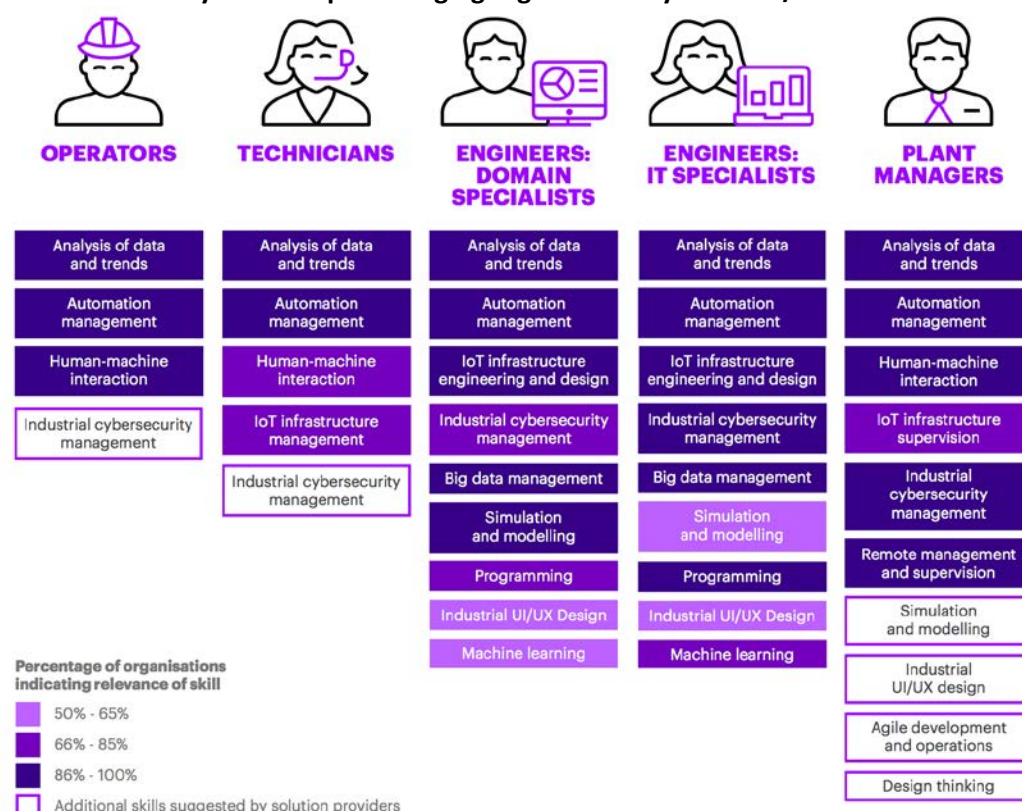
3. **Programming/coding** – the impact of technological change in the workplace and the subsequent need for digital programming skills is identified in the Aerospace; Manufacturing and Engineering; Plastics, Rubber and Cablemaking; Printing and Graphic Arts; Textiles, Clothing and Footwear skills forecasts.

Research was undertaken to determine what information was available on the need for these digital skills in the manufacturing, printing and related industries. The research identified a plethora of reports discussing the impact of digital change on job roles and therefore skills, but very few which identified specific digital skill needs in the manufacturing sector or other related industries. In relation to Australian research there was even less available (comprising mostly a small number of websites and largely anecdotal information on digital skill needs).

On review of both the external material as well as the IRCs' four-year skills forecasts (which led to this project), some digital skill requirements have started to emerge. The prevalent theme which emerged though was the need to equip workers of the future to have hybrid skills, and be able to apply technical, digital and personal skills and knowledge across a range of contexts and applications.

One of the few sources of information on digital skill needs identified in this research was Accenture Consulting's analysis for Singapore's Economic Development Board of emerging skill needs for Singapore's Energy, Chemicals and Utilities Industries (see Figure 1).²

Figure 1: Preliminary Skills Map – Emerging Digital Skills by Job Role/Persona



Source: Accenture Consulting, 2017, *Manning the Mission for Advanced Manufacturing: New Demands On Talent in Singapore's Energy, Chemicals and Utilities Industries*

² Accenture Consulting, 2017, *Manning the Mission for Advanced Manufacturing: New Demands On Talent in Singapore's Energy, Chemicals and Utilities Industries* <https://www.accenture.com/us-en/insight-advanced-manufacturing>

While Accenture's research identifies a need for both programming skills and simulation and modelling skills for domain specific engineers, the authors note that this is not an exhaustive selection of the digital skills that manufacturers surveyed by Accenture identified as being required for Industry 4.0 adoption. They go on to note that their works is a "first step towards a comprehensive understanding of emerging digital skills (needed in manufacturing, energy and utilities companies) such as robotics, agile development and design thinking" (p.10).

At the recent *Industrial Internet Summit*,³ the Director of the Australian Advanced Manufacturing Council cautioned that as low skilled jobs were lost from the Australian manufacturing sector, new jobs would be created but they would be at the "high end". It was noted that there was a lengthy lead-time for workers to gain high-level skills and that Australia must spend more time on educating people in STEM and manufacturing skills now or the country would be unable to exploit future opportunities. Other speakers to the Forum, including the CEO of the Innovative Manufacturing CRC, cautioned that it was not possible to identify which specific technical skills would be in demand in an Industry 4.0 environment but it was clear that a broad set of skills would be required. The likelihood that additive manufacturing would radically change the factory production line was also discussed.

In a 2015 presentation⁴, Manufacturing Skills Australia identified that the industry will require workers with a new set of skills which are focussed on:

- collaboration
- data mining/analytics
- computer proficiency
- advanced materials knowledge
- design skills
- marketing and sales
- logistics, and
- industrial networking.

In the same presentation, drawing on results from their annual survey of enterprises, MSA identified four major skill needs for the manufacturing sector as:

1. higher level technical skills
2. innovation/design skills
3. multi-skilled, broad-based capabilities, and
4. IT/digital skills.

In 2014 PwC identified 3D printing as a major disruptor to traditional supply chains and manufacturers⁵. In a survey of US manufacturers they found that about half believed that it was 'likely' or 'very likely' that 3D printing would be used for "low-volume, highly specialized products" over the 3-5 years to 2019. Their research identified that manufacturers were looking to re-train their existing workforces or bring in new talent – as they sought to acquire the skills needed to create digital designs as well as oversee the production process. Almost half of survey respondents cited a lack of expertise in 3D printing and the need to find the right talent as barriers to using 3D printing technology.

