This year marks the 22nd anniversary of the formation of INCOSE UK, and has also seen a welcome return of the International Symposium to the UK for the first time since 1999. We hope that this will lead to an upsurge of interest in Systems Engineering, and the continuation of conversations from Edinburgh.

Once again, ASEC 2016 will be a 2 day event bringing together world-class presenters and practitioners and providing an excellent forum for networking and sharing experiences. This remains the UK’s premier Systems Engineering event, and will feature:

- Keynote addresses given by an eminent speaker on each day:
  - Day 1: Rhys Davies, eAsset Management
  - Day 2: Andy Stanford-Clark, IBM
- Technical presentations on contemporary Systems Engineering theory and practice
- Tutorials run by leading Systems Engineering practitioners
- An academic research showcase poster competition
- The conference dinner, with an entertaining after-dinner speaker from the world of rocketry

Please join us whether you are an experienced Systems Engineering practitioner, new to Systems Engineering or just want to find out if Systems Engineering is relevant to you.

For the latest information visit our conference web site: www.ASEC2016.org.uk
Welcome to ASEC 2016 – Let’s keep the momentum going

Richard Beasley - President of INCOSE UK

I would like to invite you to join us at ASEC 2016, our annual Systems Engineering conference, where this year’s theme is “Building on Success”. This year the event is at the Scarman Centre at Warwick university – where we will have plenty of space to discuss the conference topics and other contemporary Systems issues with the presenters, and with leading Systems Thinkers and Engineers from the UK and abroad.

We have put together a first class technical programme, reflecting the strength and diversity in Systems Engineering in the UK, together with two excellent keynote speakers and an entertaining after-dinner speaker. This is the second major Systems Engineering conference in the UK this year, and we intend to build upon the success of the International Symposium in Edinburgh and continue the momentum, with a technical programme focused on the interests and concerns of Systems Engineers in the UK.

In addition to what promises to be an excellent set of papers and tutorials, this year’s ASEC also features a session on Continuous Professional Development and the MyCareerPath tool, working group sessions in the afternoons and a panel session. After getting into its stride following three very different incarnations at IS2016, we will once again be having a Fringe session each day to provide a less structured space to explore ideas.

During the event we hold our INCOSE UK Annual General Meeting (AGM), where we will report back to our members on INCOSE UK's momentous year and on our key activities. Also at the AGM the new UK Council officers will be appointed, including the passing of the presidency to the new incumbent, Ivan Mactaggart. The AGM is a great chance for new and established members alike to listen, ask questions and make suggestions.

I hope I will meet as many of you as possible at ASEC 2016 and that we all have an informative, interesting and enjoyable time.

Keynote Speaker: Rhys Davies, President of eAsset Management

Rhys is the Chairman of ISO Committee (TC251), leading 31 countries in developing International Standards for Asset Management and resulting in the publication of the ISO55000 series in 2014. He continues to lead that group in its ongoing work.

Rhys has been a member of the Executive Committee of the Joint IET / Institute of Asset Management (IAM) Technical Professional Network for Asset Management, since January 2011. Rhys is a member of the Institute of Asset Management (IAM) and has been involved in a variety of roles, both on the Board (2014 – 2016) and the Council.

Rhys is President of eAsset Management Limited.

Rhys Davies graduated with BEng (Hons) and MEng in Electronic Engineering from UCNW in 1990/91. He completed an MBA in 1999 and is a Chartered Engineer. He has developed his career as an asset management specialist in a variety of industries including Aerospace, Defence, Rail, Telecoms, Utilities and the Oil industry. Rhys’ roles have included systems design, consultancy, operations management and audit.

55001 and 15288: Two Sides of the Same Coin

Much is made of Asset Management ‘just being something we have always done’. But in a world where we have had strong bodies of knowledge in the fields of reliability engineering, Systems Engineering and maintainability, why do we still fail to deliver effective performance? This keynote will try to challenge our thinking and try to explore where Asset Management fills in some of the gaps. It will also highlight the missing bits that no standard can fill...
Keynote Speaker: Professor Andy Stanford-Clark, IBM Distinguished Engineer for the Internet of Things

Professor Andy Stanford-Clark is a Distinguished Engineer in IBM's global Internet of Things team and an IBM Master Inventor, with more than 40 patents.

