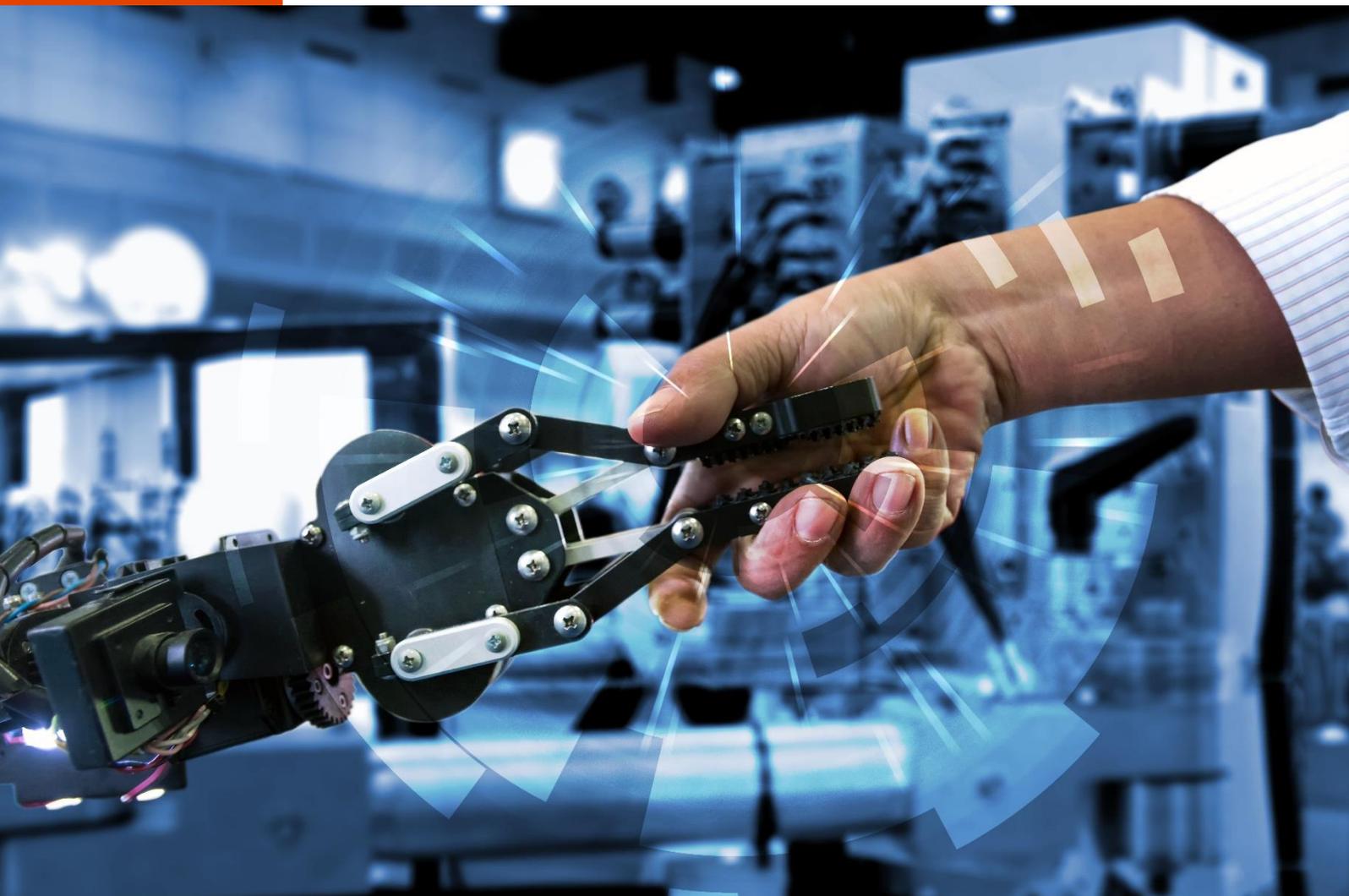




**WORKFORCE
DEVELOPMENT**

Industry 4.0 Higher Apprenticeships Program

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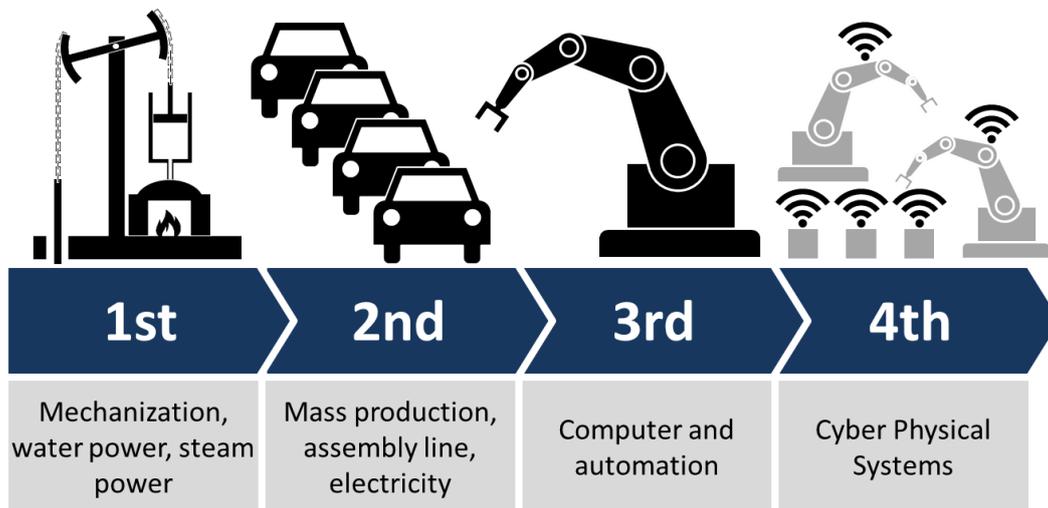
The Innovative Arrangements for Apprenticeships and Trade Training Delivery Pilot Project is supported by the Australian Government Department of Education and Training under the *Apprenticeship Training – alternative delivery pilots*.

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1. Introduction and Background to the Program

The term Industry 4.0 originates from Germany, when a project to digitalise manufacturing was launched under the name ‘Industrie 4.0’ at the Hannover trade fair in 2011. The term derives from the assertion that it represents the fourth industrial revolution, coming after the mechanisation made possible by steam power; the mass production made possible by electrification; and the development of automated production that followed the rise of computers and electronics.



The world of the fourth industrial revolution includes automation, machine learning and networked cognition where technologies link the physical, digital and biological spheres. The term Industry 4.0 encompasses the digitalisation of production processes based on devices autonomously communicating with each other along a value chain.

In 2016, having awareness of the Industry 4.0 developments, apprenticeship challenges and industry demand for higher skill levels, the Australian Industry Group applied for funding under Stream Two of the Australian Government’s *Apprenticeships Training – alternative delivery pilots* initiative. The initiative is to develop and implement an Industry 4.0 Higher Apprenticeship program in conjunction with Siemens Ltd and Swinburne University of Technology.