The impact of additive manufacturing/3D printing and the concomitant need for new skills was also examined by Brown and Satyavolu for Cognizant's *Centre for the Future of Work*. They outline its

³ *Industrial Internet Summit* Australian Advanced Manufacturing Council, <http://aamc.org.au/skilling-industry-4-0/>

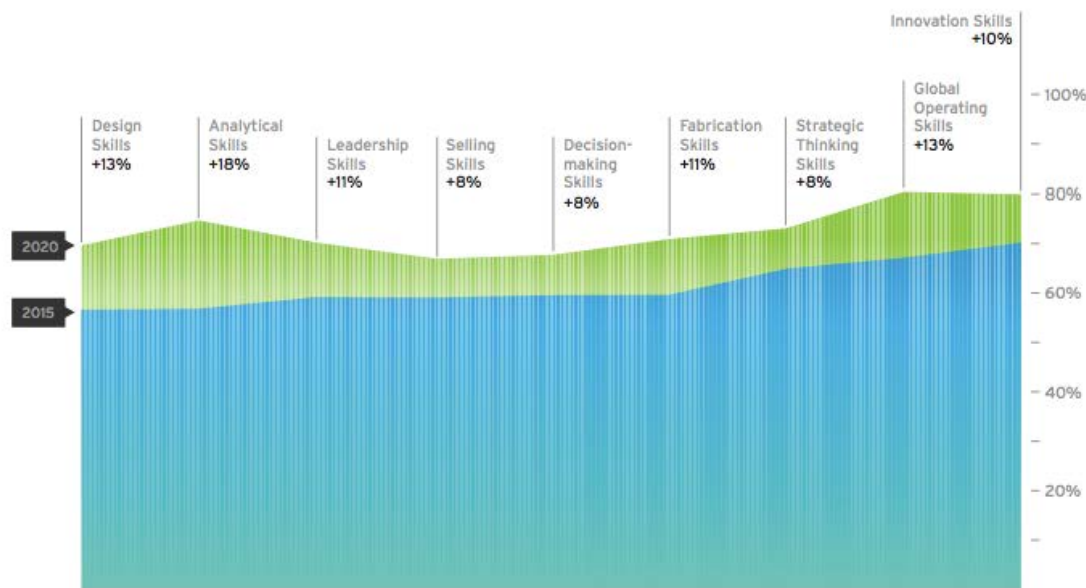
⁴ Paton, B & Baker, C; 2015, Presentation to the Australian Workplace Practitioners' Network Conference 2015 http://awpn.com.au/wp-content/uploads/2015/04/MSA_AWPN-presentation-2015.pdf

⁵PwC (2014) 3D printing and the new shape of industrial manufacturing <https://www.pwc.com/us/en/industrial-products/3d-printing.html>

potential to rapidly change the manufacturing sector – from “legacy industrial models” to “what you want, when you want it” manufacturing. They do not identify specific 3D printing skills as being the solution. They recognise that analytics and artificial intelligence are also transforming global manufacturing processes, and approximately 70 percent of respondents (to their survey of 500 senior manufacturing executives)⁶ think this digital change is boosting the need for innovation skills. Their survey also identifies that, as more tasks are automated, work will become more strategic. Specifically they posit that this will mean, less emphasis on discrete manufacturing equipment installation (and skills), and more focus on whether the equipment will improve new digital business approaches.

They predict the following skills will grow even more important in the future – see Figure 2.

Figure 2: Skills That Will Grow More Important in the Future



Source: Brown, R. H. & Satyavolu, P. (2017) *The Work Ahead: Designing Manufacturing's Digital Future* report. The Centre for Work, Cognizant

In the aerospace sector, Lappas and Kourousis⁷ note that businesses need employees with a raft of skills, including the ability to respond creatively to complex problems, effective communication, team working, and the use of technology to create new knowledge. They go on to question whether an industrial-age curriculum will fully equip students for living and working in the information-age. They cite the applicability of The Assessment and Teaching of 21st Century Skills Project (2016)⁸ and its ten priority skill areas as being particularly relevant to the aerospace industry. The priority skills are:

Ways of Thinking:

- 1. Creativity and innovation
- 2. Critical thinking, problem solving, and decision making
- 3. Learning to learn, metacognition

⁶ Brown, R. H. & Satyavolu, P. (2017) *The Work Ahead: Designing Manufacturing's Digital Future* report (p.4) The Centre for Work, Cognizant. <https://www.cognizant.com/whitepapers/the-work-ahead-designing-manufacturing-s-digital-future-codex2391.pdf>

⁷ Lappas, I. & Kourousis, K. I. (2016). Anticipating the Need for New Skills for the Future Aerospace and Aviation Professionals. *Journal of Aerospace Technology and Management*, 8(2), 232-241. <https://dx.doi.org/10.5028/jatm.v8i2.616>

⁸ Launched by Cisco Systems Inc., Intel and Microsoft in January 2008 as a research collaboration to accelerate global education reform The Assessment and Teaching of 21st Century Skills Project, focuses on defining the skills needed for the 21st Century. It drew from the assembled knowledge of 250 researchers from around the world.

Ways of Working:

- 4. Communication
- 5. Collaboration (teamwork)

Tools for Working:

- 6. Information literacy
- 7. Information and Communication Technologies (ICT) literacy

Living in the World:

- 8. Citizenship — local and global
- 9. Life and career
- 10. Personal and social responsibility — including cultural awareness and competence

Despite the lack of emphasis on specific technical skills in their list of priority skills, Lappas and Kourousis argue that this is because there is a major and rapid shift occurring in the way people work in the aviation sector, and thus there is a need for a new emphasis on 21st Century skills. They cite as an example, the design of the Airbus A380, which was divided across design offices and engineering centres located across Europe and North America; its large main components were produced in France, Germany, Spain and the United Kingdom, and the final assembly line is in France. They note that the design offices used interactive software packages, allowing teams to work collaboratively on common designs from different locations.

As a consequence of the dispersed teams now being used in major aviation projects, communication and collaboration skills have become much more critical to a project, and teams and working arrangements also need to take account of cultural differences. The authors identify that in future the aerospace industry workforce will be required to work in much more diversified environments and while analytical skills will continue to be important, soft skills like leadership, team spirit, three dimensional thinking, risk definition and risk management are expected to be critical.

