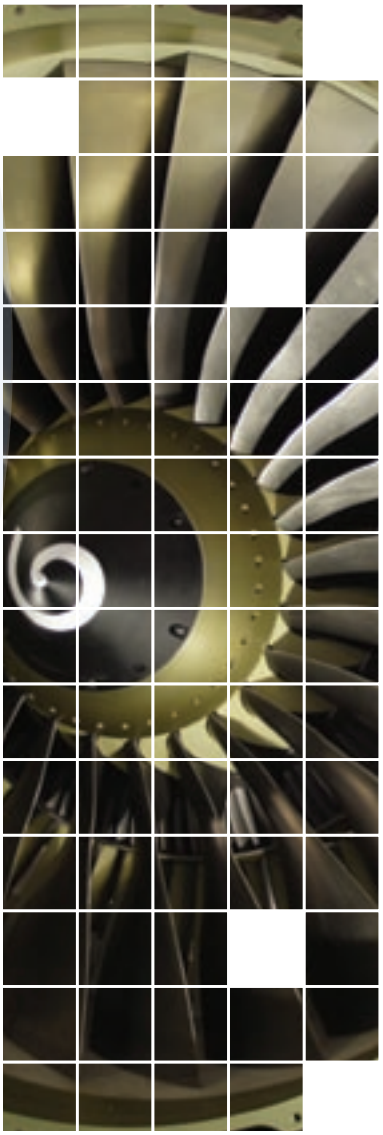
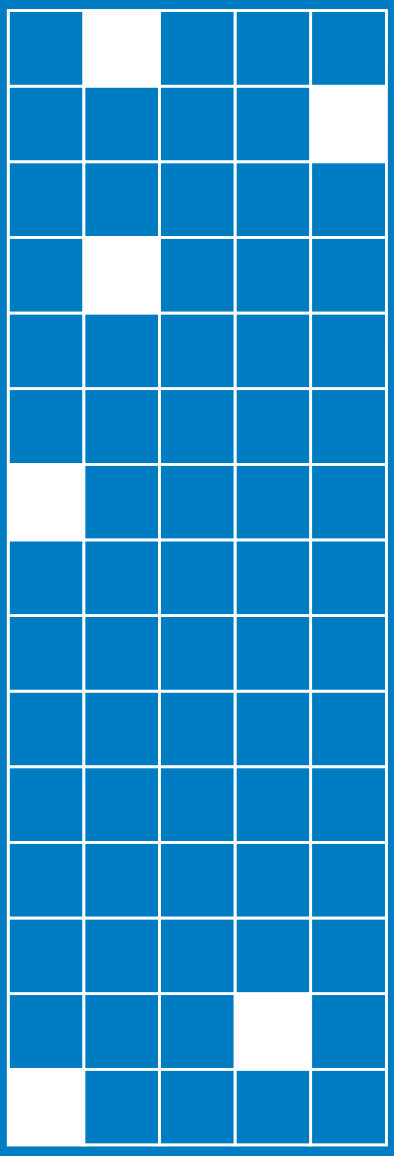
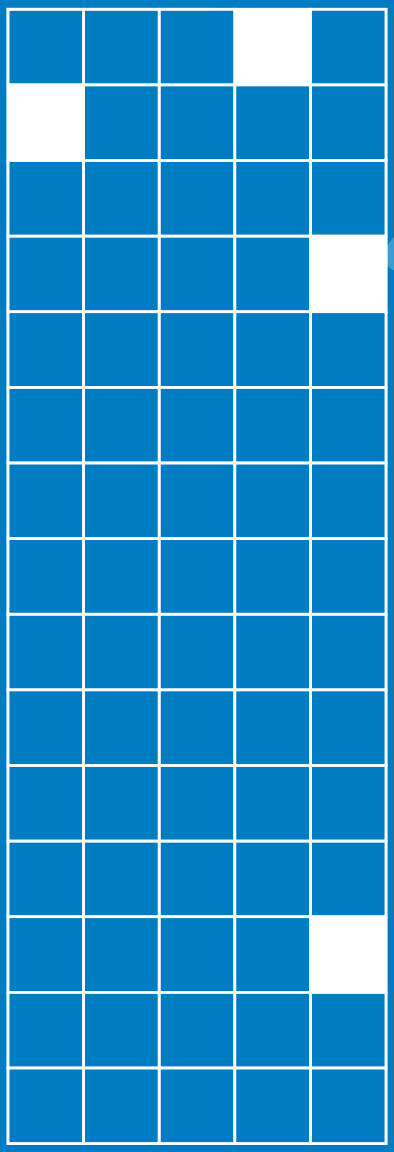
# INCOSE UK

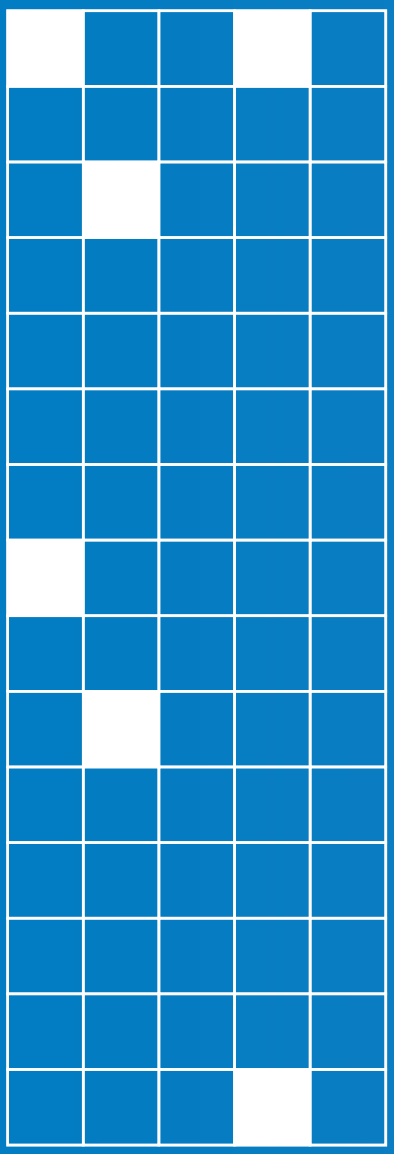
## SEASON Report 2014

Systems Engineering Annual State of the Nation









# INCOSE UK
# SEASON Report 2014

## (Systems Engineering Annual State of the Nation)

Published by the UK Chapter of the International Council on Systems Engineering



## Distribution

This report will be available as a soft copy to INCOSE UK and UKAB members from 18 November 2014 as an exclusive member benefit.

It will be available on the INCOSE UK public web site on or after 30 November 2014.

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# Contents

# Executive Summary

We are living in the age of systems challenges. Global challenges such as food, health, security and climate change are ever-more demanding. Society is recognising that sustainability is a necessity and not a luxury. And there is a constant pressure for ever more complex and integrated systems in all aspects of our lives. These challenges place new demands on the types of systems that are needed, their connectedness, and society's expectations of success. Systems engineers are linchpins in responding to these challenges and it is our opportunity to rise to these challenges. To achieve this however, the practice of Systems Engineering must continue to evolve, so that as systems engineers we have the processes and tools for the job.

The United Kingdom has a proud history in engineering and technology, and was one of the leading nations for developing and codifying Systems Engineering. This SEASON report assesses the state of Systems Engineering in the UK in 2014, following a previous report published in 2009.

From this report we can say the following with confidence:

1. Momentum for Systems Engineering in the UK is building – evidenced by the growth and diversification in INCOSE UK's individual and corporate membership, broadening academic base, and the increased adoption of systems principles.
2. More and more organisations in the UK are recognising and promoting Systems Thinking for all their people, as a core business skill. This is a very encouraging development because Systems Thinking underpins effective Systems Engineering.
3. While differing language is used, system principles are gaining traction in an increasing range of UK engineering domains, for example whole systems perspectives in rail, enterprise architecting or service design in information technology, through life capability management in defence, and sometimes System of Systems Engineering.
4. The Systems Engineering state of the art continues to mature, evidenced by concepts that are now better understood and more consistently applied. Examples include: architecting, the application of Systems Engineering to a wider range of systems-of-interest (technology, service, capability, enterprise, system of systems), and the progressive adoption of model-based approaches.

Systems Engineering does still have significant challenges to overcome:

1. Good Systems Engineering will always require good leaders with strong professional competencies. We must continue our work to identify and develop leaders at all levels in organisations applying Systems Engineering.
2. Systems engineers still struggle to convey the value of Systems Engineering to a non-specialist audience, be it chief executives or practitioners from other domains. This hampers its adoption and we must continue to provide information and support to those making the case for Systems Engineering.
3. Systems Engineering must evolve so that tailoring can be confidently applied to ensure the right mix of techniques appropriate to each project. We are seeing a demand for effective approaches informed by inter alia Agile, Lean and model-based approaches.

The 2009 SEASON report identified three key axes of development which we still believe are vital to the evolution of effective Systems Engineering in the UK. We restate them here, refined to reflect 2014 circumstances:

1. Improve the academic profile of Systems Engineering and Systems Thinking by:
   a. Setting out an agreed, intellectually rigorous foundation for the discipline.
   b. Continuing to inform and influence curricula for both Systems Engineering and the wider Engineering disciplines.
2. Continuing to build and diversify engagement across Systems Engineering stakeholders in the UK, through the INCOSE UK Advisory Board, Strategic Partnerships, and involvement in joint activities in order to understand and inform what's going on in and around Systems Engineering.
3. Continuing to support Professional Development for individuals and within organisations including Professional Registration, Systems Engineering Certification, development of leadership skills, and continuing Professional Development.

In summary, Systems Engineering in the UK is certainly maturing and delivering greater value to its stakeholders. There is, however, a long journey ahead for us all, and INCOSE UK is committed to working with Government, Industry and Academia to ensure that by the time of our third SEASON report there is continued success to report.

Alan Harding BSc(Hons) CEng FIET MINCOSE, INCOSE UK President (2012-2014)
Richard Beasley BSc(Hons) MSc CEng FRAeS MINCOSE, INCOSE UK President-Elect

# Introduction

## Background to the SEASON Report

The SEASON Report is a national baseline of the UK's Systems Engineering capability. Following the original report issued in 2009, this 2014 update has a refreshed structure and an update to the content. The update was carried out by the Council of the UK Chapter of INCOSE, the International Council on Systems Engineering. The original SEASON Report was created by a Working Group, with the support of its corporate members, the UK Advisory Board (UKAB) in 2008. The 'real economy' needs systems skills as never before to develop viable systems and services which create real, enduring and environmentally sustainable value for the economy.

This SEASON Report is an evidence base that can be used to inform decision makers in Government, Industry and Academia so that they can make decisions leading to actions that will improve the UK's national Systems Engineering capability. This will in turn improve the UK's ability to acquire and develop complex systems and manage them through life, and to participate effectively in international Systems Engineering endeavours. This will maintain the UK's economic and social viability and its international competitiveness as a value-added system and service integrator in the global supply chain.

This SEASON Report was prepared through an inclusive process engaging corporate and individual members of INCOSE UK and national and international experts in Systems Engineering. It draws also on a wide range of sources both public and unpublished.

## What is INCOSE?

INCOSE is the International Council on Systems Engineering and was founded in the US in 1990, and became international in 1994 with the creation of its UK Chapter. INCOSE runs an International Symposium every year, operates through local Chapters and Working Groups, and publishes a range of technical products for practising systems engineers, and a peer reviewed academic journal. INCOSE has 75 Chapters organised in three Sectors:

- Americas: 47 Chapters
- Europe, Middle East and Africa: 20 Chapters
- Asia-Oceania: 8 Chapters

INCOSE has approximately 10,000 individual and 100 corporate members (the latter including several UK organisations). Its website is at www.incose.org.

