Systems Engineering Degree Apprenticeship Pilot – Expression of Interest for a University Partner

27 August 2021

Introduction

BAE Systems Australia has partnered with Australian Industry Group and Apprenticeships Victoria to develop the Degree Apprenticeship model in an Australian setting. Over the past few months, we have been working with likeminded employers to scope this concept further, including desired educational and employment settings. We collectively have an immediate requirement to develop Systems Engineering capabilities in Melbourne, and are now seeking to collaborate with a local university to progress this initiative to pilot delivery.

Refer Appendix 1 for a full list of our collaborating partners.

What is a degree apprenticeship?

A work-integrated learning program focused on higher education and a proven sourcing model in the United Kingdom. Students combine work with academic studies, and undertake end point practical, knowledge and behavioural assessments.. This model also creates a community of employers willing to work together to set practical work-based standards and provides fully competent engineers into each company, bypassing a traditional graduate program.

- new educational route launched in 2015 by UK Government providing an alternate Year 12 pathway to a higher education degree.
- Bachelors or Master's degree at a partner university underpinned by practical on-the-job industry experience typical of a traditional apprenticeship
- Co-developed by a group of employers, professional institutions and higher education, so the curriculum is directly aligned to specific employer requirements. Enables a deep model of collaboration between employers and higher education sector.
- Typically five years in duration (honours degree) to enable full occupational competence and deliver real value by combining vocational experience and university learning
- Faster route to full occupational competence. Greater pastoral care than traditional academic studies alone. Improved retention rates and greater early integration with employers.
- Supports greater diversity as cohorts are directly sponsored by companies, and this avenue may by appealing to individuals who may not normally consider university studies or who come from disadvantaged backgrounds – earn while you learn model.
- Other similar global models include:
    - Canada – co-operative education: extended five year bachelor's degree with alternating semesters of work and studies
    - Germany – dual study program offering combined study and work

Desired Education Setting

Role Overview

A Systems Engineer solves some of the most complex engineering challenges by organising all the information needed to understand the whole problem, exploring it, and finding the most appropriate solution.

- Must be aligned to Australian Qualifications Framework Level 8 (Bachelor's Degree Honours) to meet Washington Accord specifications and be certified as a Professional Engineer through Engineers Australia.
- Knowledge, Skills and Behaviours – refer Appendix 2 for detailed list of employer-agreed standards.
- Work/Study Scheduling – agreed preference for integrated learning-study model at 80/20 or 70/30 time split, not block approach (eg not alternating semesters in work and study). Employers agree that the course does not need to follow traditional semester model for academic study.
- Preferred learning approach and curriculum considerations:
    - online delivery as much as possible, with intensives and/or on-campus practicals to create peer-to-peer connections and support.
    - in the first two years, set the common engineering and technology framework, then move to specialisations through majors or electives:
        - upfront 1 to 3 months intensive at start of the program to deliver basic engineering concepts, familiarisation and peer connections;
        - use of problem-based learning methodology to better enable applied learning relevant to the workplace;
        - removal of traditional first year engineering requirements that are not required for systems engineering. Focus on the fundamentals to be accredited as a Professional Systems Engineer.
        - introductory courses in: electrical and mechanical engineering, ICT systems concepts (more relatable for systems engineering), and the platforms most often used by entry-level engineers such as basic Excel and Tableau.
    - Design curriculum and scheduling in context of full-time workers being able to attend classes without having to re-learn basic concepts.
    - Include scope for bridging course if participant does not have prerequisite level of advanced maths.
- Verification of competencies: Include interim and end-point assessments agreed by employers and university partner. Partner university will also need to create a system to set employer supervisory obligations and sign-off of agreed knowledge criteria to be learnt and assessed on-the-job.
- Professional recognition: include Certified Systems Engineering Profession (CSEP) test as part of the course.
- Pastoral care: university to actively manage connections across the cohort, eg formal networking and/or peer-to-peer experience sharing network. Also seeking avenue to create regular check-ins for host employers to share lessons learnt in supervisory obligations etc.