This dispersed approach to delivering major projects (with teams with different skills working in different locations), is also going to play a part in South Australia's ship building projects. Work is underway at present, supported by the South Australian government, to build the capacity of local SMEs in the manufacturing sector – to assist them to participate in the supply chains needed for the projects.⁹

Also focussed on emerging skill needs in the aerospace industry is Matthews in an article in the Australian Defence Magazine. He focuses more specifically on changing technical skill needs and states that there will be an increased need for computer aided design tools and computer aided manufacturing programming of highly sophisticated machines as manufacturers look to use new additive metal technologies to optimise the weight of new designs.¹⁰

In relation to the changing skill needs in the printing industry, in a priorities document aimed at articulating the government policies the printing sector requires for a sustainable future, the Printing Industries Association of Australia notes that the industry is in a transition from “a traditional manufacturing industry” to one that “embraces the services, communications, creative and information technology industries”. They point out that print is reliant on a highly skilled workforce and list ten policy priorities for skills development, although none of these priorities identify specific printing skill needs.¹¹

⁹ Advice from participants involved in the consultations undertaken as part of this Digital Skills Cross Sector project.

¹⁰ Australian Defence Magazine (ADM) (October 2017) Volume 25, No.10

¹¹ Printing Industries Association of Australia (2014) *Priorities for Print Report*
https://www.piaa.org.au/verve/resources/Priorities_in_Print_2014.pdf

Summary

While every attempt has been made to identify research on specific digital skills needed in manufacturing and related industries, this review has identified that (a) there is little research available on specific digital skills in these industries and (b) even research aimed at identifying the impact of digital changes to manufacturing processes tends to identify a need for a broader set of skills for future success – rather than singling out specific digital skills. This focus on the need for a broad range of higher level thinking skills, more soft skills and creativity and design thinking were consistently echoed by participants in the consultations which supported this project. The reasons why are outlined below.

Industry 4.0

The fourth industrial revolution, focussed on digitisation, will bring “change at a speed, scale and force unlike anything we have ever seen before”.¹² Termed Industry 4.0 by the German manufacturing sector – the following case study of the impact of Industry 4.0 on the car industry provides a useful insight into the transformative power of this industrial revolution.

The example of the car – the epitome of German engineering skill – offers a good illustration of this permeation and the resulting change in business models. The product is changing in line with the technical possibilities and customers’ wishes: cars are being individually configured and increasingly connected in the Internet of Things, self-driving cars are becoming reality, and individual inspection intervals and remote servicing are possible thanks to new sensor technology and data analysis. The production processes are almost completely connected, collaborative robot systems are entering factories, and additive manufacturing processes such as 3D printing are making extremely small production runs possible. Design and product conception work is being outsourced via digital platforms, and workers have a say on shift assignments using apps. Alongside the manufacturing and sale of cars, new services are gaining in importance: from app-based car sharing, to carpooling models, to intermediaries for private driver services. This shows the breadth and speed of the digital transformation; and it also makes clear that changes in technology, the economy, consumption and work go hand in hand. (p. 20)¹³

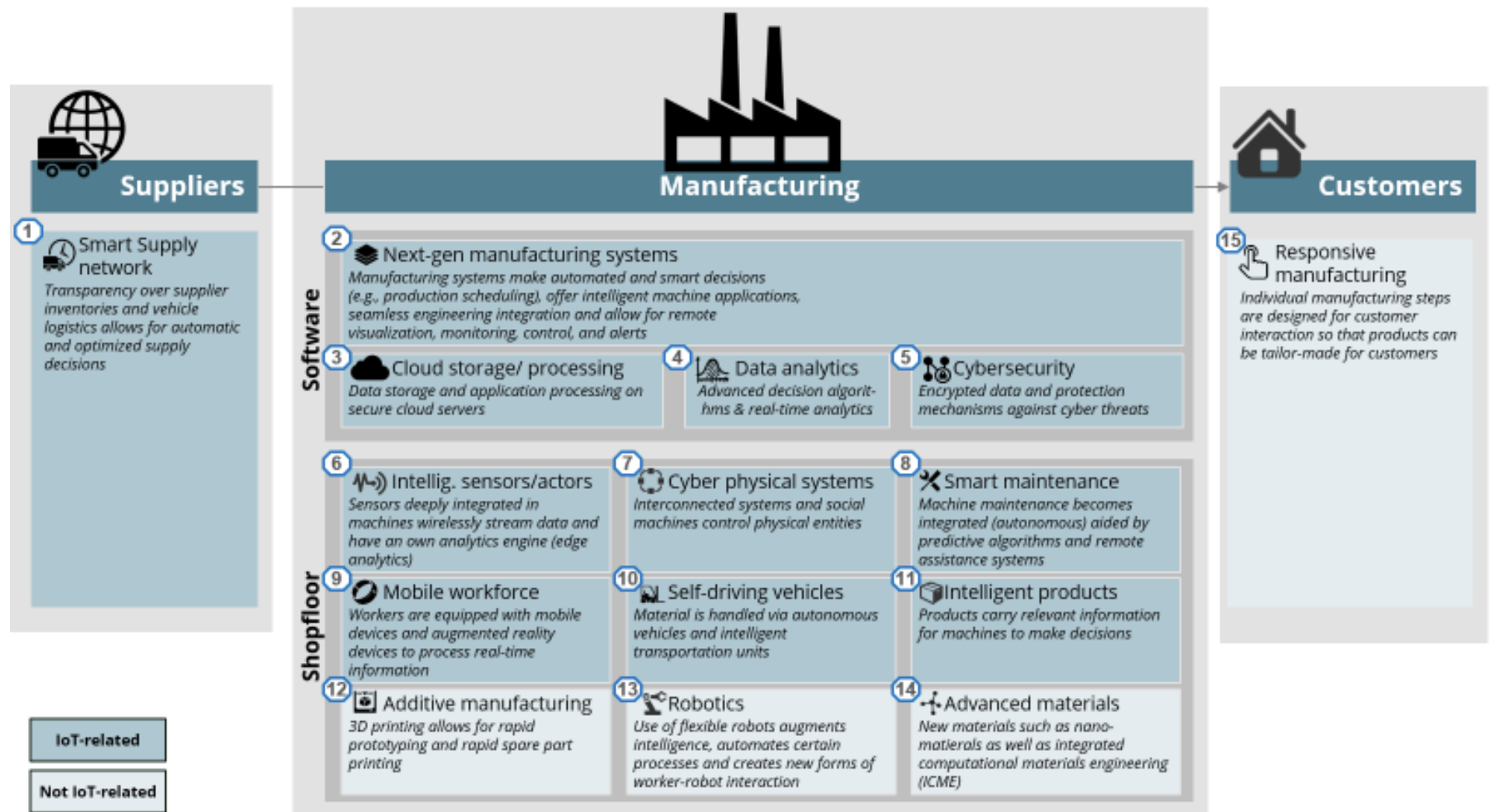
IoT Analytics¹⁴ provides more insights into how manufacturing is changing as a result of Industry 4.0, see Figure 3.