## INCOSE UK

The UK Chapter of INCOSE was formed in 1994 and over the last twenty years has grown into a vibrant community of over 830 like-minded Systems Engineers.

INCOSE UK comprises the Council, the UK Advisory Board and its individual and corporate members, supported by a professional secretariat. INCOSE UK operates a number of groups including Working Groups that focus on a specific area of Systems Engineering, Interest Groups that typically relate to a specific industry, and Local Groups that are based on geographic location. Each group runs regular events and meetings and produces work products that are available to the INCOSE UK Membership.

A number of INCOSE publications are available to the public including a set of introductory Z guides, but most publications are available exclusively to members.

INCOSE also offers a route to Professional Registration via the Institution of Engineering and Technology (IET) where successful candidates may achieve Chartered Engineer (CEng), Incorporated Engineer (IEng) or Engineering Technician (EngTech) status.

Each year, INCOSE UK hosts its flagship event, the Annual Systems Engineering Conference – the leading Systems Engineering Conference in the UK which provides a forum for industry, academia, government and commerce to meet, network and share their ideas.

The benefits of engaging with INCOSE UK include: access to a dynamic international community of Systems Engineers, the right to use of a valuable body of knowledge, and influence on the Systems Engineering agenda for research, education, standards, and application.

## Further Information

For more information, such as: Z guides, Omega Guides, Posters, the Systems Engineering Handbook, INCOSE Competencies Framework, Working Group outputs please visit us: www.incoseonline.org.uk

To keep up to date with current information, see:


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## Invitation to Participate

INCOSE UK is committed to an inclusive approach working with a wide range of stakeholders to improve the condition of Systems Engineering in the UK.

This is the first update to the SEASON Report. We want it to be inclusive and accurate and we apologise in advance for any omissions, errors and approximations. We invite all UK organisations with an interest in Systems Engineering and the systems approach to join with us to improve the accuracy, completeness and utility of future versions.
If you want to get in touch, for instance to offer help, provide details of your activities, and particularly offer examples of how you apply Systems Engineering in your industry, what courses you run, please contact SEASON@incose.org.

## Report Overview

This SEASON Report opens with an Executive Summary that was written by the President and President-elect of INCOSE UK. After this introduction, the next section provides an overview of Systems Engineering. The next main section considers Systems Engineering in the UK and covers three broad areas: the current state of Systems Engineering, Systems Engineering professionalism and Systems Engineering in Academia. The final main section discusses Systems Engineering and the wider picture.

This SEASON Report also provides a number of key annexes that cover: standards and other guidelines, Systems Engineering employers in the UK, the INCOSE UK UKAB and a summary of UK-based Systems Engineering-related university courses.

# 'Systems Engineering'

## Understanding Systems Engineering

### What is a system?

A system may be defined as 'a group of elements interacting with each other and their environment for a purpose'. Any system may be thought of as consisting of a set of interacting elements. Such elements may include: people, processes, information, organisations and services as well as software, hardware and complex elements.

Also, a system exhibits qualities that are not present in any of the parts themselves. Such qualities are known as 'emergent properties' of the system. Emergent properties arise when system elements interact with each other and their environment, but only exist when individual elements of a system interact together. They both give rise to the desired system behaviour, and bring the threat of unintended consequences. It is the role of the systems engineer to predict and manage the former, and to predict and minimise the latter.

There is no discontinuous step from 'system' to 'not a system'. Indeed it is generally accepted that 'one person's system is another person's subsystem', which will depend on one's point of view, or context.

### What is Systems Engineering?

We live in a demanding society where increased quality, timeliness and value drive our business. The systems that we develop are becoming more complex in terms of their interfaces, interaction with the environment, integration of disparate elements (such as people, software) etc.

With this increasing complexity, it is very easy for things to go wrong, which is why we need Systems Engineering

INCOSE defines Systems Engineering as 'an inter-disciplinary approach and means to enable the realisation of successful systems'

Systems Engineering is a broad field that encompasses and complements many disciplines, such as management and 'traditional' engineering techniques. Systems Engineering is utilised in many industries and applied across many and varied life cycles. In fact, it is possible to be performing Systems Engineering activities even on something that is not considered to be a System.

First codified during the 1950s for the US space and ICBM programmes, and described in a seminal text by Hall in 1962, Systems Engineering offers a dependable way to develop high integrity solutions to novel and complex problems. Systems Engineering is now seen as a key enabler for success in our increasingly complex and rapidly changing world.

Systems Engineering uses principles of 'Systems Thinking' that are also applied in areas as diverse as social science and environmental management. Systems thinking is a way of tackling complex problems that complements scientific thinking by addressing holism, emergence and intentionality.

In the UK, Systems Engineering is applied in many sectors including: defence, aerospace, rail, automotive, civil aviation, infrastructure, astronomy, space, IT and security amongst others. Each domain tends to apply Systems Engineering in a different way depending on the dominant business models, constraints and systemic risks of the domain.

As the maturity of Systems Engineering has increased, so too has need for advanced approaches to realise systems, such as Model-Based Systems Engineering (MBSE) and its associated techniques and tools.

**Perspective:**
*There are differing views on what Systems Engineering is, which confuses stakeholders. INCOSE UK aims to provide to provide a framework within which to understand and manage the application and value of Systems Engineering across all application domains in the UK.*

## Benefits of Systems Engineering

There are many recognised benefits to applying Systems Engineering on projects, including:

- Improved understanding of the needs of the stakeholders and, therefore, operational purpose, context, value, and usage of the systems
- Increased probability of project success - more than one third of all projects fail
- Managed complexity, therefore better understanding and communication amongst stakeholders
- Reduced risk, as stakeholders' expectations are managed more effectively
- Improved change management – the ability to identify, manage and control changes throughout the systems development
- The identification and management of emergent properties
- Greater understanding of the whole life of the systems by considering its Life Cycle

Of course, the realisation of these benefits will depend on the effective implementation of Systems Engineering activities, requiring effective people, processes and tools together with an appropriate organisation, infrastructure and management of information.

## Key Considerations for Systems Engineering

There are several key considerations that must be understood, managed and controlled when applying Systems Engineering. Figure 1 below shows some of the key concepts that must be considered for effective Systems Engineering and that are described in more detail in the following sections.

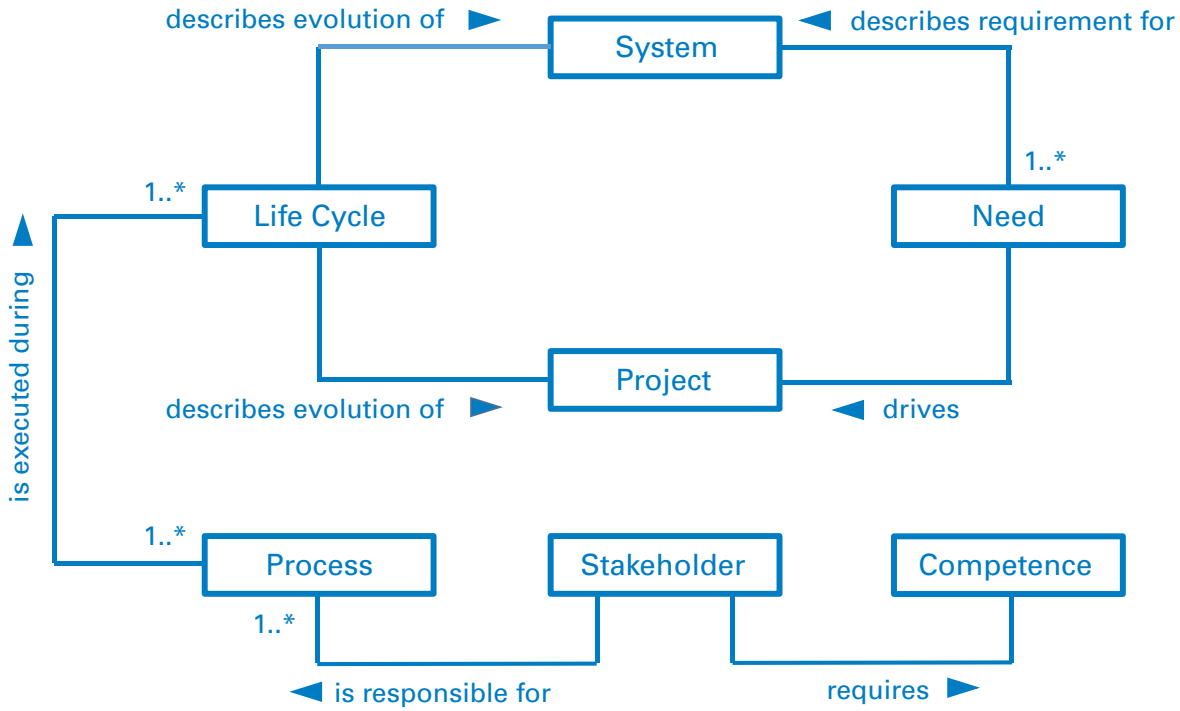



Figure 1: Key Systems Engineering concepts

## Systems and Projects

Fundamentally, it is important to understand that a Project will deliver a System (or a change to an existing system), and that this System may manifest itself in a number of different ways and is not just limited to a technical-type System. Other examples of Systems include: social Systems, financial Systems, environmental Systems, human Systems, and process Systems. Indeed, it is typical for several types of these systems to interact with one another causing additional complexity. In the same way, the term Project here may also relate to a programme of multiple Projects or a portfolio of programmes.

In some cases, groups of interacting Systems may have their own purpose and have their own unique properties and behaviours that are not present in any of their constituent system alone – such Systems are often referred to as 'Systems of Systems'

## Systems and Needs

Any System will have a set of Needs associated with it that describes the System's requirements, capabilities and constraints. Such Needs must be well written but must also be well understood from a number of different points of view. It is possible for a single Need to take on a different meaning depending on, for example, whether an end user or project manager reads it. Such points of view are often referred to as 'Contexts' and it is essential to consider each Need within a number of Contexts. Also, it is essential to be able to demonstrate that each Need may be satisfied by the delivered System, which is referred to as 'Validation'.

## Systems, Projects and Life Cycles

Within Systems Engineering, it is important to understand the concept of a Life Cycle. A Life Cycle describes the evolution of something from its initial idea right up until its final disposal. This evolution is described by a number of 'Stages', typically: Concept, Development, Construction, Operations and Support and, finally Disposal.