Andy is based at IBM's Hursley Park laboratories in the UK, and specialises in developing new applications using Internet of Things technologies. He has particular interests in Smart Metering and Smart Grid technologies, as well as driving consumer behaviour change.

Andy has been working in the area that we now call the Internet of Things for more than 15 years. He has a BSc in Computing and Mathematics, and a PhD in Computer Science. He is a Visiting Professor at the University of Newcastle, an Honorary Professor at the University of East Anglia, an Adjunct Professor at the University of Southampton and a Fellow of the British Computer Society.

Andy Stanford-Clark will explain how the Internet of Things is making a huge difference in the industrial manufacturing world, to improve process efficiency and reduce downtime through predictive analytics. He will explain how the new area of “cognitive” analytics, using unstructured data such as images and machine learning, can give a holistic view of the manufacturing process to achieve levels of improvement that have not been seen before.

He will give examples of how the IBM Watson analytics services are being used to make manufacturing more efficient and eliminate downtime due to unplanned maintenance.

After-Dinner Speaker: Dr Russ Strand, www.RocketRuss.uk

Dr ‘Rocket’ Russ Strand (PhD CEng) has been building and launching high-powered rockets for more than 10 years after first getting involved at University.

Russ completed a BSc in Aeronautical Engineering at Farnborough, as well as an MSc in Astronautics and Space Engineering and a PhD in Continuum Mechanics at Cranfield University. He now works for a large aerospace engineering firm as a Senior Principal Systems Engineer and Project Manager. Russ is also the former Chair of the United Kingdom Rocketry Association (UKRA).

‘Rocket’ Russ will share the ‘highs’ and ‘lows’ of some of his rocketry experiences. In this talk Russ shows launch footage and shares anecdotes from his appearance on James May’s Toy Stories as the builder of Sindy’s Supersonic launch vehicle. He also provides an explanation of the design and operation of one of his larger rockets ‘KAOS’, a 12-foot-long, 1-foot-wide rocket built from scratch originally in 7 days. Its most recent launch was March this year and the next was at the International Rocketry Week in August. The actual Sindy Capsule and Rocket will be available to view, along with a selection of other rocket parts.
Programme at a glance

Please note: each morning there will be a plenary session in the Conference Theatre, with additional parallel elements starting in the second morning session. This year the half-day tutorials are being held either side of lunch, rather than just in the afternoon as in previous years. These are limited to a maximum of 30 delegates each and should be registered in advance.

Although INCOSE UK will make every effort to provide the programme as advertised, it may become necessary, for reasons beyond our control, to make changes to speakers and / or to the timing and content of the programme. INCOSE UK will not be liable for any costs incurred by delegates in relation to such changes.

Registration is open each day from 08:00.

### Day 1: Tuesday 15th November

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:50 - 09:00</td>
<td>Introduction to Day 1</td>
</tr>
<tr>
<td>09:00 - 09:45</td>
<td>President’s Address &amp; INCOSE UK Highlights</td>
</tr>
<tr>
<td>09:45 - 10:30</td>
<td>Keynote Speaker: Rhys Davies, President of eAsset Management</td>
</tr>
<tr>
<td>10:30 - 11:00</td>
<td>Coffee</td>
</tr>
<tr>
<td>11:00 - 12:30</td>
<td>Conference Theatre Tutorial “Using Architectural Thinking to aid Decision Making”</td>
</tr>
<tr>
<td>12:30 - 13:30</td>
<td>Lunch</td>
</tr>
<tr>
<td>13:30 - 15:00</td>
<td>Tutorial Tutorial “How to Use the INCOSE SE Competence Framework as a Basis for Job-Matching and Professional Development” Paul Davies (The Systems Engineer UK)</td>
</tr>
<tr>
<td>15:00 - 15:30</td>
<td>Tea</td>
</tr>
<tr>
<td>15:30 - 17:00</td>
<td>“Are We Talking the same Language?”</td>
</tr>
<tr>
<td>17:00 - 17:45</td>
<td>INCOSE UK Annual General Meeting</td>
</tr>
<tr>
<td>19:00 - 19:30</td>
<td>Pre-Dinner Drinks</td>
</tr>
<tr>
<td>19:30 - 22:00</td>
<td>Conference Dinner - Guest speaker: Dr Russ Strand, <a href="http://www.RocketRuss.uk">www.RocketRuss.uk</a></td>
</tr>
</tbody>
</table>