¹² World Economic Forum <https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab>

¹³ Federal Ministry of Labour and Social Affairs, Germany (March 2017) *Re-Imagining Work*, White Paper Work 4.0 Federal https://www.bmas.de/SharedDocs/Downloads/EN/PDF-Publikationen/a883-white-paper.pdf?__blob=publicationFile&v=3

¹⁴ Source: Lueth, K. L. (2015) *Will the industrial internet disrupt the smart factory of the future?* IoT Analytics <https://iot-analytics.com/industrial-internet-disrupt-smart-factory/>

Figure 3: The 15 components of the smart factory of the future



Source: Lueth, K. L. (2015) Will the industrial internet disrupt the smart factory of the future? IoT Analytics

AIIA identifies that although no-one can accurately predict what the jobs of the future will look like decades in advance, it is clear that in the next 10 to 15 years there will be a much greater use of data and analytics, and technologies such as automation, AI, augmented and virtual reality and robotics in the workplace. They also state that these technologies will be integrated at a much faster pace than for previous technological changes and that workers doing “routine, repetitive and predictable tasks such as assembly line work” are likely to move into “higher value training jobs and operating and maintaining equipment, scheduling and supervising 3D printing runs and quality assurance roles.”¹⁵

While AIIA do not identify specific skills gaps in the manufacturing sector – their research does identify manufacturing and nine other priority industry sectors as being at high risk of digital disruption and the impact of demographic change, and finds the following common, recurring skill sets are required:

- Social perceptiveness and instructing
- Speaking and management of personnel resources
- Monitoring, supervision, coordination and time management
- Critical thinking, judgement, negotiation and persuasion
- Reading comprehension and quality control analysis
- Active listening
- Writing
- Service orientation, system analysis and operation monitoring
- Mathematics, Science, Complex problem solving and Learning strategies, and
- Quality control analysis, systems evaluation and troubleshooting.

Instead of looking ten to fifteen years ahead as AIIA attempts to do, the World Economic Forum 2016’s *Future of Jobs* survey,¹⁶ set a much shorter time horizon for predicting future job and skill needs. They determined that 35 percent of the skills deemed important in today’s workforce will have changed in four years. Unsurprisingly they identified the ability to work with data and make data-based decisions would play a major role in the jobs of future. They went on to suggest that creativity, complex problem solving, and critical thinking would be the top three broad skills that people would need for Industry 4.0, arguing specifically that these are the skills that computers cannot perform as well as humans yet.

The Boston Consulting Group offers a similar view of the skills needed to perform effectively in Industry 4.0. They state that workers will need to combine the knowledge related to a specific job or process, with IT competencies “that range from basic (using spreadsheets and accessing interfaces) to advanced (applying advanced programming and analytics skills)”. As a result of the changes taking place on the production line “soft” skills are also predicted by BCG to become more important than ever. Employees will be required to be “even more open to change, possess greater flexibility to adapt to new roles and work environments, and get accustomed to continual interdisciplinary learning”.¹⁷

In a related report, BCG go further and state that the number one challenge in progressing Industry 4.0 is training or retraining the workforce. They note that simple tasks will be taken over by robots as factories and supply chains become increasingly digitised; and that humans will need the skills to

¹⁵ AIIA (2017) *Skills for Today. Jobs for Tomorrow* https://www.aiia.com.au/_data/assets/pdf_file/0020/81074/JOBS-FOR-TOMORROW-FINAL.pdf

¹⁶ World Economic Forum (2016) *Future of Jobs*, <https://www.weforum.org/>

¹⁷ Boston Consulting Group (2015) *Man and Machine in Industry 4.0* <https://www.bcgperspectives.com/content/articles/technology-business-transformation-engineered-products-infrastructure-man-machine-industry-4/?chapter=6#chapter6>

oversee these tasks. They will also need to be multi-disciplined and have the ability to adapt to changing roles”.

Industry 4.0 is poised to significantly transform Australian manufacturing jobs and skills profiles. In their 2015 *Australia's Future Workforce?* Report, the Committee for Economic Development of Australia (CEDA) focused on the future of Australia's workforce and identified that ‘computerisation’ threatens to radically reshape the future workforce. Specifically they stated that:

*‘Australia is on the cusp of a new but very different industrial revolution. Technology is going to dramatically reshape our workforce in coming years and the nation’s ability to rapidly adapt to technological change, and even more importantly, innovate, will be paramount for job creation and our future economic success’.*¹⁸

Australia’s preparedness for Industry 4.0

The Australian Industry Group’s most recent employer survey¹⁹ finds not only that the use of digital technologies in Australian companies has improved since 2013 but there appears to be a correlation between increased use of digital technologies and improved productivity. Despite these pleasing results only 41 percent of those surveyed had planned investments in digital technologies to improve their business operations (although the report notes that while the manufacturing sector has previously been less likely to invest, it appears that their digital investment is now growing more rapidly than in other industries).

The impact of Australian businesses’ uncertainty and unwillingness to fully embrace digital technology is evident in our performance on the International *Institute for Management Development’s* ranking²⁰ of global digital competitiveness. It ranks countries on the following performance characteristics:

- knowledge: the capacity to understand and learn new technologies, which includes talent, training and education, and scientific performance
- the technology environment: encompassing regulatory and technological frameworks, and capital; and
- future readiness: based on adaptive attitudes, business agility and IT integration.