The *Apprenticeship Training – alternative delivery pilots* initiative trials the adoption of alternative apprenticeship delivery arrangements that:

- result in increased industry validation and take-up of alternative arrangements; and
- contribute to an evidence base which informs future policy development and funding settings.

Ai Group received notification on the first of September 2016 from The Hon Karen Andrews MP, Assistant Minister for Vocational Education and Skills, of the successful application for this initiative. The intention of the pilots is to learn more about the opportunities and barriers to increased industry usage, acceptance and validation of alternative apprenticeship training delivery arrangements. The aim is to drive more systemic adoption of alternative arrangements, explore challenges and examine potential regulatory or administrative barriers.

At the same time a further Higher Apprenticeships initiative managed by PricewaterhouseCoopers (PwC) was also announced. Under this initiative participants undertake an 18 month BSB50215 Diploma of Business in apprenticeship mode for professional, business, information technology and financial services. The program is being conducted in Melbourne and Sydney through TAFE NSW and Holmesglen Institute.

Within the Ai Group pilot program Swinburne University of Technology in partnership with Siemens Ltd, key members of the Prime Minister's Industry 4.0 Taskforce, are working together to develop a pilot program focusing on high-level technical skills in engineering, technology and innovation, enabling participants to transition to a new economy.

Participants from Siemens Ltd in Victoria will acquire the benefits of apprenticeship skills with a new Diploma and Associate Degree in Applied Technologies with an option to articulate into a Bachelor Degree.