### Day 2: Wednesday 16th November

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:50 - 09:00</td>
<td>Introduction to Day 2</td>
</tr>
<tr>
<td>09:00 - 09:45</td>
<td>Keynote Speaker: Prof Andy Stanford-Clark, Distinguished Engineer for the Internet of Things, IBM</td>
</tr>
<tr>
<td>09:45 - 10:30</td>
<td>&quot;Technical Debt: What is it, and how do we manage it?&quot;</td>
</tr>
<tr>
<td>10:30 - 11:00</td>
<td>Coffee</td>
</tr>
<tr>
<td>11:00 - 12:30</td>
<td>Conference Theatre Tutorial “Claims and Benefits”</td>
</tr>
<tr>
<td>12:30 - 13:30</td>
<td>Lunch</td>
</tr>
<tr>
<td>15:00 - 15:30</td>
<td>Tea</td>
</tr>
<tr>
<td>15:30 - 17:00</td>
<td>“Case Studies: Improving SE performance through organisational change”</td>
</tr>
<tr>
<td>17:00 - 17:15</td>
<td>President’s Closing Remarks</td>
</tr>
</tbody>
</table>

“Model-based Requirements Engineering Challenges and Best Practices”
Dr. Aurelijus Morkevicius & James Towers (No Magic Europe)

Model-based Requirements Engineering Challenges and Best Practices
Dr. Aurelijus Morkevicius & James Towers (No Magic Europe)

“Using EARS+ (Easy Approach to Requirements Syntax Plus) to vary the level of detail in Natural Language requirements”
Alistair Mavin (Rolls-Royce)

See following pages for details of all presentations, tutorials and workshops.
Additional Programme Elements

Following last year’s initial trial run at ASEC 2015, and the highly successful Fringe sessions at IS2016 in Edinburgh, we are once again offering a set of additional side elements to complement the main technical programme.

- Working Groups will have the opportunity to bid for up to three 45 minute sessions each day to conduct working group business, or engage with delegates who may not normally be able to attend their meetings.
- We are pleased to have Ben Jones, Professional Development Executive at the Engineering Council, with us to discuss the importance of continuous professional development (CPD) and to provide a demonstration of how to use their MyCareerPath tool to record CPD evidence against professional competencies.
- Finally, building on the success of this year’s International Symposium in Edinburgh, we are going to have a “Fringe” session each day. The exact content of these sessions is yet to be fully determined, but the intent is to be engaging and informative, providing a space where delegates can explore aspects of Systems Engineering and its relationship with its wider context. Watch out for further details on INCOSE UK media channels and social media as we approach the event.

These additional elements will take place in parallel to the main conference as indicated below.

### Day 1: Additional Elements

<table>
<thead>
<tr>
<th>Time</th>
<th>Breakout</th>
<th>Breakout</th>
<th>Breakout</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 - 11:00</td>
<td><strong>Coffee</strong></td>
<td><strong>How to Use the INCOSE SE Competence Framework as a Basis for Job-Matching and Professional Development</strong></td>
<td><strong>Model-based Requirements Engineering Challenges and Best Practices</strong></td>
</tr>
<tr>
<td>11:00 - 12:30</td>
<td><strong>CPD and MyCareerPath</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:30 - 13:30</td>
<td><strong>Lunch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:30 - 15:00</td>
<td><strong>Fringe</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:00 - 15:30</td>
<td><strong>Tea</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:30 - 16:15</td>
<td><strong>Working Group Session</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16:15 - 17:00</td>
<td><strong>Return to the main programme in the conference theatre</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Day 2: Additional Elements

