Systems Engineering training

Systems Engineering expertise is one of the most cost-effective investments for large technological projects

The *Systems* Challenges

Today, industry is given the responsibility for designing, building, operating and enhancing large, complex, highly integrated systems. It does this in the face of intense international competition. Therefore, an organisation's ability to deal with complex systems effectively is often what differentiates it in the marketplace and is critical for its future prosperity. At UCL the Centre for Systems Engineering provides training courses in Systems Engineering and Systems Engineering Management that enable organisations to develop and enhance their capability in this important area.

Systems pervade our world and 'Systems Thinking' provides a highly effective foundation for dealing with them. The principles of Systems Thinking and Systems Engineering are relatively intuitive but often compromised by the apparent pragmatism and legacy practices present in organisations. Though the term "Systems Engineering" suggests a highly technical domain, in fact the issues are relatively generic and can be applied equally well both to the complex physical systems that are developed, and to the organisations that develop them. At UCL we have developed a portfolio of training courses and material (also an MSc Programme in Systems Engineering Management) that is targeted at all those engaged in systems development within an organisation, including domain-specific engineers and managers. We have fashioned courses that combine academic rigour and up-to-date systems thinking with real-world experience to produce products that are 'fit for purpose'.

Users and procurers demand more and more capability more quickly and more cheaply. Often, this increased capability can only be delivered with ever more complex and more integrated systems. Doing nothing is not an option for survival. Whatever the sector (e.g. Aerospace, Defence, Energy, Marine, Services, etc.) our training courses in *Systems Engineering* and *Systems Engineering Management* will equip the practitioner with the skills to meet this challenge.

Benefits to the Individual

Our courses will equip delegates with a powerful set of skills and knowledge.

- An appreciation of complex systems and the issues associated with their development, deployment, maintenance, upgrade and disposal
- Key skills that are fully aligned with INCOSE's (International Council for Systems Engineering) core competencies and appropriate standards (e.g. ISO 15288)
- An understanding of systems development lifecycle options and processes. How to select the best and how to find the balance between prescription and empowerment
- Awareness and understanding of the context within which systems are developed including the economics and organisational limitations
- Necessary management skills and an understanding of the relationship between project management and systems development

- The ability to manage risk and the creation of robust systems
- Domain specific systems engineering expertise

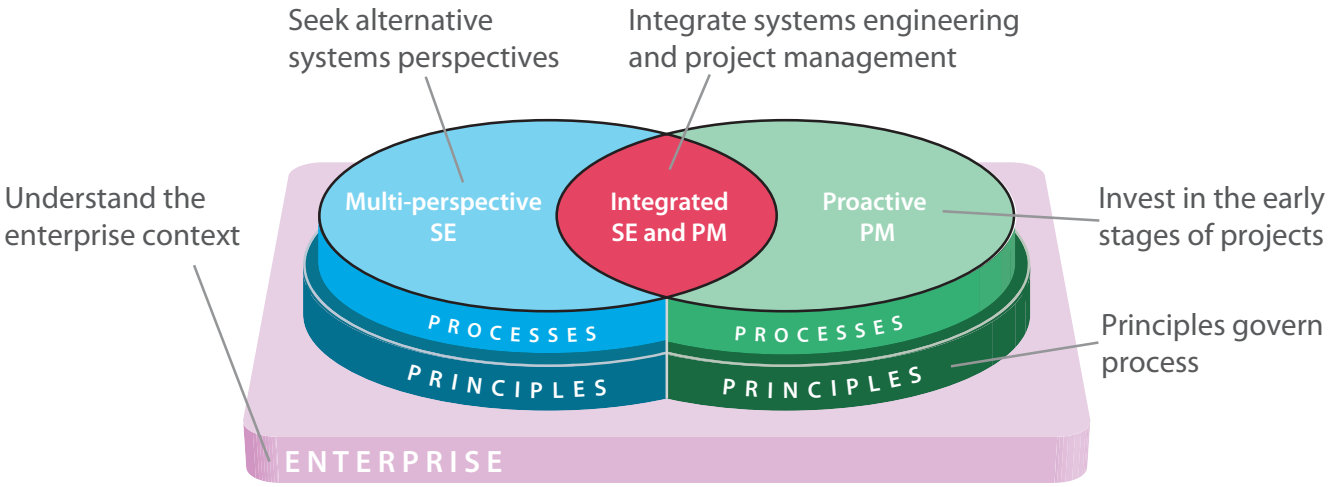
The UCLse Principles of Systems Engineering