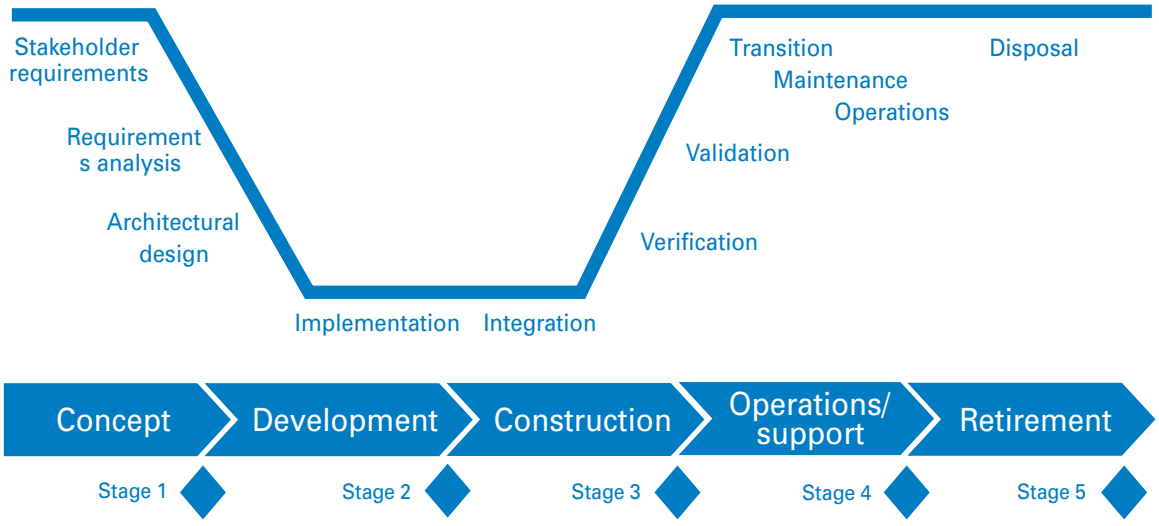



Figure 2: Generic Life Cycle, Stages and Processes

Figure 2 shows a typical Life Cycle that is made up of six Stages and that is based on the international standard ISO/IEC 15288. A Life Cycle may be applied to a System, Project, Acquisition, Programme, Technology and any number of other contexts and these Life Cycles often interact to form more-complex Life Cycles.

## Life Cycles, Processes and Stakeholders

Within each Stage of a Life Cycle, a number of Processes are performed. A Process describes an established approach to carrying out specific operations. Processes will typically be described by a set of things to do, known as 'Activities' and 'Tasks' which will result in certain 'Outcomes'.

Processes cover areas such as: Technical, Management, Organisational and Agreement. Typical Technical Processes include: Stakeholder Requirements, Requirements Analysis, Architectural Design, Implementation, Integration, Verification, Validation, Transition, Maintenance, Operations and Disposal. Although there is no single definition of which Processes will be executed in each Stage, Figure 2 shows typical Processes that may be executed.

In order to transit from one Stage to the next, a Gate must be passed, typically assessed using a review.

Stages within the Life Cycle are typically executed in an iterative rather than linear fashion. Also, Processes are typically executed in an iterative, rather than linear fashion within each Stage.

## Stakeholders and Competence

A Stakeholder describes the role of any person, organisation or external System that has an interest in the system under development. These Stakeholders are typically split into three broad categories: customer Stakeholders (such as end users, operators and sponsors), external Stakeholders (such as standards, laws and the environment) and supplier Stakeholders (such as managers and engineers).

Not only is identifying and understanding customer and external Stakeholder Needs critical, but the supplier Stakeholders also take responsibility for Processes that are executed during the Life Cycle Stages.

It is essential that each Stakeholder has the relevant skills, experience and attitude to carry out their activities. Therefore, each Stakeholder has a required Competence that may be defined, measured and assessed to assure that the Processes may be executed effectively and efficiently.

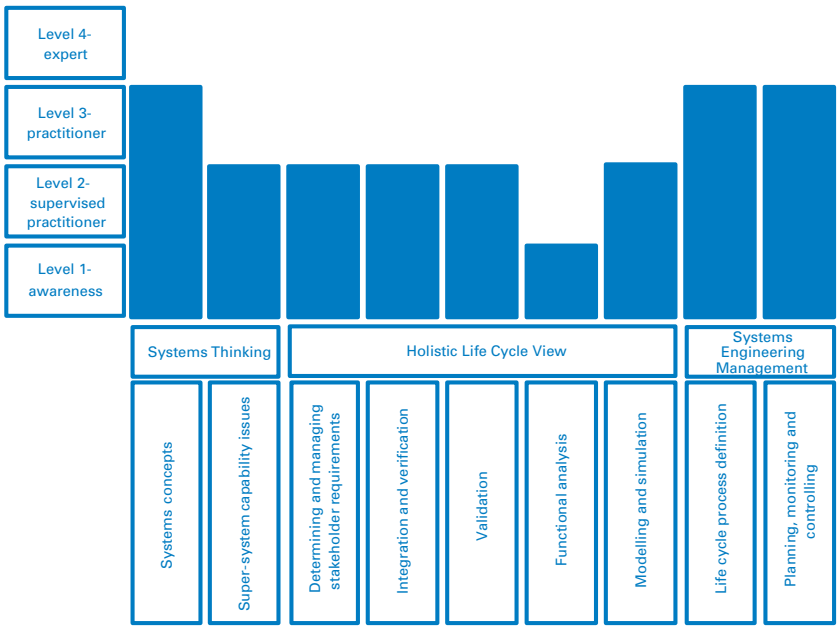
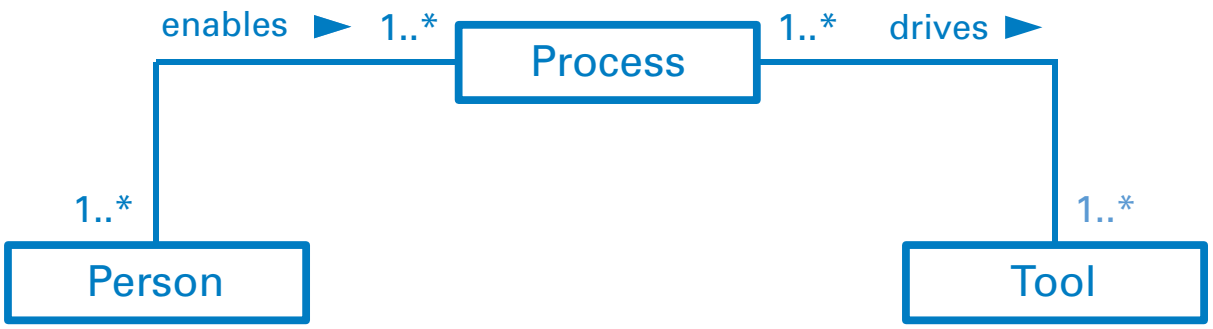



Figure 3: Example Competency scope

The INCOSE Systems Engineering Competency Framework identifies three fundamental areas of competency for Systems Engineers: Systems thinking (Systems Engineering within a context and understanding the system's environment), the holistic life cycle (the 'doing' of Systems Engineering throughout the lifecycle using processes) and Systems Engineering management (managing Systems Engineering using a process-driven approach). INCOSE defines four levels of competence: 'awareness', 'supervised practitioner', 'practitioner' and 'expert'. Figure 3 shows an example of a competency scope for a typical role, where different levels are required for the different competencies.

## Implementing Systems Engineering

In order to implement any Systems Engineering Approach effectively, it is essential to consider three main aspects.




Indeed, for advanced approaches, such as MBSE, these three aspects are essential in order to realise the full benefits of the approach.

**People**
By which we mean competent People with the appropriate skills, experience and attitude to perform the Systems Engineering. INCOSE has defined its own Competency Framework that may be used as a benchmark for an assessment. The People will enable the Process.

**Process**
By which we mean having an effective and efficient approach in place. This approach will include the definition and use of ontologies, frameworks, processes, guidelines and standards. Examples of well-established processes include those in ISO/IEC 15288 and the INCOSE Systems Engineering Handbook.

The Process will drive the need for Tools and is enabled by the People.

**Tools**
By which we mean anything that will help us to implement the process. This will include computer-aided tools, such as CASE Tools, but also modelling notations, modelling and analysis techniques, visualisation techniques and so on.
Very importantly, the selection and use of Tools should be driven by the Process and not the other way around, although enterprise factors are of course relevant.

## Trends and Indicators in Systems Engineering

There is a growing need and demand for Systems Engineering in today's industry, which is evidenced by the increased interest in INCOSE UK:

- In the last five years INCOSE UK membership has grown 21%. (See: 'Annex 2: Employers of INCOSE UK membership')
- Corporate membership of INCOSE UK has more increased by 65% in the last five years. (See: 'Annex 2: Employers of INCOSE UK membership')
- Systems Engineering is applied increasingly and effectively in a wide range of sectors including defence and aerospace, security, rail, infrastructure, civil aviation, automotive, telecoms and IT, as can be seen by the sectors represented by the INCOSE UK UKAB. (See: 'Annex 2: Employers of INCOSE UK membership')
- INCOSE UK has become a Professional Affiliate of the Engineering Council and formed a Professional Registration Agreement (known as buddying) with the Institution of Engineering and Technology (IET) to provide a route to Professional Registration for Systems Engineers.
- INCOSE UK has established a Memorandum of Understanding with the Association for Project Management (APM) in order to better understand and promote the synergies between Systems Engineering and project management through a Joint Working Group (See: 'Systems Engineering Professionalism')

The increased need for people with appropriate Systems Engineering knowledge, skills and experience (competence) is evidenced by:

- A marked increase in the number of universities offering Systems Engineering-related courses, and the course numbers themselves. (See: 'Systems Engineering in Academia')
- At least two thirds of the employers represented in INCOSE's UK Advisory Board are actively recruiting Systems Engineers, and investing in in-house competency assessment and skills development programmes. (See: 'Current state of Systems Engineering')
- The Royal Academy of Engineering is continuing its funding of Visiting Professorships at universities in Systems-level and cross-disciplinary engineering. This initiative is an experience-led education concept, whereby senior industrial engineers are appointed as Visiting Professors at specific universities. The main idea is to enrich the engineering undergraduate curriculum with the latest industrial technology and practices to enhance the quality and capabilities of UK engineering graduates. Seven schemes have been run to date, all of which have focused on promoting a particular aspect of engineering design, the fundamental discipline which underpins the wealth creating potential of all engineering innovations
- There has been an acute interest in professionalism for Systems Engineering, as displayed by the development of the INCOSE Systems Engineering Professional (SEP) certification and the route to Professional Registration that has been rolled out successfully in the UK. (See: 'Systems Engineering Professionalism')

Need for well-established and proven approaches. (See: 'Annex 1: Systems Engineering Standards, maturity models and guidance')

- The increased maturity and mutual consistency of Systems Engineering-related standards, such as: ISO/IEC 15288, CMMI, ISO/IEC/IEEE 42010
- The Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE) project has created The Guide to the Systems Engineering Body of Knowledge (SEBoK), a worldwide, open and living authoritative guide to Systems Engineering that is under the joint stewardship of the Systems Engineering Research Center (SERC), INCOSE, and the IEEE Computer Society (IEEE-CS)
- There is increased activity in maturing and embedding new approaches to implementing Systems Engineering, such as MBSE and the definition and adoption of systems-specific tailored approaches such as Lean, and Agile

The need for effective and efficient tools to support the approach and enable competences. (See: 'Annex 1: Systems Engineering Standards, maturity models and guidance')

- There has been an increase in the number and maturity of Systems Engineering-related architecture frameworks (AFs) such as MODAF, DoDAF, NAF.in the defence industry. New initiatives to rationalise industry-specific frameworks have also been developed, such as UPDM, IDEAS etc, and the emergence of non-industry-specific frameworks such as TRAK
- The previous proliferation of Model-Based Systems Engineering (MBSE) tools has become more rationalised over the last five years, with many tools providers converging on common platforms through corporate acquisitions and mergers
- Systems Engineering modelling tools are no longer being used in isolation and are increasingly being integrated with tools used in other parts of the business, such as management tools, product-line development tools, mathematical and simulation tools

**Perspective:**
*There has been a significant growth in the application of Systems Engineering in the last five years, as evidenced by the trends in the previous section. This has not only included industry but also the teaching of Systems Engineering in Academia.*

*Along with this growth we have also seen an increase in the maturity of Systems Engineering as is evidenced by the growth of new frameworks, techniques and tools that are being used in industry.*

*These trends are very encouraging but there is still a way to go. One area that can be enhanced is the dissemination of Systems Engineering to the wider community, including other related areas of industry, academia and indeed the general public. There is a need, therefore, for initiatives in outreach activities which are starting to be addressed by INCOSE UK in the form of the Academic Group and certain other outreach activities, such as Science Festivals and other public events.*

# 'Systems Engineering in the UK'

## Systems Engineering Professionalism

### Systems Engineering Career Paths

The idea of recognised career paths supporting those wishing to pursue a career in System Engineering is currently not well-established. This probably reflects the relative infancy of the profession as well as the diverse nature of those who take up such a career. However career opportunities in Systems Engineering for those from a variety of disciplines are increasing, directly reflecting the increasing complexity and inter-dependence of the many systems and associated services which now rule our lives.