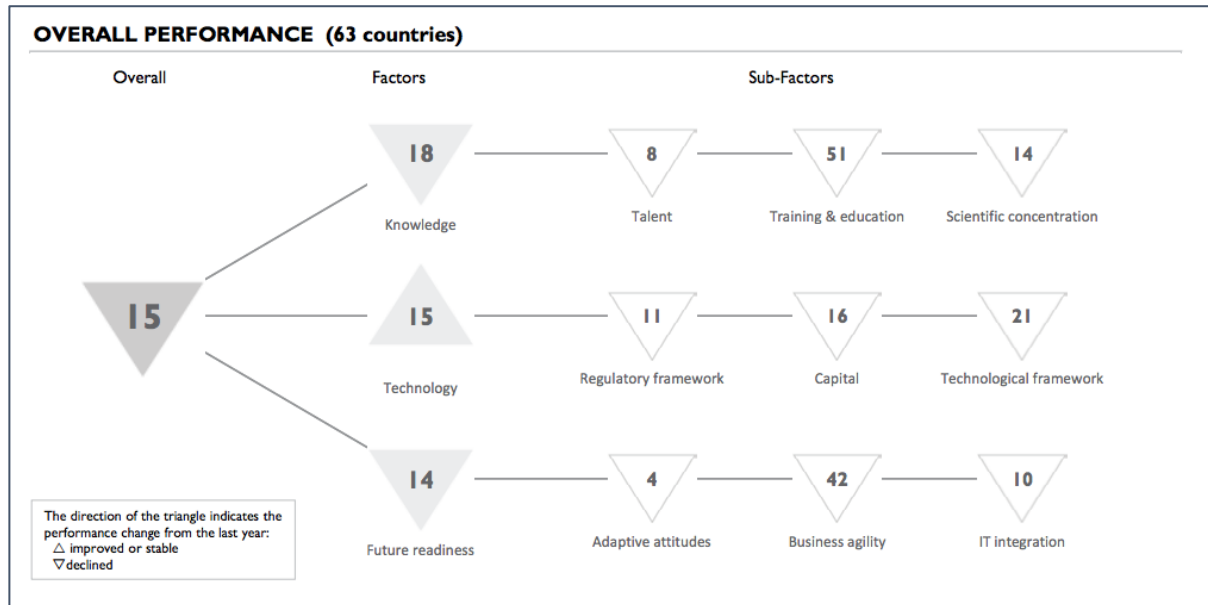
According to the IMD, Australia has fallen four places this year to 15th (of 63 countries) in digital competitiveness. Of most concern is that our lowest ranking (51st) is on the education and training sub-component of the knowledge criterion, see Figure 4.

¹⁸ CEDA (2015) *Australia's Future Workforce?* <http://www.ceda.com.au/research-and-policy/policy-priorities/workforce>

¹⁹ AiGroup (2017) *Business Beyond Broadband: Are Australian businesses ready for the fourth industrial revolution?* <https://www.aigroup.com.au/policy-and-research/mediacentre/reports/beyond-business-broadband-report-download/>

²⁰ International Institute for Management Development (2017) *IMD World Digital Competitiveness Rankings* https://www.imd.org/globalassets/wcc/docs/release-2017/world_digital_competitiveness_yearbook_2017.pdf

Figure 4: Australia's declining digital competitiveness



International Institute for Management Development (2017) *IMD World Digital Competitiveness Rankings*

Broken down further, the sub-components of Australia's lagging education and training performance is based on the following sub-criteria:

- **Training and education**
 - Employee training (rank 43rd)
 - Total public expenditure on education (25th)
 - Higher education achievement (15th)
 - Pupil-teacher ratio – tertiary education (52nd)
 - Graduates in Sciences (50th)
 - Women with degrees (31st)

In the CSIRO's submission to the *House of Representatives Standing Committee on Employment, Education and Training Inquiry into Innovation and Creativity* (2017)– the authors note that “a national approach to identifying what professions and skills will be needed to meet future challenges and opportunities is required”.²¹ In relation to the manufacturing sector specifically, CSIRO notes that Australia has the lowest rate of percentage value add across the OECD for high technology. They go on to observe that high-technology value-add is often due to poor internal capabilities which limits innovation and slows the uptake of new technology.

In the 2017 Deloitte Access Economics report, *Australia's Digital Pulse*²² for the Australian Computer Society, the authors caution that digital/technological transformation may be particularly disruptive outside the ICT and services industries. They specifically identify the potential impact on areas such as mining, manufacturing and agriculture – as these industries have “a greater capacity to be affected by physically manifested technological developments” (p. 4).

²¹ CSIRO (2017) *Inquiry into innovation and creativity: workforce for the new economy* House Standing Committee on Employment, Education and Training CSIRO Submission 16/574
http://www.aph.gov.au/Parliamentary_Business/Committees/House/Employment_Education_and_Training/Innovationandcreativity/Submissions

²² Deloitte Access Economics (2017) *Australia's Digital Pulse: Policy priorities to fuel Australia's digital workforce boom*. Report for the Australian Computer Society <https://www.acs.org.au/content/dam/acs/acs-publications/Australia's%20Digital%20Pulse%202017.pdf>

At the request of the Chief Scientist, the Australian Council of Learned Academies (ACOLA) undertook a three year research project on '*Technology and Australia's Future: How technology will transform the workforce of the future*'.²³ The report is an extensive, scientific analysis of the future impact of technology. In relation to skills – the authors note that Australia will not realise the benefits of leading edge technology unless it has the workers available to develop and use these technologies, and that workers with 'general problem solving skills', those who are 'trained to experiment', and those who 'learn by doing' will be well placed to help Australian businesses with new technologies.

The ACOLA report goes on to caution that 'occupational obsolescence' must be mitigated and suggest that this can be done by "ensuring that vocational training targets tomorrow's jobs rather than yesterday's (and that) the development of trainees' adaptive capacity may require a shift in vocational training from its present focus on highly job-specific competencies in favour of vocational streams which group a number of closely related occupations" (p.20)

This is a theme picked up by Dr Martin Parkinson, in this year's *Sir Roland Wilson Foundation Secretaries* dinner address²⁴ when he warned that in relation to technological disruption... "we're talking about skills we don't have yet; jobs that don't exist yet; an industry we're building from the ground up, and for which a siloed approach simply won't work".

Lessons to be Learned from Other Countries

Some countries have embraced *Industry 4.0* and are making changes to their education and training systems as a result. The approaches of three other advanced manufacturing countries have been chosen for analysis – as they respond to massive technological change: Germany, Singapore and the United Kingdom. Lessons from other nations are also included where they were available.