With over 50 years experience of developing complex systems for extremely demanding environments, we have developed 5 guiding principles to Systems Engineering practice that we know to work in the field:

- *Principles govern process* - Systems engineering and its management is facilitated through the development of processes. Processes should be seen as enabling rather than deterministic: certain individuals need to be both accountable for their actions and given a level of discretion in the application of high level processes.
- *Seek alternative systems perspectives* - To enhance understanding it is worthwhile exploring a range of systems perspectives, viewpoints or abstractions, including the additional capability and uncertainty that is uncovered by incorporating humans in systems. Complexity can be managed through a 'divide and conquer' approach, breaking systems into interacting systems elements and understanding the function of those elements, their interactions (both planned and unplanned) and how the elements collaborate to deliver the system's emergent properties.
- *Understand the enterprise context* - System developments are undertaken by an organisation (usually within a business environment) because they benefit that organisation. It is essential to understand the organisation's objectives and constraints when determining the optimal solution. Furthermore, the system development system (the combination of enterprise, collaborators and supply chain that develops the system solution) has to be configured to be fit for purpose within whatever constraints exist. Soft systems approaches may be applied to facilitate the accommodation of a systems development project within an organisation.
- *Integrate Systems Engineering and Project Management* - Project management and systems engineering management are highly overlapping endeavours. In both cases their general scope is the fitness for purpose of the end product and the efficiency of its production. Different organisations define differently the responsibilities of project managers, programme managers, systems engineering managers, and chief engineers/scientists. Nevertheless there needs to be cooperation and coherence in the management structure which recognises the differing approaches of (systems) engineering and (project) management.
- *Invest in the early stages of projects* - For any activity in a project there will be a correct time to undertake it. Too early wastes resources while too late can lead to downstream adverse impacts. The optimum ordering of activities should be identified, resisting pressure to defer work until later for short-term reasons. Often this means that a project's ideal resource profile will be reshaped exhibiting an earlier peak (so-called 'left shift' of effort), with the expectation that this will lead to a reduction in risk and usually a reduction in the total effort required by the project, and a greater chance of project success. This approach can be extended upstream of the project, for instance investing resources in preparing for a future bid or even in predicting customer needs and future technology requirements.

Benefits to Industry

By adopting effective Systems Engineering and Systems Engineering Management practices an organisation can significantly reduce the risks of running over-budget, late delivery and stakeholder disappointment. Complex systems often are found to have unwanted emergent properties when deployed. By taking a broad perspective from the outset and dealing effectively with



requirements management (including elicitation), systems design and modelling, and verification and validation, systems can be created with few, if any, unwanted and undesirable features.

Course options and format

Options

2-Day Continuing Professional Development (CPD) courses on subjects directly related to Systems Engineering and Management. These are all open courses held in central London.

5-Day Short Courses. All our MSc modules can be taken as stand alone short courses. This option provides an in-depth and focussed learning environment.

Industrial Training. These are bespoke courses tailored to the specific needs and sector of the client. They can be of any length, depth and presentation/exercise balance. We can adapt to the hierarchy and view point of the audience from young and inexperienced to directors and highly experienced delegates.

Our usual model for training is to split the working day into four sessions with the time of each session being typically divided about equally between presentations and syndicate exercises. These exercises are designed to provide practical experience of carrying out a method discussed in the taught element, illustrating points made by the tutor or allowing the delegates to relate their own experiences to the issue under discussion. Delegates are expected to present their findings in the syndicate exercises back to the group. Their own presentation of their work helps to reinforce the content of the learning points and by encouraging discussion the experiences of the delegates can be used to illuminate and enhance the course material. This feedback allows the course material to be related back to the real world of Systems Engineering within a competitive business.

Our tutors

Professor Alan Smith

In 1990 Alan joined University College London's Mullard Space Science Laboratory following 8 years at the European Space Agency in the Netherlands. He is founding Director of UCL's Centre for Systems Engineering (since 1998), instigator of the Centre's education and training programme and Director of MSSL. Alan's background is in space science technology and project management and he has worked with all of the major space agencies.

Dr. Adrian James

5-DAY INDIVIDUAL MODULES FROM OUR MSC IN SYSTEMS ENGINEERING MANAGEMENT

CORE MODULES	NOTES
Systems Engineering Management	
Lifecycle Managament	
Risk, Reliability and Resilience	
The Business Environment	
Systems Engineering in Practice	a
Dissertation	a
OPTIONAL MODULES	b
Systems Design	
Project Management	c
Defence Systems	
Space Systems	
Rail Systems	
Environmental Systems	d
Systems, Society and Sustainability	d

a. Research component

b. Not all optional modules are timetabled all years. Please contact us for details.

c. This module is accredited by the Association of Project Management.

d. These modules are delivered in ten half-day sessions over the course of a term instead of the usual intensive 'block week'.