Few practising systems engineers have formal qualifications in Systems Engineering, and many are not engineering graduates. Indeed some employers do not even recognise the role of 'Systems Engineer' even if they do fully recognise the need to perform System Engineering. For some individuals, being classified as a systems engineer would probably be an anathema since they would not feel themselves either to be either an 'engineer' or as working on a 'system'. There are also those who feel their role as 'designer' includes (as a subset of role) Systems Engineering skills that apply to part, but not the whole, of their job, and may feel that the Systems Engineering title weakens their role description These complexities further complicate the career path debate.

However some patterns do emerge and these are worthy of note. So for those performing 'Systems Engineering' as their day job, backgrounds often include physics, mathematics, operational research, a wide range of other sciences notably the cognitive sciences, biological sciences and system operation as well as a full range of engineering disciplines.

Many of these individuals would see a first career path step as acquiring professional registration through their original scientific or engineering discipline usually as a natural career development stepping stone in that discipline.

As a result of a recent partnership relationship with the IET, and in line with Engineering Council guidelines, INCOSE UK members who are not already IET members can take advantage of the IET mechanisms and processes for Professional Registration to become registered as a systems engineer through the IET. This is a significant step forward for systems engineers, and means that for the first time individuals who regard their 'home discipline' as Systems Engineering can become professionally registered. This initiative has proven very popular with INCOSE UKAB Organisations as well as with UK Chapter members.

The number of institutions offering a first degree in Systems Engineering remains small, but an increasing number of people are now entering (or re-entering) the workplace with post-graduate qualifications in Systems Engineering perhaps having returned to academic study after a number of years in the workforce. Opportunities exist for those wishing to develop their careers as Systems Engineers to sign-up for MSc, PhD, EngD courses or apprenticeship schemes often with significant support from an employer.

Opinions remain divided as to how effective 'direct entrants' in Systems Engineering are, especially when compared to an evolutionary approach where Systems Engineers emerge from the rest of the workforce having displayed a set of core behaviours and attitudes which we commonly associate with the discipline. Systems Engineering competence is best developed through the acquisition of 'real-world' (often bad) experiences. These experiences acts as a catalyst to those who 'think systems' and can ultimately lead to the individual (or organisation) recognising competence as a 'systems engineer' which then becomes the next career path step – from a discipline-specific role to Systems Engineering role.

Indeed as part of graduate development programmes employers will formalise this approach by putting potential systems engineers through a structured programme where they can experience different lifecycle phases, with the aim of separating those engineers who naturally respond in a manner recognisable as a 'systems engineer' from those who are more concerns with the acquisition of additional competence in their home discipline.

A number of research programmes are now underway to try to establish whether such Systems Engineering DNA exists. One of the key ongoing programmes is the Helix Research Programme, which is run by Stevens University in the USA. A number of organisations in the UK are considering whether to extend the programme to the UK population.

For the future, the ever-increasing complexity of systems spanning multiple non-traditional disciplines and with increasing socio-economic aspects will tend to widen the opportunities for the place of 'Systems Engineering' as a career path within many disciplines.

One challenge is a recognition now that many individuals who would be seen by INCOSE as performing Systems Engineering would not regard themselves as a systems engineer. Both the word 'system' and 'engineer' tend to create a barrier to the inclusivity across different domains which INCOSE strives for, preventing individuals from seeing the career opportunities that exist within Systems Engineering.

The challenge both for educator and employers will be to encourage them into areas where they can apply their skills quickly and effectively, and gain the practical delivery and domain experience required for them to become competent practitioners.

## Systems Engineering Competencies and Accreditation

In recent years the use of competences for management of all aspects of career development has increased significantly in the UK. This followed legislation aimed at eliminating (amongst other things) age discrimination in employment.

A key aim of the legislation was to ensure that requirements for a role was defined in terms of 'competence' rather than (say) '10 years of experience' with the knowledge that someone can perform a job for 10 years but perform the job badly for 10 years, i.e. never becoming competent, meaning that length of time performing a job is not an indicator of competence.

Following publication and adoption by UK Chapter member organisations, in 2011 INCOSE adopted the UK Chapter's 'Systems Engineering Competency Framework' formally as an INCOSE product. The Systems Engineering Competency Framework Version 3 and its companion Guide to Competency Evaluation have widened the audience for Systems Engineering competences.

The framework is used in a number of UK organisations applying Systems Engineering. Some organisations use it unmodified although the majority have tailored it or adapted it to fit with their organisational practices and methods.

INCOSE International has also developed a 'Systems Engineering Professional' certification programme which has now started to gain traction in the UK.

Currently three designations are available:

- ASEP – Associate Systems Engineering Professional, which is achieved by taking an invigilated on-line examination based on the INCOSE Systems Engineering Handbook; this is based in turn on the international standard ISO/IEC 15288, so is of international relevance
- CSEP – Certified Systems Engineering Professional, which in addition to the on-line examination requires a Bachelor-level technical degree and five years Systems Engineering experience (or additional experience in lieu of degree) endorsed by three competent systems engineers who know the candidate. The experience has to be both of appropriate breadth and depth. Again this qualification is potentially of international relevance
- ESEP - Expert Systems Engineering Professional, which requires nominally 25 years of experience (or 20 years if already a CSEP), endorsed by three competent systems engineers who know the candidate. Again, their experience has to be of appropriate breadth and depth to an expert in the profession. An ESEP is required to demonstrate both competence and significant leadership in the profession. Currently, ESEP candidates are not required to take the knowledge exam. However candidates undergo a rigorous competence-based telephone interview with three experienced Systems Engineering professionals, and in addition, their references are also interviewed

Although still most popular in the USA, following a slow start in the last couple of years there has been an increasing take-up of Certification accreditation by UK-based individuals. This probably reflects the increasing globalisation of markets and the wider recognition of Certification as a means to baseline competence in staff.

There has been historical confusion as to the relationship between Certification and Professional Registration. In particular, individuals are unsure as to which path makes sense for them. It is correct to say that these two designations are complementary, with significant overlap. In the INCOSE UK Chapter we are working with our partners in the IET and with INCOSE Central to try to improve the alignment of Certification through INCOSE with Professional Registration through the Engineering Council. Whilst not yet in place the belief is that at some future point individuals having CSEP (or ESEP) accreditation will be able to use this in support of their Professional Registration (as either CEng or IEng).

## Systems Engineering CPD (Continuing Professional Development)

As a Systems Engineer or Practitioner, CPD can help:

- Maintain or improve performance in your present role
- Equip you for the changing demands of your present role
- Equip you for a new role
- Equip you for a change in the tasks and responsibilities of your job
- Develop you towards higher level responsibilities
- Improve your flexibility within a team
- Enhance and complement your best talents

CPD has always been an obligation for systems engineers, but until recently this obligation was taken as 'unwritten' and many in the profession have survived their career with little or no formal Professional Development, beyond the 'on-the-job' development. Numerous systems engineers will confess that it has been many years since they either went on a training course, attended a seminar or read a relevant text book.

Lack of CPD beyond on-the-job training can often be down to limited support from their employer, or through a lack of personal motivation or indeed a belief that CPD will make little or no difference to either performance or career progression.

However, many employers do provide CPD using in-house resources, universities or commercial training providers, and ranging from half-day awareness courses to 2-year systems architect development programmes. Some of these in-house programmes are managed through rigorous adherence to competency frameworks, often derived more or less directly from the INCOSE SE Competency Framework.

Systems engineers use INCOSE and other Systems Engineering conferences and publications to develop their competencies though self-study. Some universities (including Cranfield, Bristol and Loughborough) provide modular short courses that can be optionally joined up to form a PG Cert or MSc.

Recently INCOSE UK has published policy and guidelines on CPD. These were generated in consultation with UKAB members and provide a number of more structured thoughts on good practice expected for systems engineers. This document provides the following list of potential items to be considered when those developing a personal CPD plan:

- Your employer's strategy
- Corporate and team business plans
- Legislation and statutory obligations
- Professional Registration CPD requirements
- Certification CPD requirements
- Business and team capability reviews
- Formal performance appraisals (DAP, PDR, PDP etc.)
- Introduction of new processes and tools
- Mapping your current skills, knowledge and attitudes to the INCOSE UK Competency Framework

The full CPD guideline document is available from the INCOSE UK website.

**Perspective**:

- *Few practising systems engineers have a formal qualification in the subject*
- *There are two traditional routes into Systems Engineering – engineers who grow into systems roles, and non-engineers who come in 'from the side'*
- *A third route exists in the form of graduates from Systems Engineering degrees.*
- *Individuals will tend to use Professional Registration (usually CEng but often IEng) and more recently INCOSE SE Certification as check-points in their career, and as such these can be regarded as career path development markers for those having Systems Engineering aspirations.*

# Systems Engineering and Academia

The 'Academic' section of this report covers education and research undertaken in UK academic institutions. These topics are critical to the continued development of Systems Engineering and their status gives a good 'litmus' test for the overall health of the discipline.

One difficulty in setting out the status of Systems Engineering in academia is that the subject addresses a range of fundamental issues and can therefore be found as a component of many broader courses, including science and engineering courses, computing courses and even business courses. This is particularly evident if related subjects, such as systems thinking, are included in scope. Hence, no attempt has been made to be comprehensive in this section – attention is focused primarily on 'specialist' Systems Engineering education and research.

## Academic activity within INCOSE UK

Those with academic affiliations are already well represented in the membership of INCOSE UK, including individual members and corporate members. An informal survey of the INCOSE UK membership indicated that just under 10% of members are associated with an academic institution. In total, 5.5% of the membership comprises student members. In addition, many industry-affiliated members also hold Visiting Professor posts or have other connections with specific universities.

There are currently five Academic institutions belonging to the UKAB:

- Cranfield University
- Loughborough University
- University College London
- University of Bristol
- University of Sheffield

These organisations feature strongly in the provision of education and training in Systems Engineering, as well as being active in Systems Engineering research (see below).

The INCOSE UK Council includes an Academic Director who acts as the focus for academic matters. He has recently established an Academic Team to act as a catalyst for change in relation to Systems Engineering in education and research. The Academic Team has four current themes that are being taken forward by their own sub-groups:

- Systems Engineering Research, whose aims are to: understand the extant UK research strategy and current programme focus; develop a view on collaborative research priorities, informed by industry; engage with funding bodies to promote views on priorities
- Linking Academia and Industry, whose aims are to: identify the community of potential academic/industry collaborators; capture case study and reference material for sharing by an appropriate mechanism; facilitate collaborative paper writing; facilitate industrial input to education/training
- Student Members, whose aims are to: survey student members to establish a viewpoint baseline; develop proposals for increasing the value of student membership; explore mature student needs; develop new engagement models/activities
- Schools, whose aims are to: understand the role of Systems Thinking in education; the national curriculum and specific Systems Engineering courses; survey what other professional bodies are doing; develop some standard education material; identify INCOSE members willing to brief to schools; solicit input for ASEC, Preview or other communications channels

The work of the Academic Team will directly inform future versions of the SEASON Report.