Desired Employment Settings

Context

There is no regulatory framework to formally underpin this proposed work-study employment arrangement at the university level. Tertiary Education Quality and Standards Agency (TEQSA) and *Higher Education Standards Framework* provide guidance only on work-integrated learning. An interim arrangement will need to be agreed between all employers and the university partner to ensure the best outcome for participants.

Employers have agreed that the inaugural cohort will be recruited as full-time employees with some paid time for study – noting preference for online lectures and that some learning should be delivered in the workplace as applied and real projects.

- Recruitment:
  - participants will be directly recruited by employers with criteria to include academic/ATAR requirements set and verified by partner university. All participants in the course must be employer sponsored.
  - initially targeting recent school leavers, with a strong focus on equal gender representation. Must have completed year 12 or equivalent and be an Australian citizen.
  - an inaugural group of nine employers have expressed interest in participating in the pilot.
- Some participants may need to spend a minimum amount of time in another partner employer if an 'in-workplace knowledge set' cannot be raise or qualified by the host employer (eg best practice scheduling).
- Agreed desire to underpin the model with a structured Training Contract as it obliges the employee to complete the qualification and creates a sense of guardianship for employers for engineering capability development.
- The Training Contract will:
  - provide a direct relationship between student and employer
  - include mutual contract cancellation obligations
  - specify time duration for the training contract
  - set wages and study conditions in line with Trainee Engineers in the Manufacturing and Associated Industries and Occupations Award 2020.
  - specify agreed amount of time to be released for study
  - specify work supervisor obligations and other employer support (eg mentoring and coaching)
  - can be easily replicated for national scalability
  - set out agreement for who will pay for tuition. There is ongoing deliberation amongst participating employers regarding partial or full offset of HECS debt and on potential further incentive for females and other under-represented populations.

Expressions of Interest

Victorian-based universities are invited to submit an Expression of Interest by 5.00pm AEST on Friday 8 October 2021 through this portal: https://BAESystemsGAP.icn.org.au

Respondents must include a brief presentation outlining the university's proposed approach, governance, delivery timeline including course design and pathway to accreditation, student progress tracking system, and rough costing.

You must also provide brief responses to the following questions via the online questionnaire:

1. Provide details on your current work-integrated learning programs in engineering or other STEM domains, including current approach to assessing workplace learning and relevant subjects/courses. Include a link to your relevant work-integrated learning webpages.
2. Provide details on your approach to increasing diversity in your engineering programs.
3. How is your university approaching the future of engineering education?
4. Describe your university's approach to employer engagement. Include relevant examples of industry partnerships.
5. What other innovative learning models are you currently developing?
6. Do you have any current or foreshadowed conflicts of interest that may impede delivery of this pilot program?
7. What do you think are the main challenges associated with delivery of this pilot project?
8. Provide evidence of university leadership support for your proposal.
9. Do you have an interest or hold Defence Industry Security Program membership? If yes, please state what membership level you hold. Refer to the DISP webpage for more information.

For more information

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Appendix 1 – Collaborating Partners

Employers

Associations

Government

Appendix 2 – Desired Knowledge, Skills and Behaviours

Role Overview

Solving some of the most complex engineering challenges by organising all the information needed to understand the whole problem, exploring it and finding the most appropriate solution.

1. Define and manage the system lifecycle for a project
2. Define and manage project requirements
3. Manage project risk
4. Model and analyse systems
5. Generate solution concepts
6. Architect and design systems, including covering estimating, design to cost.
7. Plan and manage systems integration
8. Plan and execute system verification
9. Plan and execute system validation
10. Provide technical leadership within a project
11. Support transition of the system into the operational environment
12. Provide systems-level in-service support of the system
13. Support technical aspects of project management
14. Take responsibility for configuration and data management
15. Co-ordinate technical outputs and work of multi-disciplinary teams
16. Design decisions framework

Knowledge

To carry out the duties of a systems engineer, the following knowledge is required:

1. Systems engineering lifecycle processes
2. The role a system plays in the super system of which it is a part
3. The characteristics of good quality requirements and the need for traceability
4. The distinction between risk, issue, and opportunity and the different forms of treatment available
5. The benefits and risks associated with modelling and analysis
6. How creativity, ingenuity, experimentation and accidents or errors, often lead to technological and engineering successes and advances
7. How system engineering can affect production and support