The pilot model aims to achieve the following:

- Build skills from a range of traditionally segregated disciplines required to meet the impact of disruptive technologies in a number of industries,
- Develop capabilities by introducing participants to cutting edge technologies required for current industries and future employment,
- Develop an employment-based pathway to higher skill development,
- Enhance learning through digital technologies, mobile devices and on-campus utilisation of a range of university wide new manufacturing technologies currently offered through Swinburne's Factory of the Future,
- Provide a flexible model for learning based in industry with authentic assessments relevant to the particular learning outcomes and industry needs,
- Integrate trades skills into higher level qualifications,
- Provide participants with a competitive edge for employment following graduation,
- Develop practical workplace skills,
- Connect this program to global leaders in advanced industrial technologies and economies such as Germany via a cooperative international placement program module hosted by Siemens AG.

The aim of the pilot is to create the first technology focused apprenticeship built around the essence of Industry 4.0, the Internet of Things, innovation and other emerging technologies which are impacting Australia's ability to compete and participate in global value chains. Through industry consultation with Ai Group members and other targeted businesses, qualifications were developed that meet the particular needs of industry with a focus on skills and tools required for future workforce participation and the adoption of high-level technology skills.

The qualifications bring together key industry initiatives and policies such as the National Science and Innovation Agenda, the Growth Centres initiatives and the Innovative Manufacturing Cooperative Research Centre into a practical experiential learning environment to address real industry needs.

The pilot combines the best of university and vocational learning models to improve Science, Technology, Engineering and Math (STEM) skills of technically minded participants. It incorporates skills for the new millennia in business and design. Participants are post-VCE and demonstrate a high capability to engage in the program. The attractiveness of this pilot program is derived from the provision of a higher-level qualification compared to the traditional apprenticeship pathway of Certificate III and IV.

The award of a Bachelor's Degree will appeal to a broader range of potential applicants. The qualification will produce work-ready graduates at an AQF 5/6 level (Australian Qualifications Framework) and prepare participants for an employment pathway beyond the traditional trade. Employers are able to train future technicians with a higher skills level to meet their increasing needs in the knowledge economy. This will integrate vocational education and academic learning to provide a broader range of skills to participants and the industry and broaden options for those interested in applied learning methodologies.

2. Participants

The program commenced with nineteen participants successfully recruited by Siemens and Swinburne University implementing a joined-up approach to meet each partner's selection criteria. Siemens recruited using an Assessment Centre approach and used Seek and social media to attract the applicants. Swinburne University's additional marketing strategies, application assessment and enrolment processes were embedded into the recruitment methodology.

The gender profile of the group is sixteen (16) male and three (3) female. The age range of the participants varies from 18 years to 37 years. The age profile was more spread than originally anticipated. It was thought that the program would appeal to school exit participants, however the timing of the program made it very difficult to advertise and appeal to schools. There are two (2) school leavers and the remainder of the cohort have already completed some form of qualification. These qualifications include Year 12, Certificate II, Certificate III, Diploma, Advanced Diploma and Degree.