## Systems Engineering Education and Research

There is now a well-recognised picture in the UK economy of mismatch between supply and demand in Science Technology Engineering and Mathematics (STEM) skills generally, with demand outstripping supply in the engineering professions and across the whole economy [5, 6]. There is no reason to believe that Systems Engineering is different to the generality of engineering disciplines. In fact, there is some evidence that the demand for Systems Engineering may be even higher than the average – for example, a recent survey conducted by the Defence Growth Partnership (DGP) indicated that improving availability of high quality Systems Engineering skills was the highest priority for skills development across the Defence sector [7].

### Schools

The challenge for engineering education starts with primary and secondary education, where the teaching of engineering and the associated 'engineering habits of mind' are largely non-existent [2]. It is in principle possible for pupils to study 'Design and Technology: Systems and Control Technology' at GCSE and A Level – but anecdotally these courses do not seem to be offered by many schools/colleges, nor are they particularly popular. There are many Systems Engineering practitioners who were never formally educated as such but who came from other technical disciplines like physics or mathematics. Such 'transfers' into Systems Engineering may be at risk given the shortage of STEM skills in general.

Overall, the lack of understanding of Systems Engineering as a key subject area within schools is a major cause for concern. Traditional engineering subjects are understood by careers advisors and heads of disciplines within schools but without signposting Systems Engineering as a subject it is unlikely to be strongly considered during selection of University courses in preparing for sixth form and later during UCAS searches.

### Higher Education

In higher education the Engineering Council's accreditation requirements [7] have a strong influence on course design. Positively for Systems Engineering, the need for an integrated or systems approach to engineering problems is recognised, as are many other factors that would normally be thought of as core to Systems Engineering (such as the need to understand business and stakeholder needs, as well as effective communications with non-specialists).

Many of the better Systems Engineering programmes are accredited by Professional Institutes such as the IET, Royal Aeronautical Society and Institute of Measurement and Control. Each Institute undertakes a regular review of the curriculum and the environment in which programmes are taught. This means that graduating students will have attained the educational standards for Chartered or Incorporated Engineer.

### Undergraduate Education

At undergraduate level a search of UCAS and other websites (see Annex 3) reveals only two universities currently offering specialist Systems Engineering courses, namely Loughborough and the University of Sheffield. Until recently there had been a third establishment, Warwick University, which reportedly withdrew its courses due to a lack of applicants. There are, however, twenty six establishments (see Annex 3) offering undergraduate courses with Systems Engineering in their title. Additionally, there are numerous courses that provide exposure to a related topic (e.g. systems thinking) or a domain specific focus (e.g. energy systems), which we have not attempted to quantify.

### Postgraduate Education

At postgraduate level there is in 2014 a healthy selection (see Annex 3) of specific Systems Engineering and highly related courses resulting in MSc, PhD, EngD or other qualifications. The relative preponderance of higher degree courses, as compared to first degree courses, could suggest that Systems Engineering is still seen as a subject that is difficult to teach at undergraduate level and a profession that is best entered after gaining experience working in a traditional subject area. An alternative explanation is simply that students do not gain exposure to Systems Engineering at school and therefore do not opt to take Systems Engineering degrees.

### Apprenticeships

A recent relevant development is the government's promotion of apprenticeships to address skills gaps – for example the Defence Growth Partnership has announced 'a Trailblazer apprenticeship' in 'advanced Systems Engineering' at Level 7 (Level 7 of the Qualifications and Credit Framework (QCF) equivalent to a Master's degree).

### Postgraduate Education/Research

The picture presented in Annex 3 is, however, only a snapshot and there are already changes on the horizon, particularly in relation to EngD and PhDs. The EngD scheme, first established by EPSRC in 1992, was for PhD level students wanting to pursue a career in industry and had a very strong industry focus. The Industrial Doctorate Centres (IDCs) were a development of the EngD scheme and were funded in 2009 for a period of 5 years. In 2009 some 45 new Doctoral Centres were funded, of which 19 were IDCs.

As a result of the 2012 EPSRC call, a total of 115 Doctoral Centres have been funded [8], but none of these are IDCs. Currently there are 12 DCs having some connection with systems, and of these, several are relevant to Systems Engineering, including centres for complex systems, autonomous systems and specific types of systems (energy, infrastructure, computer, health):

- EPSRC and ESRC Centre for Doctoral Training in Quantification and Management of Risk & Uncertainty in Complex Systems & Environments
- EPSRC Centre for Doctoral Training in Robotics and Autonomous Systems (RAS)
- EPSRC Centre for Doctoral Training in Future Autonomous and Robotic Systems – FARSCOPE
- EPSRC Centre for Doctoral Training in Autonomous Intelligent Machines and Systems (AIMS)
- EPSRC Centre for Doctoral Training in Sustainable Infrastructure Systems
- EPSRC Centre for Doctoral Training in Wind and Marine Energy Systems
- EPSRC and MRC Centre for Doctoral Training in Mathematics for Real- World Systems
- EPSRC Centre for Doctoral Training in High Performance Embedded and Distributed Systems

Not only has funding been phased out from IDCs/EngD centres but funding for PhDs has also been removed from EPSRC research proposals. The only ways for PhDs to be funded now are via DTCs, CASE studentships, industry sponsorship or self-funded by the student.

Although these developments, including the loss of the IDCs/EngD centres and their natural link to industry, are a cause for concern [8], there does still appear to be a strong systems theme underpinning the current EPSRC programme.

## Publicly Funded Research

In the following paragraphs key research centres for Systems Engineering are identified and a brief summary is provided of their activities [9]. Note that whilst some research is undertaken in DTCs, arguably the greater proportion of research is undertaken by post-doctoral Research Associates, often as part of large projects funded across institutions or internationally.

Additional context to the UK research activity is provided by the latest EPSRC Grand Challenges, particularly Risk and Resilience in a Connected World. This is focused on Complex Systems and promotes the idea that systems engineers need to turn their attention to Complex Systems and Systems of Systems.

### Loughborough University

Loughborough has a number of research groups focusing on Systems Engineering and related topics:

- Engineering System of Systems (ESOS), point of contact: Prof Michael Henshaw
- System Architecture Group for Engineering (SAGE), point of contact: Prof Charles Dickerson
- Advanced VR Research Centre, point of contact: Prof Roy Kalawsky. Prof Kalawsky also leads the EPSRC UK Systems-NET. This network brings together leading Systems Engineering practitioners (industry and academia) to tackle SE issues of relevance to the Grand Challenges

### University of Bristol

Bristol has several research themes and numerous projects within its Systems Centre. Examples of current projects include: understanding Systems Engineering development systems; distribution of Systems Engineering project performance; game theoretic approach to security analysis. The research activities are organised into themes, as follows:

- Design and Integration of Complex Engineered Systems, point of contact: Prof Patrick Godfrey
- Developing Theory and Methodology in Systems Thinking and Application in Engineering Practice, point of contact: Dr Mike Yearworth
- Learning and Leadership in Engineering Organisations, point of contact: Prof John Davis
- Developing Advances in Studies of Security, Systems Resilience, Engineering Risk, Safety Critical Systems and Uncertainty Management, point of contact: Dr Theo Tryfonas

### University College London

The UCL Centre for Systems Engineering addresses both Systems Engineering and the management of technology projects across a number of sectors including space, transport and health. Its research themes include:

- Systems thinking, point of contact: Dr Michael Emes
- Technology risk management, point of contact: Dr Michael Emes
- Systems Engineering capability diagnostics, point of contact: Prof Alan Smith
- Front end of projects, point of contact: Prof Alan Smith
- Integrating Systems Engineering and project management, point of contact: Matt Whyndham
- Value-based Systems Engineering, point of contact: Dr Raul Leal

### Cranfield University

Systems Engineering research at Cranfield is multi-sector, with particular capabilities in the aerospace and defence domains. This includes recent multi-million pound investments in new research and innovation facilities and its lead role as the Academic Provider to the UK Ministry of Defence for science and engineering education and research. The strategic approach to Research, Development and Innovation (RDI) at the Centre for Systems Engineering has an over-arching objective to support the development of sustainable Resilient Systems. This is underpinned by a number of core areas of interest:

- Foundational Systems Engineering, point of contact: Dr Emma Sparks
- Organisational Systems Engineering, point of contact: Dr Emma Sparks
- Optimisation Drivers for sustainable resilience through life, point of contact: Dr Emma Sparks
- INCOSE Systems Engineering Body of Knowledge, point of contact: Dr Emma Sparks

### Newcastle University

In Computing Science at Newcastle, research and training is focused on the foundations, methods and tools for delivering dependable and trustworthy systems.

- Collaborative modelling, verification, simulation and implementation of Systems of Systems (SoSs) and Cyber-Physical Systems (CPSs), point of contact: Prof John Fitzgerald
- Increasing the capability of multidisciplinary co-modelling technology, point of contact: Prof John Fitzgerald
- Transitioning CPS design technology to the marketplace, point of contact: Prof John Fitzgerald
- Developing the Roadmaps and Transatlantic research agendas for CPSs, point of contact: Prof John Fitzgerald
- Developing formal techniques for development of energy-efficient, high-capacity and safe transport point of contact: Prof Alexander Romanovsky
- Formal analysis of complex evolving systems, point of contact: Prof Maciej Koutny

### York University

The High Integrity Systems Engineering group is concerned with the modelling, analysis, justification and certification of complex (computer-based) systems. Example subjects of interest include:

- Safety Case Development, point of contact: Prof Tim Kelly
- Dependability Cases, point of contact: Prof Tim Kelly
- Safety Certification of Systems of System, point of contact: Prof Tim Kelly
- Safety Requirements Engineering, point of contact: Prof Tim Kelly

### Birmingham University

The Railway Systems Department at the University of Birmingham hosts the Birmingham Centre for Railway Research and Education. Research interest include:

- System modelling and simulation, point of contact: Prof Clive Roberts
- Traffic management, point of contact: Prof Clive Roberts
- Fault detection and diagnosis, point of contact: Prof Clive Roberts
- Data collection and decision support, applied to railway traction, signalling, mechanical interactions and capacity, point of contact: Prof Clive Roberts

### University of Liverpool

The University's Institute for Risk and Uncertainty is dedicated to helping people and organisations create a safer world. The multidisciplinary research team includes experts from architecture, engineering, environmental sciences, financial and actuarial mathematics, computer science, electrical engineering and electronics, economics and finance, social sciences, psychology and law. Research interests include:

- The EPSRC and ESRC Centre for Doctoral Training (CDT) on Quantification and Management of Risk and Uncertainty in Complex Systems and Environments, point of contact: Prof Mike Beer
- Multi-/inter-disciplinary problems of risk and uncertainty, point of contact: Prof Mike Beer

### Warwick University

The University has numerous systems related programmes, including those within the Warwick Manufacturing Group (WMG). A selection is described below.