8. Understanding primary and secondary effects of design decisions, including: supportability of the system, cost and complexity of manufacture/production, as well as impact of scope constraints on design
9. Understanding of design thinking and other methodologies to capture user requirements
10. Different types of systems architecture, techniques and tools to support the architectural design process (eg the specification of systems elements and their relationships) including NATO Architecture Framework (NAF), Ministry of Defence Architecture Framework (MODAF), Department of Defense Architecture Framework (DoDAF) and Advanced Product Quality Planning
11. Non-functional design attributes such as manufacturability, testability, reliability, maintainability, affordability, safety, security, human factors, environmental impacts, robustness and resilience, flexibility, interoperability, capability growth, disposal, cost and natural variation
12. Integration as a logical sequence to confirm the system design, architecture and interfaces
13. Interface management and its potential impact on the integrity of the system solution
14. Systems verification against specified requirements and characteristics and the need to execute it in a logical sequence
15. The relationship between verification, validation, and acceptance including the methodologies and the effect of different acceptance standards has on these activities. The relationship of service quality to user satisfaction and cost, risk, and availability of the operational system
16. The purpose and importance of system validation in relevant commercial context
17. Scientific, technical, engineering, and mathematics fundamentals and a broad technical domain knowledge for the relevant industry
18. How to take account of health and safety legislation and sustainable development requirements in the relevant industry
19. The relationship of service quality to user satisfaction and cost, risk, and availability of the operational system
20. The elements of a project management plan (including statement of work, work breakdown structure, resource allocation, scheduling, management plan, monitoring, risk management, change requests, record keeping, and acceptance)
21. The commercial and financial environment in which a project is being executed (e.g. procurement model, interest rates, exchange rates)
22. The role of systems engineering planning as part of an overall project/programme plan
23. The legal, commercial, and security constraints that affect the management of data and information (e.g. General Data Protection Regulation, handling of specific commercial contract restrictions)
24. Support and sustainability needs of a deployed system or product.
25. Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline
26. Understanding of the mathematics, numerical analysis, statistics, and computer and information sciences that underpin the engineering as a discipline.

27. An appreciation of the production and trade skills required to manufacture, as well as an understanding/particle application of Industry 4.0 skills

28. Understanding of product safety and security, from an architecting point of view

29. Understanding of different systems engineering approaches including Model-Based Systems Engineering.

30. Understanding of the basis and relevance of standards and codes of practice, as well as legislative and statutory requirements applicable to the engineering discipline

31. Understanding of the principles of safety engineering, risk management and the health and safety responsibilities of the professional engineer, including legislative requirements applicable to the engineering discipline

32. Understanding of the social, environmental and economic principles of sustainable engineering practice

33. Understanding of the fundamental principles of engineering project management as a basis for planning, organising, managing resources and evaluating progress, including examples of developing progress metrics

34. Understanding of the formal structures and methodologies of systems engineering as a holistic basis for managing complexity and sustainability in engineering practice

35. Understanding of Intellectual Property as applicable to engineering and product development

36. Can apply a wide range of engineering tools for analysis, simulation, visualisation, synthesis and design, including assessing the accuracy and limitations of such tools, and validation of their results

37. Understanding of different lifecycle models and how they can be applied to a project when deciding how a project is delivered. This should also include how to use multiple lifecycle models in a project and how they need to synchronised in order to achieve acceptance by the customer.