3. Development and Description of Relevant Qualifications

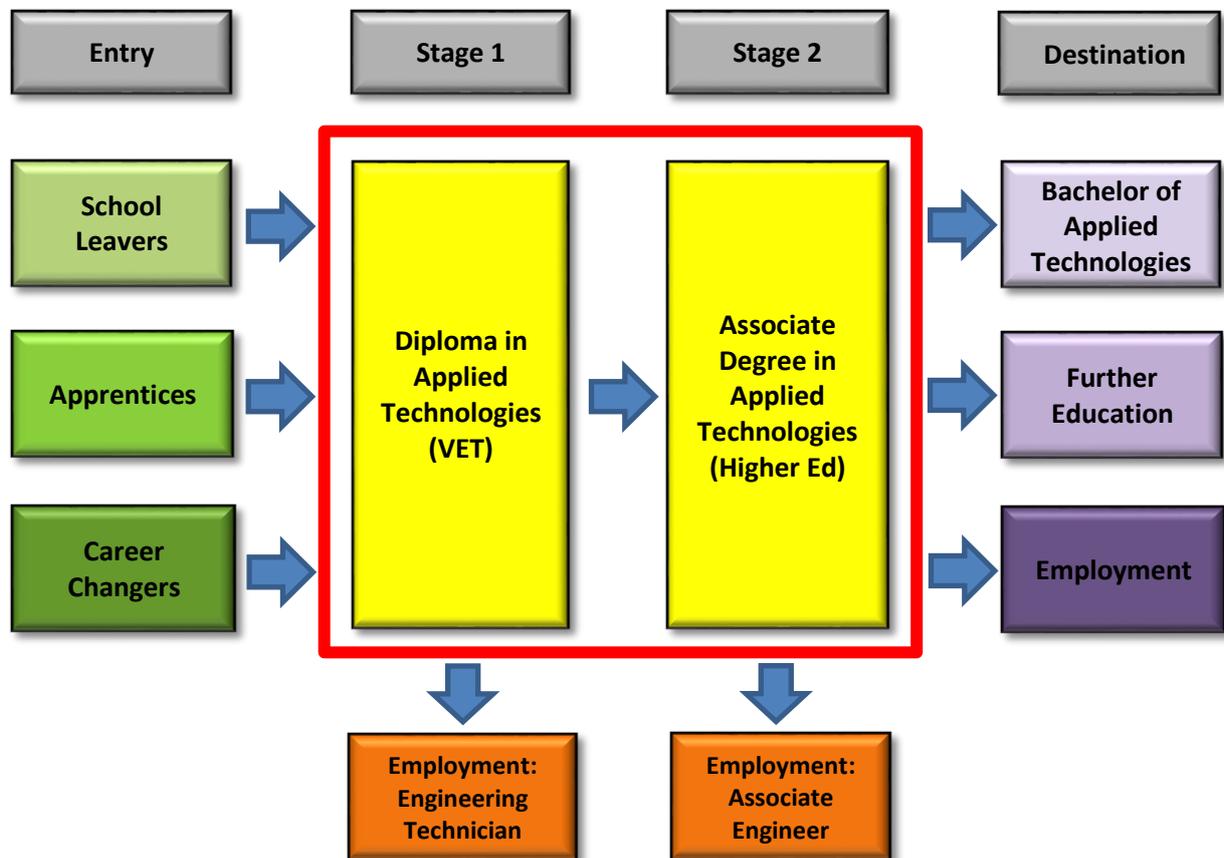
The project contracted Swinburne to consult with project partners and other external industry and education stakeholders to inform the development of two qualification levels for piloting a higher apprenticeship model. This process commenced in late October 2016 for the first level qualification; Diploma of Applied Technologies. The second level; an Associate Degree commenced in March 2017 and was accredited in September 2017.

Extensive consultation took place to inform the course development, particularly as this course is the first accredited course in Australia, that focuses specifically on the knowledge and skills required of an Industry 4.0 technician role. As Australian industry is yet to fully implement Industry 4.0, it was necessary to broaden the consultation and include international industry and education experts.

A close working relationship was forged between the Siemens Australia team and Swinburne University of Technology to ensure their inputs and feedback was embedded into all elements of qualification design; course structure, content, delivery model, assessment approach, entry requirements, nomenclature and study / work placement timetable.

The following diagram represents the project’s planned qualification development and pathway. In addition to this plan a Higher Education Diploma was also developed to enable commencement of the project from the beginning of 2017.

Table 1: Industry 4.0 Higher Apprenticeship Pathways



= Industry 4.0 Higher Apprenticeship Pilot Program

The team facilitated access to a large number of Siemens Business Managers and Executive members to contribute directly to the course content and provide feedback on appropriate work place based assessment activities. Siemens Australia also introduced the Swinburne course coordinator to the Head of International Business and Professional Education, Siemens Germany, who also distributed the draft curriculum among colleagues. The input from Siemens into the qualification design has been both significant and invaluable. This highlights a key principle of this project of industry leadership including in the design of qualifications.

The Swinburne Course Coordinator took advantage of a pre-arranged trip to Europe and arranged meetings with key staff in Siemens Germany and other industry and education experts in Industry 4.0. A communication channel was established for ongoing collaboration, including on the next qualification development; the Associate Degree.