- Complex Electrical Systems Group (Automotive), point of contact: Prof Gunny Dhadylla
- The Institute of Digital Healthcare's, point of contact: Prof Gunny Dhadylla
- WNG's Cyber Security Centre, point of contact: Prof Gunny Dhadylla

### City University

The Software and Systems Engineering research group investigates fundamental theories, methods and technologies related to the development of complex socio-technical and software intensive systems and the assessment and verification of critical qualities of such systems. In particular, they are focusing on:

- The evaluation, assurance and certification of the dependability, safety and security of complex socio-technical systems, including critical infrastructures, point of contact: Prof George Spanoudakis
- The investigation of the fundamental principles and technologies supporting creativity in system requirements and design, point of contact: Prof George Spanoudakis
- The development of adaptive service oriented systems, point of contact: Prof George Spanoudakis

### University of Sheffield

The Department of Automatic Control and Systems Engineering is the largest department in Europe dedicated to the study of control and Systems Engineering. The department conducts research along three strategic themes: Complexity, Intelligence and Autonomy, in the following four cross-cutting application areas:

- Aerospace and Transport, point of contact: Prof MA Balikhin
- Life Sciences and Healthcare, point of contact: Prof D Coca
- Energy and Environment, Manufacturing, point of contact: Prof V Kadirkamanathan
- Robotics, point of contact: Prof M Mahfouf

# Systems Engineering and the Wider Picture

This section discusses three main questions:

- What is Systems Engineering?
- How do we describe a Systems Engineer?
- Is Systems Engineering 'just common sense' or core skills for all engineers.

These questions illustrate a significant scope and branding issue for Systems Engineering worldwide, and one that faces most systems engineers much of the time. The issue centres on whether Systems Engineering is a distinct discipline or an engineering approach that can be seen as a core skill and thus us used in part by many people who are not identified as systems engineers. Coupled with the fact that many Systems Engineering roles focus on a narrow subset of process areas, it makes any answer apart from 'it depends' quite difficult.

The Royal Academy of Engineering document 'Creating Systems That Work' suggests that there is a continuum from a single discipline engineer who has to work in multidisciplinary team, through an engineer who designs integrated systems, to one who specialises in the systems aspects and is called a systems engineer. Interpretations of the definition of Systems Engineering range from 'a holistic approach to the creation of successful systems' to a 'systematic process for technical project management' to 'application of Systems Thinking to engineering'.

This justifiable difference of opinion (each of which may be quite valid in their own particular context) makes comparisons difficult, and even comparisons across different parts of the same company. Thus when, as for example with the US Department of Defense, the use of 'Systems Engineering' is mandated there has to be a careful consideration of what that means.

The range of interpretation and definition of Systems Engineering is inherent to the nature (including near universal applicability) of Systems Engineering. Initial INCOSE meetings could come up with no unique definition of Systems Engineering, as every situation where Systems Engineering can be applied requires a bespoke application. Therefore Systems Engineering has to be recognised as an underlying approach, to be applied in a specifically appropriate way, to any difficult problem situation where unwanted emergence is otherwise highly probable. This is supported by one of the 'imperatives' from the INCOSE Systems Engineering Vision 2025 that states that the development of Systems Engineering must 'embrace and learn from the diversity of Systems Engineering approaches'.

The UK has its own distinctive heritage of Systems Engineering. The air defence system that controlled the Battle of Britain was the first integrated 'networked system', and remains an exemplar of the type. The discipline of Operational Research was developed during WW2 to apply systems thinking and quantitative methods at a national and strategic level to optimise many aspects of the war effort [1]. 'Soft Systems Methodology' was developed in the UK, pioneered by Peter Checkland (an INCOSE Pioneer) during the 1970s, to find better ways to design systems to serve human and organisational purposes. Derek Hitchins, the first president of the UK Chapter of INCOSE and also an INCOSE Pioneer, has been hugely influential in shaping the thinking of the current generation of UK systems practitioners and is recognised internationally.

The UK Systems Engineering community is significant on an international level. INCOSE UK has almost 10% of the worldwide INCOSE membership and has consistently been one of the most active and top performing INCOSE Chapters worldwide. This was recognised by the receipt of INCOSE President's award for 'outstanding contribution to INCOSE' at the INCOSE International Symposium 2014, and on three previous occasions.

There is a healthy UK representation in the number and quality of papers presented at conferences such as the INCOSE International Symposium and the Conference for Systems Engineering Research (CSER), and in international activities such as the Body of Knowledge and Curriculum to advance Systems Engineering (BKCASE) project.

Industrially, the UK is very successful worldwide in securing major infrastructure contracts. There is however a persistent belief that we 'can't do major projects' at home – a perception exacerbated by the negative press coverage on issues such as the Millennium Dome, the teething problems with Heathrow Terminal 5, and any problems in major Government IT and defence programmes.

There remains an open market for systems integration in UK Government acquisition. This should be a good thing in terms of allowing the UK to access the best systems integration capabilities worldwide. However it places a very heavy demand on the Systems Engineering capabilities of Government to intelligently choose between and manage such a diverse range of suppliers. Recruiting and developing systems engineers with a broad and challenging enough career path is proving a significant challenge in Government.

The engagement with Systems Engineering is becoming much broader that the traditional applications in defence, aerospace and software. This is reflected by the broadening membership of INCOSE, with increasing engagement from domains such as: rail, automotive, power and energy, other manufacturing domains and healthcare.

Within the UK various professional bodies are engaged, as summarised below:

Royal Academy of Engineering: The Royal Academy of Engineering is committed to furthering the development of engineering at the heart of policy making. Its reports, ranging for 'Creating Systems that work' (2007)[2] and on education, 'Thinking like an Engineer' (2014)[3] consistently, and independently from INCOSE, support the critical importance of the Systems Engineering approach to successful engineering in the UK [4].

The Engineering Council: the Engineering Council is aware of the need for better coverage of Systems Engineering as a skill that is relevant, though not necessarily core, to many of its members and affiliates. INCOSE UK is a Professional Affiliate of the Engineering Council, and was involved in the consultation for the 2013 update to the UK-SPEC for engineering professional registration.

The Science Council: Many Systems Engineers were educated as Physicists and some aspects of complexity science are key to the successful design and operation of very large-scale complex systems. The Science Council's web site gave no hits for 'Systems Engineering' and only two for 'systems'.

Professional Engineering Institutions (PEI): Many systems engineers whose career path started in a single discipline remain members of PEIs, for instance the Institution of Engineering and Technology (IET) or BCS, The Chartered Institute for IT.

Association of Project Managers (APM) – INCOSE UK is collaborating with the APM to explore the synergies and common ground between programme management and Systems Engineering practice. Internationally, INCOSE has a similar relationship with the Project Management Institute (PMI).

Other bodies with interests relating to Systems Engineering include the System Dynamics Society, the Design Society, the Operational Research Society, NAFEMS (The International Association of the Engineering Modelling, Analysis and Simuation) and the International Centre for Compex Project Management.

In the UK recent developments in public research strategy, such as the formation of the Transport Systems Catapult, Aerospace Technology Institute, the Defence Growth Partnership (who in July 2014 announced the development of a Trailblazer Advanced Apprenticeship in Systems Engineering), EPSRC (whose 2014 Engineering Grand Challenges include 'Risk and Resilience in a Connected World'). The pronouncements of the various Professional Bodies discussed above show recognition of the need for application of Systems Engineering and the potential for meaningful action to improve the state and application of Systems Engineering in the UK. UK industrial strategy places an emphasis on high 'value-add' – there is evidence that it is recognised that Systems Engineering is a key element in achieving this.

**Perspective:**
*From international discussions, exchanges and soft benchmarking we believe that UK is comparable with the other leading nations in the application of Systems Engineering. There is room for improvement in how we in the UK develop our systems knowledge and capability and convert them into business outcomes. There is a need for more systems awareness across the whole engineering, project management and commercial community, and for a more consistent professional identity for systems engineers and systems-trained professionals.*

*There is evidence (e.g. from the balance of INCOSE individual and corporate membership worldwide) that the range of domains and organisations actively seeking a Systems Engineering capability is increasing. This increasing demand will further exacerbate the shortage of skilled systems engineers.*

*So the situation can be summarised as one of potential. There is a growing recognition and tentative uptake of Systems Engineering in the UK. The key objectives are:*

- *Increased recognition and acceptance of the applicability of Systems Engineering to a large range of domains – and recognising the need to adapt to the specific needs of the domain.*
- *Improving the general academic underpinning of the theory, principles and means of application of Systems Engineering, and to drive advances in the tools and methods to address complexity.*
- *Improving the level of training and education in Systems Engineering – from the broadest scope ('Thinking like an Engineer') to wider range of courses (academic and vocational) for specialist systems engineers – addressing the potential short fall in skilled systems engineers.*

*The danger is that if the first objective is achieved without the second or third then there will be unsatisfied demand for the application of effective System Engineering. The UK is no better placed than other countries to achieve these challenges - failure by the UK will mean a gradual erosion of our level of 'high value' adding work. It is INCOSE UK's role to maintain a holistic view of this situation, and to focus effort and attention where it is most needed.*

# Appendices

# Annex 1: Systems Engineering Standards, Maturity Models and Guidance

## Standards

'ISO 9001:2008 Quality management systems — Requirements', International Standards Organisation, 2008

'ISO/IEC 15288:2008 Systems and software engineering – System life cycle processes'. International Organisation for Standardisation, 2008

'Systems and software engineering — Architecture description ISO/IEC/IEEE 42010'. Website for ISO 42010 (based on original IEEE 1471:2000): http://www.iso-architecture.org/ieee-1471/cm/ (Accessed November 2011)

## Maturity Models

'CMMI for Development, Version 1.3' CMMI-DEV (Version 1.3, November 2010). Carnegie Mellon University Software Engineering Institute. 2010. Retrieved 16 February 2011

ISO 15504, Software Process Assessment, Parts 1-9,

ISO/IEC 14291 – capability maturity model for assessing against ISO 15288

## Handbooks and Guidance

'Systems Engineering Guide for Systems of Systems' Office of the Under Secretary of Defense, USA DoD, August 2008

INCOSE. 'Systems Engineering Handbook - A Guide for System Life Cycle Processes And Activities'. Version 4, INCOSE; 2015

INCOSE Systems Engineering Competency Framework, http://incoseonline.org.uk/Documents/Groups/UKChapter/SE_Competencies_Framework_v2_200611.pdf (accessed October 2014)

'Survey of architecture framework' http://www.iso-architecture.org/ieee-1471/afs/frameworks-table.html (accessed October 2014)

DoDAF Architectural Framework, version 1.5, 2007

The Ministry of Defence Architectural Framework, 2010: https://www.gov.uk/mod-architecture-framework (Accessed October 2014)

NATO Architectural Framework version 3, 2007 http://nafdocs.org/ (Accessed October 2014)

SEBoK, Pyster, A., D. Olwell, N. Hutchison, S. Enck, J. Anthony, D. Henry, and A. Squires (eds). 2012. Guide to the Systems Engineering Body of Knowledge (SEBoK) version 1.0.1. Hoboken, NJ: The Trustees of the Stevens Institute of Technology ©2012. http://www.sebokwiki.org (accessed October 2014)

The Open Group Architectural Framework (TOGAF), version 9: http://www.opengroup.org/architecture/togaf9-doc/arch/ (Accessed October 2014)

'TRAK – Enterprise Architecture Framework', http://trak.sourceforge.net/ (accessed October 2014)

UPDM, Unified profile for the Department of Defense Architectural Framework (DoDAF) and the Ministry of Defence Architectural Framework (MODAF), OMG Standard, 2011: http://www.omg.org/spec/UPDM/ (Accessed October 2014)

## Wider Awareness

[1] Hall, AD (1962), A Methodology for Systems Engineering (Princeton: Van Nostrand)

[2] 'Creating systems that work', Royal Academy of Engineering, 2007

[3] 'Thinking like an engineer - implications for the education system', Royal Academy of Engineering, May 2014

[4] 'Educating engineers to drive the innovation economy', Royal Academy of Engineering, 2012

[5] Harrison, M. (2012) Jobs and Growth: the importance of engineering skills to the UK economy. London: Royal Academy of Engineering.