Germany

A global manufacturing leader with a highly advanced VET system (which has both similarities and key differences from Australia's VET system), the German government have not just embraced Industry 4.0 as the future of their manufacturing sector, they have also recently released a white paper identifying the impact on the world of work from profound technological change²⁵ – and the consequent changes government intends to make as a result.

In developing a White Paper on the *Future of Work 4.0*, the German Ministry of Labour and Social Affairs note that in their consultations on the preceding Green paper they heard repeatedly of "the vital importance of education, continuing vocational education and training, and skills development for a successful digital transformation"²⁶ (p. 119).

As a consequence of the advice received from experts involved in the consultation process, as well as by studies and responses to the Green Paper, the German government intends making a raft of

²³ Williamson et al (2015) *Technology and Australia's future: New technologies and their role in Australia's security, cultural, democratic, social and economic systems*, ACOLA <http://acola.org.au/wp/project-5/>

²⁴ <https://www.pmc.gov.au/news-centre/pmc/sir-roland-wilson-foundation-secretaries-dinner>

²⁵ Wahlster, W (2017) *Industry 4.0 Smart Manufacturing for the Future*, Germany Trade and Invest <https://industrie4.0.gtai.de/INDUSTRIE40/Content/EN/Media/Publikationen/industrie4.0-smart-manufacturing-for-the-future-en.pdf>

²⁶ Federal Ministry of Labour and Social Affairs, Germany (March 2017) *Re-Imagining Work*, White Paper Work 4.0 Federal https://www.bmas.de/SharedDocs/Downloads/EN/PDF-Publikationen/a883-white-paper.pdf?__blob=publicationFile&v=3

changes to its education and vocational training system to assist businesses and individuals to adapt, and continue to adapt, to Industry 4.0. They include:

- systematic monitoring of future demand for skilled labour to provide a regularly updated forecast of trends in demographic, regional and skills related mismatches
- the Federal Ministry of Labour and Social Affairs intends to update the Federal Government's Skilled Labour Concept, which was established in 2011, and link it with a skills strategy for the changing world of work.
- the education and vocational training system will focus more on digital skills – specifically, additional digital qualifications for almost all sectors and occupations
- social, communicative and intercultural skills, systemic and creative thinking, the capacity for abstract thinking, and rapid information processing and data selection capabilities will also be needed
- lifelong vocational learning will play a much more important role in future and Germany will look to develop a national strategy to guide this – recognising the challenges this poses in a diverse system where continuing training institutions currently follow their own mandate
- new and evolved formats for training will be introduced, including a greater use of both blended learning and work integrated learning facilitated through computer based training
- qualified counselling and comprehensive skills assessments will be strengthened and the quality of advice enhanced by “properly taking into account the individual's formal and informal skills, state of health and life circumstances, requirements of the labour market and the complex continuing training landscape”, and
- improved support options and incentives will be made available to low-skilled and semi-skilled workers to undertake vocational training and gain qualifications later in life.

United Kingdom

With a VET system that is broadly comparable to Australia's – it is interesting to note that the government of the United Kingdom is also planning changes to better address digital skill needs and to lift the overall quality of its training system.

Firstly, in terms of digital skills, the UK is introducing a *Digital Strategy*,²⁷ which includes access to digital skills as one of its seven pillars. Not only does the strategy include an explicit commitment to supporting all citizens to develop the skills they need to participate in the digital economy. It also commits to providing businesses with the skills they need to benefit from digital innovation, including through the creation of a 'pipeline of specialist skills'.

The strategy acknowledges that the UK will also need to develop a range of specialist digital skills to fill specific digital jobs. They use modelling from the UK's Commission for Employment and Skills to estimate that 1.2 million new technical and digitally skilled people will be needed by 2022 to satisfy future skills needs.

Initiatives underway at the vocational education and training level include:

- reform of the technical education system to create a specialist “digital route”, with employers setting standards and specifying the knowledge, skills and behaviours that individuals will need (13 standards having been approved for delivery and more in development)
- new innovative digital degree apprenticeships have been introduced

²⁷ Department for Digital, Culture, Media and Sport (United Kingdom) (March 2017) *Digital Strategy*, <https://www.gov.uk/government/publications/uk-digital-strategy/executive-summary>

- Ada, the National College for Digital Skills, opened in September 2016. It will train 5,000 students over the next five years for a wide range of digital careers, and
- the introduction of a new Digital Skills Partnership, which will see government working with industry and other partners including technology companies, local businesses, local government, charities and other organisations to improve the coherence of digital skills provision, for example by setting ambitions for increasing the level of certain types of training on offer and agreeing how it can be targeted where it is needed most.

The UK government is also in the middle of developing an *Industrial Strategy* through a Green paper/White paper process.

The Green Paper for the strategy contained 10 pillars of which the second is “Developing skills”. The Green Paper recognises that while the UK’s higher education system has its strengths, the country’s poor performance in basic and technical skills is a key reason for its ‘persistently lower levels of productivity’ compared with other advanced economies.

The report goes on to note that skills shortages in some areas contribute to imbalances in productivity in the UK. And that, excluding apprenticeships, other forms of technical education have “fallen behind”. To address its skills shortages and reduce its reliance on migrant labour, the paper proposes the following solutions:

1. Action to improve basic skills
2. The creation of a new system of technical education
 - a. Clear, high quality routes for technical education (reducing the number of qualifications offered in their system and replacing them with 15 technical ‘routes’ which can be studied as an apprenticeship or in an institutional model)
 - b. High quality, technical providers with excellent teaching (more training at higher levels, new qualifications to meet the needs of industry)
 - c. Higher level technical education and new Institutes of Technology in all regions (fewer approved providers)
 - d. Ensuring Technical Education routes are demanding
 - e. Creating a course-finding process for technical education similar to the UCAS process (like our Tertiary Admissions centre processes)
3. Addressing STEM shortages
4. Identifying and addressing sector-specific skills gaps
5. Higher quality careers information and advice
6. Testing new approaches to lifelong learning

To date a White paper has not been produced outlining how the government intends to progress its reforms but the proposed consolidation of qualifications within the VET system to be replaced by 15 technical ‘routes’ all of which can be studied as an apprenticeship or in an institution, fewer institutions, and new institutions as well as higher standards are all noteworthy.