The following companies and Industry 4.0 education experts validated the final draft curriculum:

- Siemens Australia and Siemens Germany
- Ai Group Project Reference Group members
- FESTO Australia and FESTO Germany (Stuttgart)
- Pfizer Pharmaceutical company, Australia
- Stuttgart University, Germany (ARENA 2036)
- Aalborg University, Denmark

There were many steps to obtaining accreditation, TEQSA registration and setting the course up on required internal systems before public marketing could occur. A significant amount of human resources was assigned to the Swinburne team to scope and develop the Diploma qualification within a three-month period in order to gain Academic Senate endorsement by December 2016.

The course was then established and ready to be marketed publicly by December 22, 2016. This was subsequently accredited through the Academic Senate Courses Committee as DP-APPTEC Diploma of Applied Technologies at Australian Qualifications Framework (AQF) Level 5 through the higher education section of Swinburne. This initial step of accreditation through higher education rather than as intended through the VET system was taken to establish the availability of a program from the beginning of 2017. The late timing of the accreditation caused a number of challenges in relation to marketing the course.

The project utilises an apprenticeship framework to deliver a new Diploma and Associate Degree in Applied Technologies. The participants are in apprenticeship mode and engaged in the Diploma initially followed by the Associate Degree. A Higher Education Diploma was initially developed in order to have an accredited first year qualification available for the commencement of participation in 2017. This consists of 800 Nominal Contact Hours over eight units. In addition, each unit has a nominated 50 hours for unspecified learning activities including independent study, assignment preparation and revision.

Table 2: Diploma of Applied Technologies (Higher Education) Course Content

Unit Name	Nominal Contact Hours
Working in Industry 4.0	100 hours
Engineering Skills for Industry 4.0	100 hours
CAD/CAM Engineering Materials	100 hours
Industrial Networking and Cloud Computing	100 hours
Electrical Systems	100 hours
Object Oriented Programming: Industrial Control System	100 hours
Digital Control Systems	100 hours
Cyber Physical System Integration	100 hours
Total	800 Hours

An annual course timetable has been set with approximately 50 per cent of the course hours undertaken at the workplace. The Course Coordinator and teaching group met with Siemens Business Managers to identify ‘work based’ projects that will benefit the company and also meet unit assessment requirements. Swinburne has also appointed a teacher to be the Work Placement Coordinator who is the conduit between industry (Siemens) and the teaching group.

The VET Diploma of Applied Technologies was developed during 2017 and combined VET and higher education components as a key design principle for the project. The development of the 22460VIC *Diploma of Applied Technologies* included 16 units of competency with 14 core units and 2 elective units:

- 1 unit from the elective list below, plus
- 1 unit which may be selected from the elective list below or any currently endorsed units that appear within a training package qualification or accredited course.

Some units were drawn from existing training packages (BSB, ICT, MEM) while others were newly created (VU). The nominal duration of the program is 780 to 860 hours.

Table 3: 22460VIC Diploma of Applied Technologies

Unit of competency code	Unit of competency title	Nominal hours
Core Units		
BSBPMG417	Apply project life cycle management processes	40
ICTTEN202	Use hand and power tools	40
MEM12024A	Perform computations	30
MEM13014A	Apply principles of occupational health and safety in the work environment	10
MEM234028A	Produce and manage technical documentation	40
MEM30025A	Analyse a simple electrical system circuit	40
MEM30007A	Select common engineering materials	40
VU22310	Work in Industry 4.0	40
VU22311	Commission a cyber-physical system	80
VU22312	Produce components using CAD and CAM technologies	80
VU22313	Implement and problem solve a PLC-based industrial control system	60
VU22314	Troubleshoot digital control systems	80
VU22315	Use SCADA system to monitor and control an industrial process	60
VU22316	Apply principles of networking technologies for manufacturing and engineering applications	60
Elective Units		
VU22317	Analyse and manage big data in cloud-based systems	40
VU22318	Work safely with collaborative robots	60
MEM14091A	Integrate manufacturing fundamentals into an engineering task	60
MEM16012A	Interpret technical specifications and manuals	40
MEM23004A	Apply technical mathematics	80
MEM23111A	Select electrical equipment and components for engineering applications	40
VU21106	Plan, implement and apply preventative maintenance procedures	80
	Total nominal hours	780-860

A further curriculum development was the Associate Degree of Applied Technologies. This was developed during the first half of 2017 and accredited as AB-APTEC the Associate Degree of Applied Technologies at AQF Level 6 through Swinburne’s Academic Senate Courses Committee. The course consists of the following 16 units:

