The Cranfield Systems Engineering Masters Apprenticeship Programme

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Course Direct MSc Systems Engineering
Systems Engineering

Systems engineering is the field of engineering concerned with providing coherent solutions for needs, taking into account a full life-cycle perspective. This is particularly important in situations involving one or more of the following characteristics:

• A large complex system integrating many components
• High value systems
• Systems where failure could have major consequences for the owner/user, the environment, the economy or society at large
• Systems with a long or very long intended service life
• Systems that interface to many other systems
• Systems for which assurance of design process is required for certification purposes
Systems engineering began in large defence and aerospace projects. Now applied in many other sectors as well (e.g. transport, automotive, medical devices).

Systems engineering is used where there is a need for:
- Dealing with complex systems and environments
- Providing confidence that the most appropriate product is developed
- Providing assurance of the quality of the engineered product
- Discovery of what would be a good solution for a need
- Integration of the technical and organizational and commercial issues at producer, supplier and customer organisations
Typical roles of Systems Engineers

Systems engineers as individuals usually specialize in part of SE. Many organizations employ people to perform SE roles under other job titles reflecting the specific roles performed. Typical job titles include:

- Lead engineer
- Project engineer
- Technical lead
- Acquisition engineer
- Test engineer
- Requirements manager
- Systems architect
- Systems designer
- Systems analyst
- Engineering manager
- Systems specialist
- Technical manager
- In-service engineer
- Integration engineer
- Interface manager
- Operation and support engineer
History

The Defence Growth Partnership

Vision
The Defence Growth Partnership will secure a thriving UK defence sector delivering security, growth and prosperity for our nation.

Strategy
Taking a fresh and ambitious approach through a Joint commitment from the Government and the Defence Industry to work together to develop new opportunities by Building on our nation’s strengths in air capabilities and intelligent systems and deliver growth through Innovative and tailored solutions for Customers around the globe.
Defence Growth Partnership skills group formed in 2013 under chairmanship of Allan Cook CBE

A skills survey identified systems engineering as the biggest gap
‘SE has broad applicability and will become increasingly important’

BIS / Skills Funding Agency launched Trailblazer programme

In response an Systems Engineering Masters Apprenticeship (SEMAP) was proposed:

The first Defence Trailblazer
First apprenticeship at Master’s Level 7 linked with a university
Launch Employers .....
The Journey

- **Employer group comprised** 20 parties from employers, academia, professional bodies - in partnership with BIS Skills Funding Agency.

- **Employers**: Atkins, Altran, BAES, Cobham, General Dynamics, Marshall, MBDA, MoD DE&S, Dstl, MooD, QinetiQ, Raytheon, Rolls-Royce, Leonardo and Thales

- **Universities**: Cranfield University, Bristol University, Loughborough University, UCL