Adrian has worked at UCL for twenty years on various space programmes, in the role of project manager. As Director of the MSc in Systems Engineering Management he leads one of the foremost postgraduate programmes in the field. He is active in teaching project management on the UCL APMP course and providing bespoke Systems Engineering consultancy to industry.

Dr. Michael Emes

Michael is a Senior Research Fellow in UCL Centre for Systems Engineering. His research interests include technology management tools and theory, modelling, and the causes of project failure. He teaches in the areas of systems thinking, design, modelling and management and has delivered industrial training courses in the UK and US. Before joining UCL, Michael was a strategy consultant working on projects in retail, e-commerce and transport.

Dr. Raúl Leal

Raúl is the Business Development Manager for the Technology Management Group at the Department of Space and Climate Physics in UCL. He is interested in systems thinking, systems modelling, systems design, project management and the professional development in these areas in industry. His involvement in education and training extends to over 20 years and several countries. Before joining UCL Dr. Leal was systems design authority in the development of a nuclear imaging (PET) instrument.

Simon Jackson

Simon spent 20 years working in the defence industry at Rolls-Royce and BAE Systems, performing a variety of project management roles at all phases of the project lifecycle on a wide range of engineering and business change projects. He then retrained as a teacher and has been lecturing in Project Management and Systems Engineering for over ten years on a range of undergraduate, post graduate, industrial and professional courses. Simon is a Chartered Engineer and a Member of the Association for Project Management and the Royal Aeronautical Society.

Matthew Whyndham

Matthew is a practising project manager and research scientist in UCL's Department of Space and Climate Physics (MSSL). Most of his work has been in the instrumentation field (radiation detectors and data handling systems). He is the Course Organiser for the Department's MSc programmes, in Systems Engineering Management and in Space Science/Space Technology. He teaches topics in space technology, technology management and project management within these programmes, and is a lead tutor in UCL's APM-accredited project management course.

Dr. Laura Mullin

Laura is a tutor in management for the Technology Management Group, teaching project management and business topics for the group's postgraduate courses, including the MSc in Systems Engineering Management. She has industrial project experience in Ariane 5 ground safety and International Space Station integration activities, working for CNES and EADS Astrium respectively. Previous to this, Laura worked as a researcher and undertook postdoctoral research in the domain of orbit determination subsequent to completing her PhD in astrophysics.

Ian Raper

Ian is a project manager and lecturer in the Technology Management Group. Prior to joining MSSL he had 22 years of industrial experience working on all aspects of the systems design lifecycle from user requirements through to integration, acceptance and deployment. Part of Ian's career was in the defence sector, within Vickers Shipbuilding and BAE SYSTEMS. In subsequent time, he worked in the space sector covering mission and system level activities at Astrium. Ian has been a member of the UK chapter of INCOSE since 1995 and holds an MSc in Systems Engineering from UCL.

- *UCL is ranked **fourth** in the world by the 2012 QS World University Rankings.*
- *Founded in 1826, UCL was the first English university established after Oxford and Cambridge.*
- *In the 2008 Research Assessment Exercise (RAE) UCL was rated third in the UK, for the amount of research considered of 'world-leading quality'.*
- *UCL has about 22,000 students and more than 4,000 academic and research staff, including 650 professors - the highest number in the UK.*

EXAMPLE 5-DAY COURSE SYLLABUS

Day 1	Introduction
	Basic Concepts
	Systems Thinking
	The System Development System
Day 2	Left-Shift
	The Se Lifecycle
	Lifecycle Models
	Se Roles and Responsibilities
	Debate
Day 3	Requirements Management
	Modelling
	Architecture and Design
	Decision Making
Day 4	Sub-Systems Development
	Cots, Mots and Re-Use
	Integration, Verification and Validation
	Operations, Maintenance and Integrity
Day 5	Systems Failure
	Human Behaviour and Systems
	Implementation Issues
	Review and Feedback

Organisations we have worked with

AILU, Alexander Dennis, Astrium, Atkins Rail, BAE Systems, BERR, BP, Cassidian, CIP, Defra, DTI, EPSRC,

C O N T A C

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