Singapore

The Singapore government has a very strong commitment to advanced manufacturing and engineering (AME). *RIE2020* (its *Research, Innovation and Enterprise Plan 2020*) includes AME as one of four industry sectors for the government’s \$19 billion research and innovation investment.

Specifically in relation to advanced manufacturing and engineering, RIE 2020 contains the following strategic goals:

- support economic growth, create good jobs for Singaporeans and prepare our economy for the future

- strengthen linkages across public research performers and both large and small enterprises to sharpen value creation from public R&D investments, and
- build capabilities where Singapore can offer a differentiated value proposition, including making strategic bets ahead of industry to position Singapore for emerging opportunities

There are eight industry verticals within AME in Singapore (including aerospace, electronics, chemicals, etc). Underpinning these different verticals are four “cross-cutting technology areas” which are seen as essential enablers. They are:

- Robotics and Automation
- Digital Manufacturing
- Additive Manufacturing
- Advanced Materials

In addition to the funding available through *RIE2020* to employers looking to adapt their businesses and innovate, the Singaporean government also offers other employer focussed training initiatives:

- *Skills Future* (which includes the Operations Management Innovation (OMNI) Programme – the aim of which is to train key personnel - engineers, managers and senior staff to be technology innovators to achieve manufacturing excellence. The program promotes the use of operations management techniques and technologies to support the organisation’s strategy), and
- *Adapt and Grow* (which includes the Digital Workplace initiative aimed at helping Singaporeans, both individuals and employers, develop the mindset and some of the basic technology skills for the future economy).

Also on offer to senior employees in the manufacturing sector are Professional Conversion Programmes which have helped more than 1,000 professionals, managers, executives and technicians re-train in new skills (eg data analytics). Following the success of the first 36 programmes, an additional eight have been launched focussing on mid-level managers in manufacturing organisations.²⁸

Earlier this year, Singapore’s *Committee on the Future Economy* released a seven-point national Economic Strategy²⁹. While the strategies are intended to be mutually reinforcing, the second focuses on skills development – and specifically vocational skills.

The report intends that to facilitate the acquisition of deeper skills, training providers and Institutes of Higher Learning (IHLs) should support more modularised and technology-enabled training programmes, and that the nexus between the acquisition and utilisation of skills needs to be strengthened, including through more company-led programmes. The Committee also intends that the government of Singapore and businesses should support more place-and-train schemes and work-learn programmes, not just for new graduates, but also for existing employees. They go on to note the success of the Professional Conversion Programme.

²⁸ Economic Development Board, Singapore (March 2017) <https://www.singaporebusiness.com/2017/how-singapore-is-addressing-talent-gaps-in-the-smart-manufacturing-sector.html>

²⁹ <https://www.gov.sg/microsites/future-economy/the-cfe-report/7-strategies#2>

Other approaches

The OECD recommends four priorities for skills policies to meet the challenges of the fourth industrial revolution. Three are of particular relevance to the VET system:

1. Education and training systems need to better assess and anticipate changing skill needs (including through the use of big data).³⁰
2. The skills workers need for the digital economy include reading, numeracy and problem solving in technologically rich environments, and work practices including teamwork, work autonomy, training, and flexible work hours are required to help people make maximum use of their skills. Employers may in turn need skills to help them introduce better work organisation and management practices.³¹
3. As skill demands change, continuous training for workers to keep up with new skill requirements is crucial.³²

The South African Chairman of the BRICS³³ Business Council Skills Development Working Group group of nations commissioned research from German Consulting Firm, Roland Berger, ³⁴ to identify the specific skill needs for Industry 4.0. The research identified the following skills:

- Knowledge about ICT
 - Ability to use and interact with computers and smart machines
 - Understanding machine to machine communication
 - Data and IT security
- Ability to work with data
 - Processing and analysis of data and information
 - Basis statistical know how
- Technical know-how
 - Inter disciplinary knowledge
 - Specialised knowledge about manufacturing processes
 - Specialist maintenance skills
- Personal skills
 - Ability to change
 - Ability to learn, unlearn and relearn and lifelong learning
 - Decision making abilities
 - Team skills
 - Communication skills – human and machine”

Based on the research they have recommended the development of a specific Industry 4.0 BRICS qualification to support upskilling of existing workers and the development of new skills, as well as the greater mobility of resources between BRICS countries.

³⁰ OECD (2016) *Getting Skills Right: Anticipating and Responding to Changing Skill Needs*, OECD publishing Paris.
<http://dx.doi.org/10.1787/9789264252073-en>

³¹ *ibid*

³² OECD (2016) *New Markets and New Jobs*, OECD Digital Economy Papers, No. 255, OECD Publishing, Paris.
<http://dx.doi.org/10.1787/5jlwt496h37l-en>

³³ The BRICS nations comprise Brazil, Russia, India, China and South Africa.

³⁴ Roland Berger (2016) *White Paper Summary: Skill Development for Industry 4.0*
<http://indiainbusiness.nic.in/newdesign/upload/whitepaper-summary-skill-development-for-industry-4-0.pdf>

Challenges for the Australian VET Sector

The nature and pace of change as a result of Industry 4.0 pose significant challenges for the Australian VET sector.

There are few studies at this stage which specifically analyse the impact of technological change on the Australian VET sector and how the sector is preparing workers for a future of technological change. Amongst those that do – the following reports are notable.

Firstly TAFE Queensland has commissioned researchers from the CSIRO³⁵ to investigate how the VET sector can best support Australia's future workforce in the context of changing skill needs and digital disruption. They conclude that:

- based on past trends VET enrolments are likely to increase as the workforce responds to technological change and the growth mature age learners seeking new skills is likely to outpace growth in younger learners
- VET providers are likely to struggle with the rate of change as skills become obsolescent at an ever increasing rate and the multi-year process required to make changes to Training Packages in the VET sector is a 'major hurdle' to developing skills to meet the rate of change occurring in the workplace
- VET faces reputational problems which combined with a move to online learning opens up competition from overseas providers and could further impact on quality in the system

The report makes the following recommendations:

- Increase use of digital technology to achieve both efficiency and quality in the delivery of VET.
- Identify those basic and core skills associated with a qualification (which need to be standardized at a national level) and allow high-performing VET providers the flexibility to modify other components of the training package in line with current industry practice.
- Build high-quality, two-way communication between VET providers and employers to support agility and responsiveness in a fast changing environment.
- Use predictive analytics and modelling (drawing upon big data available online) to obtain real-time insight into job demands and student pathways.