<table>
<thead>
<tr>
<th>Time</th>
<th>Breakout</th>
<th>Breakout</th>
<th>Breakout</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 - 11:00</td>
<td><strong>Coffee</strong></td>
<td><strong>The Way Ahead – Implementing An MBSE Strategy In Your Organisation</strong></td>
<td><strong>Using EARS+ (Easy Approach to Requirements Syntax Plus) to vary the level of detail in Natural Language requirements</strong></td>
</tr>
<tr>
<td>11:00 - 12:30</td>
<td>The UK certification process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:30 - 13:30</td>
<td><strong>Lunch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:30 - 15:00</td>
<td><strong>Fringe</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:00 - 15:30</td>
<td><strong>Tea</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:30 - 16:15</td>
<td><strong>Working Group Session</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16:15 - 17:00</td>
<td><strong>Return to the main programme in the conference theatre</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A Guide to the Event Programme

Event Structure

Each day of the conference consists of the following elements.

Early Morning Session

The early morning session each day features a keynote speaker. On Tuesday this will be preceded by an address from the President of INCOSE UK, covering the highlights from the previous year. On Wednesday this will be followed by a technical presentation.

Late Morning Session & Early Afternoon Session

At this point, delegates have the option to choose between a set of parallel tracks:

- The main conference theatre offers back to back sessions of two presentations each, covering contemporary topics expected to be of general interest to the audience, with a break for lunch half way through
- There are two tutorials running each day in parallel to the main conference session, which need to be booked in advance when booking for the conference. Details of these tutorials can be found on page 7. Attendance at these tutorials will be strictly limited on a first-come-first-served basis when booking
- A session on CPD and how to use the MyCareerPath tool will take place on the first day. On the second day there will be a session covering the UK online certification process, led by Ian Presland, INCOSE UK’s Professional Development Director
- The “fringe” session will take place each day after lunch, featuring a facilitated “unconference” element

Late Afternoon Session

The final afternoon session is primarily based in the main conference theatre, but also offers the opportunity for delegates to attend 45 minute Working Group sessions running in parallel with the first paper of the session.

Signposting

Each presentation has been characterised in two dimensions, indicating the content and target audience.

Accessibility. This indicates the level of knowledge required by the delegates to fully understand the paper and gain the maximum benefit from its content. There are three levels here: ‘Beginner’ which is aimed at people who are new to the topic and will typically hold the Awareness level of competence in this area; ‘Practitioner’ which is aimed at people who have performed some work in this area and are looking to increase their knowledge and who will typically hold the Supervised Practitioner or Practitioner level of competence; and ‘Advanced’ which is aimed at people with extensive experience and who are looking to hone their skills and knowledge in the area and who will typically hold the Expert level of competence.

Application. There are three levels here, which are: ‘Research’ aimed at new ideas that have been carried out as part of a research project; ‘Case Study’ that details examples of how Systems Engineering good practice has been applied on real projects, showing real results; and ‘Good Practice’ that details how mature Systems Engineering practices are being disseminated, deployed and adopted.

These are indicated on the following pages using a set of icons depicted below.

Accessibility:

Beginner
Practitioner
Advanced

Application:

Research
Case Study
Good Practice

So for example, a presentation containing a Case Study, and aimed at Practitioners would have the following set of icons after the title:

We hope that this will assist delegates in choosing which elements of the event programme they will attend.
Afternoon Tutorials / Workshops

Day 1: 11:00 - 15:00

**How to Use the INCOSE SE Competence Framework as a Basis for Job-Matching and Professional Development**
Paul Davies (The Systems Engineer UK)

The aim of this tutorial is to provide a framework for the career evolution of a systems engineer. The objectives are that delegates will acquire a working knowledge of the INCOSE Competence Framework; how to augment it and tailor it to their business domain and job requirements; how to assess candidates against it; and how to propose personal development plans to junior systems engineers as an outcome.

We start with presentation of the basics of the SE Competence Framework; range of competencies, skill levels, assessment methods. We then talk about what is not in the framework (domain competencies, underlying technical skills, behavioural attributes), but are referenced therein. We workshop some likely candidates for these on domain-by-domain, and then role-by-role bases.