38. Understanding of business and commercial acumen – finance for engineering

Skills

To carry out the duties of a systems engineer, the following skills are required:

1. Select appropriate lifecycle for a system or element of a system and establish its lifecycle stages and the relationships between them

2. Define context of a system from a range of viewpoints including system boundaries and external interfaces

3. Use appropriate methods to analyse stakeholder needs to produce good quality, consistent requirements with acceptance criteria and manage them throughout system development

4. Identify, analyse, recommend treatment, and monitor and communicate risks and opportunities throughout project

5. Generate a physical, mathematical, or logical representation of a system entity, phenomenon or process

6. Apply creativity, innovation and problem solving techniques to system development or operation

7. Define the systems architecture and derived requirements to produce an implementable solution that enables a balanced and optimum result that considers all stakeholder requirements across all stages of the lifecycle

8. Identify, define, and control interactions across system or system element boundaries

9. Assemble a set of system elements and aggregate into the realised system, product, or service using appropriate techniques to test interfaces, manage data flows, implement control mechanisms, and verify that elements and aggregates perform as expected

10. Define verification plans (including tests) to obtain objective evidence that a system of system element fulfils its specified requirements and characteristics

11. Provide objective evidence that the operational system fulfils its business/mission objectives & stakeholder requirements/expectations

12. Communicate effectively with all stakeholders of the project using the most appropriate medium and techniques including written and verbal presentation, in the English language

13. Has developed the capability to perform relevant investigation analysis, interpretation, assessment, characterisation, prediction, evaluation, modelling, decision making, measurement, evaluation, knowledge management and communication tools and techniques pertinent to the engineering discipline

14. Integrate a system into its operational environment, including the provision of support activities (e.g. specification of site preparation, training, logistics, etc.)

15. Define and collect operation data for monitoring and control of a system

16. Initiate design change proposals in response to system failure or degradation

17. Create and maintain project management plan, including work breakdown structure, scheduling, and risk management

18. Balance project scope, time, cost, risk, and resources to optimise product or service quality and return on investment

19. Manage and control system elements and configuration over the project or programme lifecycle ensuring overall coherence of the design is maintained in a verifiable manner throughout the lifecycle

20. Plan, execute, and control the storage and provision of information to stakeholders.

21. Define, coordinate and maintain effective and workable plans across multiple disciplines

22. Identify concepts and ideas in sciences, technologies and engineering disciplines beyond their own discipline that could benefit the project solution

23. Partition between discipline technologies and work with specialists to derive discipline specific requirements

24. Exercise leadership in organisation, plan and prioritise work to meet commitments and accountabilities aligned with organisational goals aligning individual objectives with broader organisational and team priorities and goals

25. Financial acumen – interpret and apply understanding of key financial information to make informed business decisions, understanding the finance policies and procedures as they apply to engineering roles

26. Manage risk, understand risk relevant risk frameworks, to be able to make sound business decisions, reduces risks and maximises opportunity through implementing pilots, tests, proto-types to allow for testing without far-reaching consequences

27. Manage SHE, to cultivate and maintain a culture and mindset of safety. Anticipates how tasks and decisions may impact the Safety, Health and Environment of the workplace, and proactively prevent incidents or harm to others and the environment

28. Manage complexity, making sense of complex, high quantity, and sometimes contradictory information to effectively solve problems; and able to operate effectively even when things are not certain or the way forward is not clear

29. Optimise process, knowing the most effective and efficient processes to get things done, with a focus on continuous improvement

30. Separates and combines activities into efficient workflow

Behaviours

A competent Systems Engineer will exhibit the following behaviours:

1. Adopt and encourage within the team a holistic thinking approach to system development

2. Perform negotiations with stakeholders recognizing different styles of negotiating parties and adapts own style accordingly

3. Adopt and encourage within the team a critical thinking approach using a logical critique of work including assumptions, approaches, arguments, conclusions, and decisions

4. Take personal responsibility for health and safety practices and sustainable development

5. Operate with integrity and in an ethical manner, and ensure that team members perform with integrity and in an ethical manner

6. Take a proactive and systematic approach to resolving operational issues

7. Maintain awareness of developments in sciences, technologies and related engineering disciplines.

8. Refer also Engineers Australia's Code of Ethics

Professional Recognition

Systems Engineers who successfully complete the apprenticeship will achieve the standard of Practitioner against a selected profile of the International Council on Systems Engineering (INCOSE) competences as detailed in the Assessment Plan. The apprenticeship also provides a route towards the knowledge, experience and competence required to apply for recognition by INCOSE as a Certified Systems Engineering Professional (CSEP) and to apply to be registered by the Engineering Council as a Chartered Engineer (CEng).