- **Professional bodies**: INCOSE, SEMTA, Royal Academy of Engineering, IEEE

<table>
<thead>
<tr>
<th>September 2014</th>
<th>March 2015</th>
<th>January 2016</th>
<th>Current</th>
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<tbody>
<tr>
<td>Employer group formed</td>
<td><strong>Standard approved</strong></td>
<td><strong>First 55 apprentices start</strong></td>
<td><strong>Revised Standard submitted</strong></td>
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<td>Chair: Allan Cook CBE</td>
<td><strong>Assessment plan approved</strong></td>
<td><strong>9/16, 1&amp;9/17, 1&amp;9 18 Further intakes</strong></td>
<td>First EPAs due Jan 19</td>
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<td><strong>August 2015</strong></td>
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The Systems Engineering Masters Apprenticeship Programme (SEMAP) is a 3-5 year programme of blended vocational and academic learning at Masters level that will develop a rounded systems engineer at INCOSE practitioner level who should also be able to apply for a CEng.
<table>
<thead>
<tr>
<th>Competency Area</th>
<th>Minimum number of Competencies Required</th>
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<tbody>
<tr>
<td><strong>Systems Thinking</strong></td>
<td>A and B (2 from 3) must be demonstrated at practitioner level</td>
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<tr>
<td>A. Systems Concepts</td>
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<td>B. Super Systems Capability Issues</td>
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<td>C. Enterprise and Technology Environment</td>
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<td><strong>Holistic Lifecycle View</strong></td>
<td>A minimum of one competency area at supervised practitioner level</td>
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<tr>
<td>Determine and Manage Stakeholder Requirements</td>
<td>Must be demonstrated at practitioner level</td>
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<tr>
<td>Architectural Design</td>
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<td>Concept Generation</td>
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<td>Design for …</td>
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<td>Functional Analysis</td>
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<td><strong>Interface Management</strong></td>
<td>A minimum of one competency area at supervised practitioner level</td>
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<td>Maintaining Design Integrity</td>
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<td>Modelling and Simulation</td>
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<td>Select Preferred Solution</td>
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<td>System Robustness</td>
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<td>Systems Integration and Verification</td>
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<td>Validation</td>
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<td>Transition to Operation</td>
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<tr>
<td><strong>SE Mgt</strong></td>
<td>A minimum of one competency area at supervised practitioner level</td>
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<td>Concurrent Engineering</td>
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<td>Enterprise Integration</td>
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<td>Integration of Specialisms</td>
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<td>Lifecycle Process Definition</td>
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<td>Planning, Monitoring and Controlling</td>
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* Employers may wish to impose additional rules that the minimum of two competencies at practitioner level should originate from different groupings, to reflect a broad systems engineering view.
The benefits of SEMAP

- An apprenticeship combines vocational and academic learning to create competent people.
- The portfolio can be used as evidence for professional chartership.
- The SEMAP is aimed at up-skilling and attracting new entrants to the Defence sector.
- At level 7, it is likely that ‘apprentices’ will already have work experience, possibly in another sector and/or be employed already.
- At Level 7 this apprenticeship provides a pathway from other apprenticeships and delivers the advanced skills for the kind of high value economy that Britain aspires to.

An Apprentice could be:
- A recent graduate in STEM with some experience in a technical discipline with the Employer.
- An ex Higher Apprentice with a Level 4 qualification and at least 8 years experience in systems engineering.
- A mid-career engineer looking to transfer to the sector from another sector.

Who is this for?
Benefits for the employer and for the student

• **Student benefits**
  - SEMAP offers a **clear route to Practitioner level in Systems Engineering**
  - A qualification that is nationally recognized
  - The option to complete a **hybrid degree**
  - **Structured learning and development with an employer**
  - **An opportunity to expand your professional network** and work with and learn from others in the industry
  - **An opportunity for professional development** without interruption to employment

• **Employer benefits**
  - Fosters a common approach across the Defence sector.
  - A **blended approach of academic and vocational learning** that will provide **enhanced competence** over a purely academic route
  - The scheme has **flexibility so that it can be tailored to the needs of an Employer**, reflecting local needs and the particular domain interests of the Employer and Apprentice
  - Creating an internal network of mentors within an organisation and encouraging continuing professional development
Apprenticeship programmes must be reviewed each three years
Review enables
• Verification that the apprenticeship serves a valid purpose going forward
• Evaluation of the need for changes to ensure currency

SEMAP is now 3 years old
The employers have reviewed the original standard and prepared a revision
The revision has been submitted to IfA for approval
SEMAP – Changes

SEMAP v1 included only PGDip as the academic component
   This was a consequence of funding rules at the time
SEMAP v2 (pending decision) includes MSc (adds a thesis project)
   This is now permitted
   Justified by completion of thesis demonstrating ability to plan and
   perform a substantial project – applying many skills learned
SEMAP v1 described learning using INCOSE UK competency framework –
   describing kinds of abilities to do SE work
   Compliant at the time
SEMAP v2 (pending decision) describes learning in terms of Knowledge,
   Skills and Behaviours
   This is now the required form
SEMAP apprentices come/have come from all the organizations involved in developing the standard
Some other organizations have sent apprentices

Cranfield University is currently the only university providing the academic component of the apprenticeship
Other universities that have MSc SE courses are preparing to become academic providers in SEMAP v2

This is consistent with the philosophy of apprenticeships
• Provide education/training against a public standard
• Provides national recognition and portability of apprentice qualifications