This moves naturally on to role-profiling – what typical roles exist, at various responsibility levels? What competencies of each category do we need for these roles? In groups, we try to move away from “ideal” role definitions towards n-out-of-m in each of the competence categories. A scoring system is proposed, and delegates invited to reflect on their own business needs and likely usage patterns.

Finally we talk about assessment methods; comparison of candidate scores versus the required role-profile and how to use this to create a Professional Development path. Experience and feedback will be invited and collected from the participants.

The tutorial is aimed at SE team leaders with responsibilities for recruitment, capability appraisal, and assessment of training needs / personal development of junior systems engineers.

**Model-based Requirements Engineering Challenges and Best Practices**
Dr. Aurelijus Morkevicius & James Towers (No Magic Europe)

Requirements definition is one of the most important and critical phases of modelling any system. Mistakes made in the requirements phase are much more painful than the ones produced in any later phase of system analysis and design. Multiple studies show that more than 80% of all system defects occur because of misleading requirements specification. This proves the value of and motivates the use of requirements management. Nowadays, plenty of approaches for requirements management are available.

This tutorial focuses on a Model-Based Systems Engineering (MBSE) approach for requirements management (MBRE) throughout different abstraction layers of system analysis and design. Starting from stakeholder needs elicitation and finishing with functional requirements specification, the approach proposes means for requirements categorization, grouping, horizontal and vertical traceability, metrics, and quantitative verification. Unambiguous modelling workflow and requirements traceability gives this approach a big advantage over similar methodologies and frameworks.

The introduction of the approach is followed by a case study of requirements management as a part of a real-world system, modelled with a widely known MBSE tool.

This tutorial is aimed at requirement engineers, system architects, system engineers, software architects and other stakeholders who are creating and using models, or are planning to create and use models.

Day 2: 11:00 - 15:00

**The Way Ahead – Implementing An MBSE Strategy In Your Organisation**
Dr. Jon Holt & Simon Perry (Scarecrow Consultants)

The main aim of the workshop is to provide attendees with an overview of the pragmatic issues concerned with implementing an MBSE strategy in their organisation. This will include participants working in groups to create a visual representation of their MBSE strategy using the Review And Visualisation of ENabling Strategy (RAVEnS) approach. This new approach involves constructing a physical ‘as-is’ representation of the organisation’s model-based Systems Engineering activities, identifying the way ahead for the ‘to-be’ situation and, from this, abstracting the overall strategy for MBSE implementation.

This workshop is not a modelling session and does not include the use of any established notations, such as SysML. The RAVEnS approach uses simple two-dimensional, physical building blocks to represent MBSE concepts that are built into a concise and coherent representation, which is then used as a basis for the MBSE strategy.

This workshop is aimed at systems engineers and Managers who have a stake in introducing MBSE into their organisation and would like to gain experience of a powerful technique for understanding an organisation’s MBSE position and needs, in order to develop a strategy for introduction or improvement.

**Limited to 20 delegates only**

**Using EARS+ (Easy Approach to Requirements Syntax Plus) to vary the level of detail in Natural Language requirements**
Alistair Mavin (Rolls-Royce)

Black box system requirements are often written in unconstrained natural language (NL), which is inherently imprecise. During system development, any problems in system requirements inevitably propagate to lower levels. This creates unnecessary volatility and risk, which impact programme schedule and cost. To mitigate this problem, there is a need to provide simple, practical guidance for authors of NL requirements. Easy Approach to Requirements Syntax (EARS) is a philosophy for authoring NL requirements through the application of a template with an underlying rule set. EARS has proved popular with practitioners because it is lightweight, there is little training overhead and the resultant requirements are easy to read.

This interactive tutorial will:
1. Introduce the EARS+ approach
2. Illustrate worked examples of both simple and detailed requirements
3. Demonstrate the evolution of requirements through the development lifecycle
4. Include a group discussion on the benefits of adopting the approach

Participants will be provided with a quick reference guide and will leave with a working knowledge of EARS+, ready to apply the approach to their own requirements.