[6] Department for Business, Innovation and Skills (2013) Professor John Perkins' review of engineering skills. London: BIS.

[7] Defence Growth Partnership (2014) Delivering Growth: Implementing the strategic vision for the UK Defence Sector. DGP.

[8] Lucas, B., Hanson, J. and Claxton, G. (2014) Thinking like an engineer: Implications for the education system. London: Royal Academy of Engineering.

[9] http://www.engc.org.uk/engcdocuments/internet/Website/Accreditation%20of%20Higher%20Education%20Programmes%20third%20edition%20(1).pdf

## Academic Links

### Calls

http://www.epsrc.ac.uk/newsevents/pubs/engineering-grand-challenges/

http://www.epsrc.ac.uk/funding/calls/engineeringgrandchallenge/

http://www.raeng.org.uk/grants-and-prizes/support-for-education-and-study/schemes-for-people-in-industry/visiting-professors-in-innovation#sthash.ezqX84Jo.dpuf

### Departments and Groups

Loughborough University: http://www.lboro.ac.uk/departments/eese/research/systems/

University of Bristol: http://www.bristol.ac.uk/eng-systems-centre/

University College London: http://www.ucl.ac.uk/syseng

Cranfield University: http://www.cranfield.ac.uk/courses/masters/systems-engineering-for-defence-capability.html

Newcastle University: http://www.ncl.ac.uk/computing/research/

York University: http://www.cs.york.ac.uk/hise/

Birmingham University: http://www.birmingham.ac.uk/research/activity/railway/research/systems-engineering.aspx

University of Liverpool: http://www.liv.ac.uk/risk-and-uncertainty/

Warwick University: http://www2.warwick.ac.uk/fac/sci/wmg/

City University: http://www.city.ac.uk/department-computer-science/software-and-systems-engineering

Sheffield University: https://www.sheffield.ac.uk/acse/index

# Annex 2: Employers of INCOSE UK membership

| | | |
|---|---|---|
| Organisations employing at least one member | 211 | |
| Of which the top 15 by individual membership are: | | |
| Thales | 37 | |
| Atkins | 32 | |
| BAE Systems | 31 | |
| AWE | 21 | |
| DSTL | 21 | |
| Rolls Royce Plc | 20 | |
| QinetiQ | 18 | |
| Parsons Brinckerhoff | 16 | |
| Network Rail (UK) | 15 | |
| Lockheed Martin | 14 | |
| Babcock | 11 | |
| Loughborough University | 11 | |
| MOD | 11 | |
| Purple Secure Systems Ltd | 10 | |
| Airbus UK | 8 | |
| Total | 276 | |
| 31% of INCOSE UK membership is employed by the 'top 15' organisations | | |
| Total members on date of sample | 882 | |
| Number who gave no allegiance | 163 | |
| Number who gave an allegiance | 719 | |
| Of which: | | |
| Government | 52 | 6% |
| Universities | 47 | 5% |
| Rest | 783 | 89% |

## All Employers of INCOSE UK Membership Excluding 'Top 15'

3SL Inc
Abbott Risk Consulting (ARC) Ltd
ACPM Ltd
Actica Consulting Ltd
AECOM
Aero Engine Controls
Aker Solutions UK
Alstom Grid PES
ALTRAN UK
Amec
Apogee Consulting Ltd
Appledore Associates (UK) Ltd
Arbutus Technical Consulting Ltd
ARCADIS
Astrium Ltd
Atego
Atlas Elektronik UK Ltd
Balfour Beatty
Birmingham Centre for Railway
BMT Defence Services
BMT Sigma Ltd
Boeing Defence UK Ltd
Bombadier Transportation LUPD
Bombardier Transportation UK Ltd
Bournemouth University
Brasec
Burge Hughes Walsh Partnership
Buro Happold Ltd
C4 Systems Ltd
Callis
Callisto Consulting Ltd
CASSIDIAN UK
Central Government
Ceres Power
CGI UK
Chemring Technology Solutions (EOD)
Chester Brown Ltd
City University
Cleave Systems Ltd
Clifton Suspension Bridge
CLS Services
Colin Hood Systems Engineering Ltd
Com Dev International Systems
Control & Dynamics Ltd
Cranfield University
CSC
Cubic Transportation Systems Ltd
Dashwood Consulting
Dassault Systemes UK Ltd
DE&S MoD
Defence Equipment & Support
Defence Science and Technology Laboratories
Delphi Diesel Systems
Detica
Devonport Royal Dockyard Limited
Domino UK Ltd
Dot-The-Eye Ltd
Dowty Propellers (GE Aviation)
e2v
EADS Astrium Ltd
EADS
Eclectica Systems Ltd
Elite Consulting Ltd
Energy Technologies Institute
Eurofighter GmbH
European Space Agency
Eurostep Ltd
EziLogic Ltd
Faithful+Gould
FCO
Finmeccanica
Frazer-Nash Consultancy Ltd
Fujitsu
Furse Associates Ltd
GCHQ
GEC Marconi Avionics
General Dynamics IS&T Arabia
General Dynamics UK Ltd
General Electric
GHD
Glasgow Caledonian University
GlaxoSmithKline
Gutteridge, Haskins & Davey
Halcyon Rail Ltd
Halliburton Drilling and Services
Hana Associates
Harding-Hall Ltd
HARGO Consulting Ltd
Harmonic Ltd
Hewlett Packard
HS2 Ltd
HMGCC
Home Office
HYTSIO ABOA LTD
IBM
icklefrog Consulting Ltd
IET
iKnowledge Imetrum Ltd
IMI Webber
Imperial College London
Incolumis Ltd
INCOSE UK Chapter
Indra Sistemas S.A.
INSYSCO Ltd
Integrate Systems Engineering Ltd Intelligent Energy Interactive Systems & Business Consulting
Invensys Rail
iota7
ISS BATCIS
ITP ENGINES UK LTD
J P Kenny Ltd
J+S Ltd
Jacobs Sula
Jaguar Land Rover Ltd
JGD Projects Limited
John Boardman Associates Ltd
Johnson and Johnson
KACST
KPIT Infosystems Ltd
L-3 TRL Technology Ltd
Langsfords Ltd
Laser Know How Ltd
LifeScan Scotland Ltd
Lister Technical Services Ltd
Lloyd's Register
LMUK Ampthill
Logica
London Underground Ltd
LSC Group Ltd
Mace Requirements
Magnamosaic Ltd
Managed Complexity Ltd
Manna Solutions Ltd
Mary McKinlay Projects Ltd
Mass Consultants Ltd
MATRA BAE DYNAMICS, Ltd
MBDA UK Ltd
McLaren Applied Technologies
Meggitt Avionics
MetaWave Video Systems Ltd
Mike Hughes Associates Ltd
MirvSys Ltd
Modica Partnership Ltd
Mott MacDonald Ltd

Murdoch Associates
NATS Ltd
Natural Integration Ltd
Naval Engineering Test Establishment
NBPT (Mids) Ltd
Neil Clarke Systems Engineering Ltd
Newcastle University
Nigerian National Petroleum Corporation
NiteWorks
Northrop Grumman
Numerate Consultants Ltd
Object Flow Limited
Objektum Solutions Ltd
Omflow Ltd
Operativ Ltd
Optima Systems Consultancy Ltd
Optos Plc
Ove Arup & Partners Ltd
PA Consulting Group
PARKER HANNIFIN
Pazcat Ltd
Performance Systems and Methods
Persides Consultancy Services Ltd
PGS EM Ltd
Plymouth City Council
Poyner Consulting Ltd
Protean Electric Ltd
Provantage Ltd
QCC Abu Dhabi
Quintec Associates Ltd
Rail Safety and Standards Board
RAL Space
Raytheon UK
Reaction Engines Ltd
Realising Systems Ltd
Robert Briggs & Associates Ltd
Rockwell Collins (UK) Ltd
Roke Manor Research Ltd
Russell Cox Systems Engineering Ltd
SA Capabilities Ltd
Safran Power UK
Samsung C&T
Seframe Ltd
Serco Shell Nigeria E & P Company (SNEPCo) Ltd
Siemens
Sillitto Enterprises
SIMULABS LIMITED
SL Systems Consulting Ltd
SMT (Staff Management Tools) Ltd Sofintsys Ltd
Square Kilometre Array Project Development
STFC-Rutherford Appleton La.
Storm EMC Services Ltd
Subsea 7
Supersonic Systems Ltd
Sustain Ltd
SW Dynamics Ltd
Swasivious Systems Ltd
Sydac Ltd
Symtech Ltd
Synoptix Ltd
SyntheSys Systems Engineers Ltd
System Consultant Services Ltd
System Dependability Ltd
Systemic Consult
Systems Consultants Services Ltd
Systems Engineering & Assessment Ltd
Systems Ergonomics Ltd
Technical Programme Delivery
Telaugos Solutions Ltd
Telelogic DOORS UK Ltd
Tesla Engineering
The Defence Academy
The Mathworks Ltd
The Real Time Data Co Ltd
Thermal Design Solutions Ltd
Thomson Racal Denfence Ltd
Tobias Jones Consulting Ltd
TopQuadrant
Transport for London
TRW Conekt
UK AC
Ultra Electronics
Univeristy of Oxford, Department of Physics
University College London
University of Birmingham
University of Bristol
University of Derby
University of Hertfordshire
University of Leeds
University of Manchester
University of Sheffield
University of Southampton
University of the West of England
University of York
University of Bristol Dstl
Upkeep Systems Engineering Ltd
URS Infrastructure & Environment UK Ltd
UTAS Actuation Systems
UTC Aerospace Systems
Vaisala Ltd
Vectra Group Ltd
Visteon UK Ltd
Visure
Waters Corporation
Weir Strachan & Henshaw
WoodGroupKenny Ltd
Woomerang Research
WSP Group
Xyratex Ltd

# Annex 3: INCOSE UK UKAB

The UKAB provides a forum for UK Systems Engineering organisations (within industry, government and academia) to influence the activities that INCOSE UK undertakes, and the Systems Engineering good practice that INCOSE UK promotes.

The UKAB was established in order to bridge the identified gap between INCOSE UK and the employers of its membership. The purpose of the UKAB is to allow UK Systems Engineering Enterprises (Industry, Government & Academia) to have their say in influencing the practice of Systems Engineering and to see directly the benefits of INCOSE UK.

The formation of the UKAB was also to stimulate the support of INCOSE UK working groups as this was seen as providing an executive arm for groups like the Royal Academy of Engineering (RAEng) and the Department of Trade and Industry Systems Engineering National Advisory Committee (DTI SE NAC). The executive arm could provide worked solutions to the issues these groups were raising and trying to address with very busy senior people.