Table 4: Associate Degree of Applied Technologies

Unit Code	Unit Name	Level	Nominal Hours
EAT10008	Working in Industry 4.0	1	150
EAT10009	Engineering Skills for Industry 4.0	1	150
EAT20016	CAD/CAM and Engineering Materials	2	150
EAT20017	Industrial Networking and Cloud Computing	2	150
EAT10010	Electrical Systems	1	150
EAT10011	Object Oriented Programming: Industrial Control Systems	1	150
EAT10012	Digital Control Systems	1	150
EAT20018	Cyber Physical System Integration (Major Project)	2	150
EAT20019	Software Tools for Industry 4.0	3	150
EAT20020	Advanced Digital Control Systems	3	150
EAT20021	Advanced Electrical Machines	3	150
EAT20022	Predictive Engineering Analytics	3	150
EAT10013	Robotics and Digital Twin	4	150
EAT10014	Cyber Security and Cloud Services	4	150
EAT10015	Distributed Control in a Smart Factory	4	150
EAT20023	Smart Product Design using Industry 4.0	4	150

This course is being delivered to project participants during 2018.

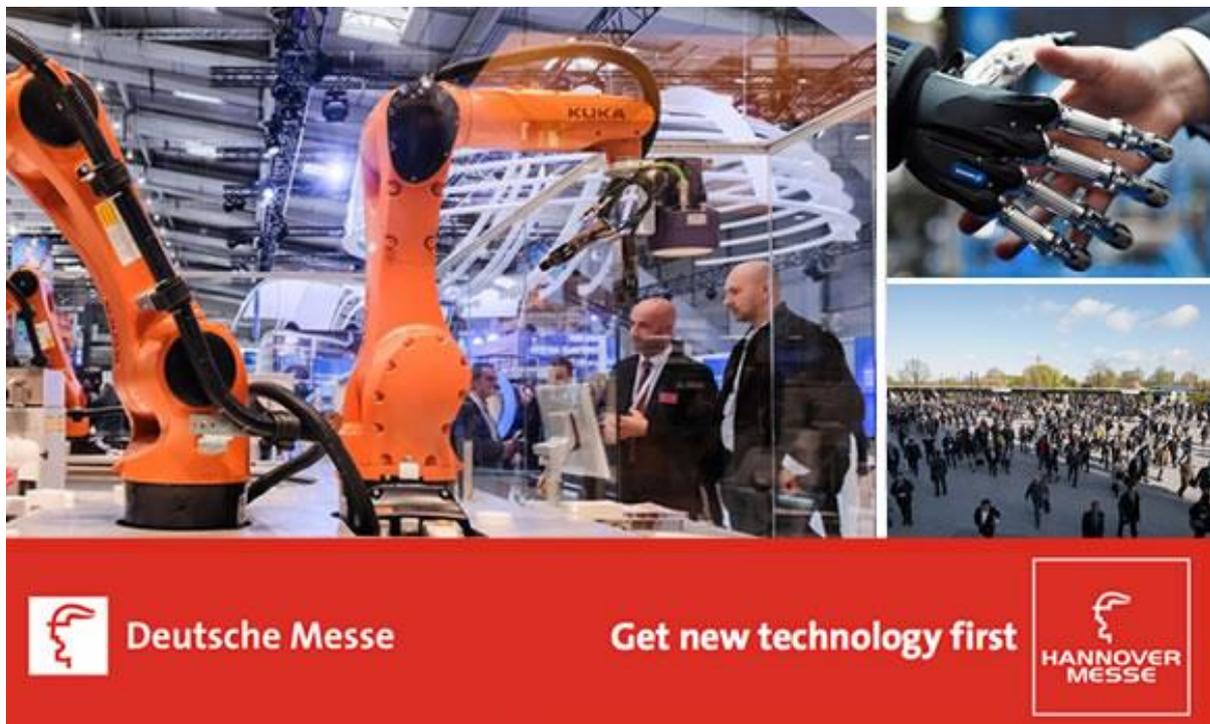
The final stage in the development of qualifications is the Bachelor of Applied Technologies. This will be developed by Swinburne prior to the completion of the pilot program in 2020. The Associate Degree will constitute the first year of the Bachelor program. This is being developed to provide an articulation option for participants although any such option will occur after the completion of the pilot. In addition to this Swinburne has identified further potential articulation options through the Bachelor of Engineering Practice.