**Limited to 25 delegates only**
### AM - Session 1.1: Using Architectural Thinking to aid Decision Making

**11:00 - 11:45**  
**A Model-based Systems Engineering Approach to Evidence based Decision making**  
*Lt Col Helen Coleman (British Army), Michele Trevithick (BMT Defence Services Ltd)*

Following the Defence Reform in 2011, the UK Ministry of Defence (MOD) developed the Defence Operating Model and Generic Capability Model (GCM) in 2013. Integral to this approach is the need for evidence-based advice and decision making alongside an architectural methodology based on the Systems of Systems Approach (SOSA). This paper looks at a case study where a Model-Based Systems Engineering (MBSE) method is used to develop the supporting evidence for a Defence Medical Information Services programme. In 2014 the Surgeon General group decided to launch a pilot for its Medical Information Services (Med IS) programme, with the objective of investigating how a MBSE approach using Enterprise Architecture (EA) techniques could develop the evidence required for MOD Initial Gate submission and assure completeness of the requirements set.

Achieving this objective presented a number of challenges from a Systems Engineering (SE) perspective; how to adopt an EA way of working that represents customer and stakeholder concerns, while remaining within the MOD Architecture framework (MODAF); how to elicit relationships between policy, process and procedure using clinical practitioners whose familiarity with SE is limited; and how to provide a solid business architecture foundation that can be exploited by new Information Services procurement strategies.

This paper will discuss how we approached these challenges, the lessons learned and the insights gained on using this approach and, with the initial work completed in June 2015, we will discuss how our work could form a case study on how MBSE can be used to develop the evidence.

### 11:45 - 12:30

**Digital Railway – Technology or change?**  
*Mike Brownsword (Atkins), Diana Hogbin-Mills (Digital Railway), Colin Brown (Digital Railway), Jon Linsdell (BAE Systems)*

As with any SE journey, few of us would choose to start where we do: the beginning is preferable but rarely realistic. Digital Railway is no different; it brings with it a history as long as the rail industry itself. This presentation won’t focus on the history, but on how the DR programme is trying to help move forward from where we are today using a System of Systems approach.

The programme’s challenge is to compress a 50 year capability development into 15 years. To do this we are trying to innovate the approach to capability readiness and delivery across the industry. The Digital Railway programme is trying to work in partnership with the whole industry to maximise the potential of digital technology. In essence one programme can’t do it alone, it requires the whole industry to get behind the move otherwise it will fall flat… again I hear some of you say!

This paper will focus on the both the small changes we are making within the team to deliver high levels of performance, through to the whole industry challenges which affect both the traditional SE community and the SoS movement and the way we work together across technical and business systems.
## PM - Session 1.2: Scenarios and Visualisations

### 13:30 - 14:15

**Scenario Selection Method for System Scenario Analysis**  
Tim Ferris, Stephen Barker & Rick Adcock  
(Centre for Systems Engineering, Cranfield University)

Scenario analysis is a frequently-used method to explore what a proposed system is required to do in the early phases of system development leading towards finding system requirements. A system which is intended to perform a variety of roles under a range of conditions, is likely to result in the need for a quantity of scenarios that becomes intractably pluriform. The consequence of too many scenarios is that either the number of scenarios to be analysed must be reduced to a manageable number or the analysis is likely to be perfunctory, diminishing its value. We present a method for reducing the number of scenarios to be analysed, through study of the organization of the factors which distinguish scenarios from each other, and for selecting which scenarios need analysis through identifying their points of commonality and identifying where differences may impact system capability. Our method organises the types and potential values of factors related to a particular system development in order to reduce the number of scenarios to be investigated.

### 14:15 - 15:00

**Data Visualisation for Systems Engineers**  
John Welford (WSP | Parsons Brinckerhoff)

A case is made for data visualisation as an essential Systems Engineering skill. Examples of Systems Engineering visualisations used within the rail industry are given, along with discussion of the philosophy behind them. Finally, a comment is made on the relationship between the visualisations presented and model-based Systems Engineering.

The art and science of data visualisation has been developing since the work of William Playfair in the early nineteenth century; however, as with much of science and technology, its progress has accelerated rapidly in the last few years. We now live in an age of abundant data, more than we can really comprehend, and terms like big data, infographics and analytics are starting to enter the common parlance. Increasing use of the internet for communication and improvements in computer processing power, along with the prevalence of smart devices and the internet-of-things, enables presentation techniques that were not previously possible.