Altran
ATKINS
AMEC
AWE
BAE SYSTEMS
BMT Hi-Q Sigma
Cranfield University
Defence Equipment and Support (DE&S)
Dstl
Frazer-Nash Consultancy Ltd
GCHQ
General Dynamics UK Ltd
Harmonic Ltd
HMGCC
IBM Software Group
Jacobs UK Limited
Jaguar Land Rover Limited
Lockheed Martin
Loughborough University
MBDA
Messier-Bugatti-Dowty
MIRA Ltd
Network Rail
Parsons Brinckerhoff
Purple Secure
QinetiQ
Raytheon UK
Rolls-Royce
SA Capabilities
Selex ES Ltd
Serco Ltd
Synoptix Limited
Thales
Ultra Electronics
University of Bristol
University College of London
University of Sheffield

# Annex 4: Systems Engineering and related courses in UK Universities

## 'Systems Engineering' Courses available in 2014

| University | University Code | Course Title | UCAS Course Code | Type |
|---|---|---|---|---|
| **Undergraduate Systems Engineering Courses (BEng/MEng)** | | | | |
| Loughborough University | L79 | Systems Engineering | H641 | 5Yr MEng Sandwich |
| Loughborough University | L79 | Systems Engineering | H660 | 4Yrs MEng |
| Loughborough University | L79 | Systems Engineering | H652 | 3Yrs BEng |
| University of Sheffield | S18 | Systems and Control Engineering | H660 | 4Yrs MEng |
| University of Sheffield | S18 | Systems and Control Engineering | H690 | 3Yrs BEng |
| **Post Graduate Systems Engineering Courses** | | | | |
| City University London | | Systems and Control Engineering | | MSc (1 Year) |
| Cranfield University | | Military Electronic Systems Engineering | | MSc (4 Years) |
| Imperial College London | | Systems Engineering and Innovation | | MSc (1 Year) |
| Kingston University | | Engineering Projects & Systems Engineering | | MSc (3 Years) |
| Lancaster University | | Smart Systems Engineering | | MSc (1 Year) |
| Leeds University | | Embedded Systems Engineering | | MSc (1 Year) |
| Loughborough University | | Systems Engineering | | MSc (4years) |
| Newcastle University | | Mechanical and Process Systems Engineering | | PhD / MPhil |
| University College London | | Environmental Systems Engineering | | MSc (1 Year) |
| University College London | | Systems Engineering Management | | MSc (1 Year) |
| University of Bath | | Systems Engineering | | EngD (4 Years) |
| University of Birmingham | | Railway Systems Engineering and Integration | | MSc (1 Year) |
| University of Bolton | | System Engineering & Engineering Management | | MSc (1.5Years) |
| University of Bristol | | Systems (Doctorate) | | EngD |
| University of Portsmouth | | Communication Systems Engineering | | MSc (1 Year) |
| University of Reading | | Research Systems Engineering | | MRes (1 Year) |
| University of Southampton | | MSc Space Systems Engineering | | MSc (1 Year) |
| University of Surrey | | Process Systems Engineering | | MSc (3 Years) |
| University of York | | Digital Systems Engineering | | MSc (1 Year) |
| University of York | | Safety Critical Systems Engineering | | MSc |
| University of South Wales | | Energy Systems Engineering | | MSc (1 Year) |
| Warwick University | | Manufacturing Systems Engineering | | MSc (4 Years) |
| **Systems Engineering Short Courses** | | | | |
| University College London | | Systems Thinking | | Short Course - 6 Days |
| University College London | | Systems Engineering | | Short Course - 36.5 Days |
| Cranfield University | | Systems Engineering for the 21st Centry | | Short Course |
| Cranfield University | | Applied Systems Thinking | | Short Course |

## 'Other' Courses Available in 2014 with Systems Engineering in Title

| University | University Code | Course Title | UCAS Course Code | Type |
|---|---|---|---|---|
| **Other Courses** | | | | |
| Bangor University | B06 | Computer Systems Engineering | H617 | 4Yrs MEng |
| Bangor University | B06 | Computer Systems Engineering | H612 | 4Yrs BEng |
| Bangor University | B06 | Computer Systems Engineering | H603 | 4Yrs Bsc |
| University of Bath | B16 | Computer Systems Engineering | GH46 | 3Yrs BEng |
| University of Bath | B16 | Computer Systems Engineering | HG64 | 4Yrs MEng |
| University of Bath | B16 | Computer Systems Engineering | GHK6 | 4Yr BEng Sandwich |
| University of Bath | B16 | Computer Systems Engineering | HGP4 | 5Yr MEng Sandwich |
| University of Bedfordshire | | Computer Systems Engineering | H650 | 3Yrs BEng |
| University of Birmingham | B32 | Computer Systems Engineering | H604 | 4Yrs MEng |
| University of Birmingham | B32 | Computer Systems Engineering | H602 | 3Yrs BEng |
| University of Birmingham | B32 | Computer Systems Engineering | HP50 | 5Yr MEng Sandwich |
| University of Birmingham | B32 | Computer Systems Engineering | H6N0 | 4Yr BEng Sandwich |
| Brunel University | B84 | Computer Systems Engineering | G600 | 4Yrs MEng |
| Brunel University | B84 | Computer Systems Engineering (Networks) | G421 | 3Yrs BEng |
| Brunel University | B84 | Computer Systems Engineering | GH56 | 3Yrs BEng |
| Brunel University | B84 | Computer Systems Engineering (Networks) | G4N6 | 4Yr BEng Sandwich |
| Brunel University | B84 | Computer Systems Engineering (Software) | G603 | 3Yrs BEng |
| City University London | C60 | Computer Systems Engineering | H601 | 4Yr BEng Sandwich |
| City University London | C60 | Computer Systems Engineering | H600 | 3Yrs BEng |
| Coventry University | C85 | Aerospace Systems Engineering | H410 | 4Yr BEng Sandwich |
| Coventry University | C85 | Aerospace Systems Engineering | H410 | 3Yrs BEng |
| University of East Anglia | E14 | Computer Systems Engineering | HG65 | 3Yrs BEng |
| University of East Anglia | E14 | Computer Systems Engineering | HG6M | 4Yr BEng Sandwich |
| University of Essex | E70 | Computer Systems Engineering | H650 | 3Yrs BEng |
| University of Essex | E70 | Computer Systems Engineering | HP50 | 4Yr BEng Sandwich |
| Glasgow Caledonian University | G42 | Computer and Electronic Systems Engineering | IH17 | 4Yrs Bsc |
| Glasgow Caledonian University | G42 | Computer and Electronic Systems Engineering | IH16 | 4Yr BEng |
| Glasgow Caledonian University | G42 | Mechanical Electronic Systems Engineering | H361 | 6Yr MEng Sandwich |
| Glasgow Caledonian University | G42 | Mechanical Electronic Systems Engineering | H361 | 5Yrs MEng |
| Glasgow Caledonian University | G42 | Mechanical Electronic Systems Engineering | H360 | 4Yrs BEng |
| University of Hertfordshire | H36 | Aerospace Systems Engineering | H431 | 4Yrs MEng |
| University of Hertfordshire | H36 | Aerospace Systems Engineering | H430 | 3Yrs BEng |
| University of Hertfordshire | H36 | Aerospace Systems Engineering | H430 | 4Yr BEng Sandwich |
| University of Hertfordshire | H36 | Aerospace Systems Engineering | H431 | 5Yr MEng Sandwich |
| University of Huddersfield | H60 | Computer Systems Engineering | H6G4 | 4Yr BEng Sandwich |
| University of Huddersfield | H60 | Computer Systems Engineering | H6G4 | 3Yrs BEng |

## 'Other' Courses Available in 2014 with Systems Engineering in Title

| University | University Code | Course Title | UCAS Course Code | Type |
|---|---|---|---|---|
| **Other Courses** | | | | |
| University of Hull | H72 | Computer Systems Engineering | H606 | 4Yrs MEng |
| University of Hull | H72 | Computer Systems Engineering | H600 | 4Yrs Bsc |
| University of Hull | H72 | Computer Systems Engineering | H650 | 4Yr Bsc Sandwich |
| University of Kent | K24 | Computer Systems Engineering | H613 | 4Yrs MEng |
| University of Kent | K24 | Computer Systems Engineering | H618 | 3Yrs BEng |
| University of Kent | K24 | Computer Systems Engineering | H617 | 5Yr MEng Sandwich |
| University of Kent | K24 | Computer Systems Engineering | H615 | 4Yr BEng Sandwich |
| Lancaster University | L14 | Computer Systems Engineering | HHP6 | 4Yrs MEng |
| Lancaster University | L14 | Computer Systems Engineering | HH66 | 3Yrs BEng |
| London Metropolitan University | L68 | Computer Systems Engineering | HG65 | 3Yrs BEng |
| University of Manchester | M20 | Computer Systems Engineering | HH66 | 3Yrs BEng |
| University of Manchester | M20 | Computer Systems Engineering | H650 | 5Yr MEng Sandwich |
| University of Manchester | M20 | Computer Systems Engineering | GH4P | 4Yrs MEng |
| University of Manchester | M20 | Computer Systems Engineering | HHQ6 | 4Yr BEng Sandwich |
| Middlesex University | M80 | Computer Systems Engineering | HPM0 | 4Yrs MEng |
| Middlesex University | M80 | Computer Systems Engineering | HPM0 | 5Yr MEng Sandwich |
| Middlesex University | M80 | Computer Systems Engineering | HP50 | 4Yr BEng Sandwich |
| Middlesex University | M80 | Computer Systems Engineering | HP50 | 3Yrs BEng |
| Nottingham Trent University | N91 | Computer Systems Engineering | 351F | 3Yrs Bsc |
| Nottingham Trent University | N91 | Computer Systems Engineering | GG56 | 4Yr Bsc Sandwich |
| Queen Mary University of London | Q50 | Computer Systems Engineering | HI62 | 3Yrs BEng |
| Queen Mary University of London | Q50 | Computer Systems Engineering | HI6D | 4Yrs MEng |
| Queen's University Belfast | Q75 | Software and Electronic Systems Engineering | GH6P | 3Yrs BEng |
| Queen's University Belfast | Q75 | Software and Electronic Systems Engineering | GH6Q | 4Yrs MEng |
| University of Sheffield | S18 | Computer Systems Engineering | H130 | 3Yrs BEng |
| University of Sheffield | S18 | Computer Systems Engineering | G500 | 4Yrs MEng |
| University of Sheffield | S18 | Computer Systems Engineering | 2A47 | 4Yr BEng Sandwich |
| University of Sheffield | S18 | Computer Systems Engineering | 8M74 | 5Yr MEng Sandwich |
| University of South Wales | W01 | Computer Systems Engineering | HP00 | 4Yr BEng Sandwich |
| University of South Wales | W01 | Computer Systems Engineering | H602 | 3Yrs BEng |
| Southampton Solent University | S30 | Broadcast Systems Engineering | H642 | 3Yrs Bsc |
| University of Westminster | W50 | Computer Systems Engineering | H655 | 4Yrs MEng |
| University of Westminster | W50 | Computer Systems Engineering | H655 | 5Yr MEng Sandwich |
| University of Westminster | W50 | Computer Systems Engineering | H650 | 3Yrs BEng |
| University of Westminster | W50 | Computer Systems Engineering | H657 | 4Yr Bsc Sandwich |
| University of Westminster | W50 | Computer Systems Engineering | H650 | 4Yr BEng Sandwich |
| University of Wolverhampton | W75 | Automotive Systems Engineering | H330 | 5Yr MEng Sandwich |
| University of Wolverhampton | W75 | Automotive Systems Engineering | H331 | 3Yrs BEng |
| University of Wolverhampton | W75 | Automotive Systems Engineering | H330 | 4Yrs MEng |