A follow-up report³⁶ examines how the changing demand for, and supply of, skills impacts at a regional level (in this instance the Fraser Coast).

In considering the changes that are coming from digital change in the workplace and being cognisant of the way in which the Australian VET system is currently funded – Francesca Beddie and colleagues in a 2014 research report³⁷ for the National Centre for Vocational Education Research found that “the current emphasis in public funding on entry-level training can work against the need to refresh STEM skills and potentially inhibits readiness to meet demand for growth in all industries” (p. 27).

The New South Wales Department of Industry is taking a very different approach to meeting rapidly changing skill needs. In their submission to the *House of Representatives' Standing Committee*

³⁵ Reeson, A et al (2016) *The VET Era: Equipping Australia's workforce for the future digital economy* Report for TAFE Queensland. <http://tafeqld.edu.au/resources/pdf/about-us/research-papers/vet-era.pdf>

³⁶ Reeson, A, Mason, C & Sanderson, T (2017) *Growing Opportunities in the Fraser Coast: Informing regional workforce development* <https://jobsqueensland.qld.gov.au/projects/growing-opportunities-in-the-fraser-coast/>

³⁷ Francesca Beddie et al., *Readiness to meet demand for skills: a study of five growth industries*, NCVET Research Report, 2014, page 27. The growth industries in question are food and agriculture, biotechnology and pharmaceuticals, advanced manufacturing, mining equipment and oil and gas.

Inquiry into Innovation and Creativity they provide preliminary details of a ‘capabilities framework’ that they are piloting initially for qualifications within the agriculture sector.

They are working with a consortium of universities (the University of Sydney, UTS, and the University of Melbourne) on an approach that recognises the uncertainties regarding the future labour market. They go on to state that the project advocates for the benefits of a capabilities-based, rather than competency based, approach to VET qualifications. They anticipate the pilot will achieve increased autonomy and job flexibility for learners, and a streamlined and enhanced set of qualifications within the sector. And that, if successful, this pilot could be transitioned to other industry sectors, including STEM areas.

New pilots have also emerged to tackle the digital disruption which looms for the Australian manufacturing and related sectors. For example, the WA Minister for Education and Training, the Hon Sue Ellery MLC, recently announced³⁸ a \$2 million partnership between South Metropolitan TAFE and Rio Tinto to pioneer a new curriculum required for the mining industry’s jobs of the future. The training scheme is specifically focussed on preparing workers for changes in their industry as a result of innovation and digitisation. The training is aimed at the post-school level and incorporates industry based traineeships.

Other initiatives

The agility available to the universities as a result of their self-accrediting powers is assisting them to quickly respond to new opportunities in an Industry 4.0 environment.

RMIT University, for example, has an explicit aim to “to become a first mover in training for Industry 4.0”. RMIT has recently identified a ‘surge’ in demand for graduates with skills in Industry 4.0, including the industrial internet of things (IIoT) and augmented reality (AR) for the enterprise.³⁹

Their aim is to ‘comprehensively’ expose all engineering students to state-of-the-art virtual prototyping and Industry 4.0 tools. They also intend to ensure that their engineering students acquire new employability skills. They have entered into a partnership with ThingWorx technologies to expand the university’s collaboration with local businesses, especially those without sufficient resources to harness Industry 4.0 on their own.

In another project, funded as part of the Commonwealth government’s ‘Apprenticeships Training – Alternative Delivery Pilots’ AiGroup, Siemens and Swinburne University have developed two higher level apprenticeship courses in Applied Technologies. They are designed to help new entrants to the labour market work in an Industry 4.0 environment. The apprenticeships are respectively at Diploma and Associate Degree level. While both courses were initially accredited as higher education offerings by Swinburne University, the Diploma is now being considered for reaccreditation by the VRQA, which would make the diploma available in the VET sector.

At the 2017 Asia-Pacific Regional Conference⁴⁰, Siemens announced that they were also making an investment in a partnership with the University of Western Australia – offering researchers at UWA the same access to the software Siemens has provided to Swinburne University. Supported by a \$5 million investment from the Federal Government, the aim of the partnership is to assist Australian SMEs to transition to the digital economy (and meet the challenges of Industry 4.0).

³⁸ <https://www.mediastatements.wa.gov.au/Pages/McGowan/2017/10/Industry-training-partnership-to-future-proof-Western-Australian-jobs.aspx>

³⁹ <https://www.iothub.com.au/news/rmits-plan-to-lead-in-industry-40-training-472578>

⁴⁰ <http://www.afr.com/business/german-tech-giant-hands-software-to-top-universities-20171102-gze1im?btis>

Beyond Australia, a wider threat to the Australian VET system looms – technology itself. Panasonic is already using augmented reality to assist its aircraft maintenance engineers to learn new tasks and deal with more complex situations. They have also developed a system they refer to as “Remote Expert,” which is a form of teleconferencing that uses smart glasses’ front-facing cameras to enable an expert (at the company’s headquarters) to see through an operator’s glasses and push out information — documents, etc — to guide the inspection/maintenance process.⁴¹

Conclusion

The fourth industrial revolution is rapidly changing the world of work and broader society. The evidence is that the pace and nature of change is more profound than any previous period of change. Australian businesses are realising the need to invest in digital technologies but are still doing so at what appears a relatively low rate. As a consequence Australia is falling behind in its digital competitiveness and education and training is a key drag on our ability to compete.

While there is a need for specific new skills to accommodate technological change, these typically have only a very short life cycle. Being able to accurately predict new skills and make them available to education providers in a timely manner is a significant challenge. It was noted during the consultations underpinning this project that universities self-accrediting powers allow them to offer new courses in a matter of weeks rather than the much longer lead times required in the VET sector.

In addition to the challenges in making specific new technical skills available quickly in the VET sector, the consistent view from the research and the consultations was that there is a need for a wider range of skills (beyond the sector’s current notion of employability skills) required for workers to adapt and thrive in an Industry 4.0 environment.

Other countries are making significant changes to their VET systems to ensure they can deliver the workers of the future. It is recommended that further work be done in the Australian VET system to determine how Training Packages can continue to meet the needs of the workforce as Industry 4.0 introduces profound change to manufacturing and related industries.

⁴¹ <https://up.panasonic.aero/augmented-reality-maintenance/>