4. Project Implementation

4.1 Delivery Schedule

The major feature of the delivery of the pilot program is the time allocation for participants between Swinburne as the provider and time spent as an employee at Siemens. The delivery schedule for the Diploma year involved 33 weeks at Siemens which emphasises the work-based learning nature of the program. The time was organised into week blocks of varying length.

In some instances, partners were used in the delivery of the program. Swinburne University in conjunction with Siemens, embedded a Project Management / Electrical Systems Component into the second placement block, which was taught in partnership with a representative from Siemens Global (Germany). While all of the participants are employed by Siemens they will spend some time in other companies. This has already occurred with Asahi Australia and Hydac and further placements are being planned.



University teaching staff, prior to the commencement of the course, worked closely with the Siemens Business Managers to identify and develop effective and appropriate work options for participants to undertake the application of theory to workplace tasks.

Teaching staff visited Siemens regularly to meet with Business Managers, observe participants undertaking relevant tasks within the workplace, and gain a better understanding of the industry processes involved in Industry 4.0. Working closely with representatives from Siemens Australia and Siemens Global trainer, a work placement manual was developed for the Industry Supervisors to guide the participants through workplace projects. An important feature of the project has been the professional development provided by industry to the education and training system and trainers. The same principle applies in the second year for the delivery of the Associate Degree program.

An additional component to the 2018 program is a week-long international placement in Germany. Pilot participants travelled to Germany to undertake a placement focused on the local operations of Siemens. The apprentices also visited the Hannover Messe industrial technology trade fair during the placement. It is expected that the information and experiences gained by apprentices through their placements in Germany will benefit themselves and their employer.

4.2 Development of Changes to the Relevant Award

Siemens employed the pilot participants under the provisions of the Manufacturing and Associated Industries and Occupations Award 2010. Given the highly advanced nature of the work being undertaken by the participants it was difficult to align to the Award. It was established that the participants would be regarded within the Technical Field Trainee category. Participants are working full-time at the workplace and on campus to receive their wage.

In the second year of the program the participants are undertaking the Associate Degree and more advanced work at Siemens. Consequently, it was decided that the participants would be designated as Trainee Engineers.

It is apparent that neither of these current designations within the Award accurately reflect or align with the work being undertaken by the participants. Given the nature of developments in the Industry 4.0 domain it is difficult to be precise about the nature of employment. Discussions with representatives from Siemens indicate that Engineering Technician – Digital Technologies is a more appropriate description for participants undertaking the Diploma of Applied Technologies. In the following year, while undertaking the Associate Degree of Applied Technologies, the employment title of Associate Engineer – Digital Technologies has been considered appropriate.

As a consequence, discussions have begun with the relevant parties about potential changes to the Award to better reflect these occupational designations.

4.3 Innovative Application of the Diploma

While strong industry input to the design of the Industry 4.0 Diploma in Applied Technologies has reinforced the need for the qualification, some companies have indicated to Ai Group their potential use of only selected units to meet the higher-level skill needs of some emerging positions.

Changing roles, often higher level but specialised, are leading to demands from employers for some workers with a qualification base, eg Certificate III, plus new higher-level components or units. This potential model could apply to both new and existing workers. It fits with the growing demand from employers for shorter chunks of training such as skills sets, and could allow for recognised micro-credentialing for individuals.

Future application of the Higher Apprenticeship Diploma should consider innovative options as the need to quickly build capabilities is driven by changing work requirements in the digital economy.

4.4 Availability for Systemic Use

An early indication that the pilot program is appropriate for more systemic implementation is the commencement of a second intake group at the beginning of 2018.

In this higher education intake Siemens has employed a further eight participants and a further nine are spread across three other organisations: Orora Packaging has four participants, CSIRO has three and two employees of Swinburne have also joined the group.

All project partners have had discussions with potential organisations interested in the program across industry, the education and training sectors and governments. For example, in October 2017 the Ai Group hosted a forum attended by 110 people including a wide range of businesses. There is considerable interest in the program and its availability following the conclusion of the pilot program.



INDUSTRY 4.0