In the context of this paper we will use the terms such as visualisation, data presentation and diagram interchangeably to describe non-text-based documentation, produced with the intent of communication and as an aggregation of raw data into useful information. This includes all kinds of graphs, models, designs, dashboards and maps. They may be produced in a variety of mediums, from a sketch on a whiteboard through to an interactive software application. Visuals can be completely static and unchanging, or highly dynamic, responding to changes in the background data and interacting with user input.
### PM - Session 1.3: “Are We Talking the same Language?”

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
</table>
| 15:30 - 16:15 | **Multilingual Systems Engineering**  
Stephen Powley (Omflow Ltd), Simon Perry (Scarecrow Consultants), Richard Powley (Make Paper)  
When engineering operates on a global scale, collaboration should be encouraged by removing language barriers. Requiring stakeholders to work in a language that is not one of habitual use is at best a compromise and at worst a costly source of unmanaged risk.  
Established practice and the restrictions of the tools we use mean that many Systems Engineering activities require various stakeholders to capture written information in a single human language. At the same time it is almost inevitable that there will be project members who are not fully conversant in the single language chosen. Model-based approaches help reduce the burden of language difficulties, but descriptions continue to include a text component. In most projects, certain stakeholders will interact mainly via the written word.  
There are many hidden costs associated with the lack of an integrated translation activity in an organisation’s workflows. People working in a language that is not their mother tongue work more slowly, struggle with the nuances of linguistic choices and make more errors. Where translation is part of the workflow, it often happens outside of the controlled engineering environment, introducing unknown and unmanaged risks.  
Organisations will benefit by adopting a multilingual approach as an integral, quality-controlled part of their everyday workflows. “Left shifting” multilingual capability and translation effort to early phases of a lifecycle can reduce risk and increase quality. This paper proposes a flexible, multilingual engineering environment that allows all stakeholders to create and access the same information, but in their language of choice. Examples are provided of how a multilingual approach can be incorporated alongside existing tools and practices. More advanced techniques that make multilingual information a fundamental part of Systems Engineering are also explored. Both traditional and Model-Based Systems Engineering environments are considered. |
| 16:15 - 17:00 | **Ask The Experts?**  
Led by Technical Director, Prof. Jon Holt  
This light-hearted panel session will see a collection of experts answering a collection of questions from both the panel chair and the audience.  
We intend to provide a facility for delegates to suggest questions and topics in advance of the conference, and during the conference itself. The exact set of “experts” on stage will be chosen to best address the set of topics proposed! |
## AM - Session 2.1: Technical Debt: What is it, and how do we manage it?

**Technical Debt: What is it, and how do we manage it?**  
*Thomas Walworth, Alistair Blair & Laura Shrieves (Thales Corporate Services)*

Ward Cunningham devised a metaphor for technical debt in 1992. Commonly understood within software development, it is used to describe the impact of compromises (in relation to completeness and quality) arising during software architecting, design and implementation and is often observed as high costs in future product evolution. We believe this metaphor to be transferable across engineering disciplines, and that, as we commit to more complex engineering projects, technical debt management becomes an underlying ‘Golden Rule’ for engineering teams. This places value on projects able to 1) identify why, how and when decisions may result in technical debt, 2) quantify technical debt in meaningful ways, and 3) react accordingly. For such projects, the impact of compromise becomes a known quantity against which sound engineering judgement follows.

This research looks to expand the technical debt metaphor, to describe the origins of technical debt from a cross-functional engineering perspective, and to provide an approach to assessing it. The complexity of this problem, and the variety of stakeholder perspectives, pushed a systemic approach. The solution presented relies on input collected via group model-building sessions, from engineers with a huge variety of domain and discipline experience. Two workshops were conducted focused on finding a working definition for technical debt, and creating a schema of technical debt attributes. These activities are used as the basis for a process, and associated tool, built to perform an assessment of the technical debt associated with a project. Our research concludes by identifying where projects can utilise this approach most effectively, and the benefits of technical debt assessment for complex projects.

## AM - Session 2.2: Claims and Benefits

**Model Based Systems Engineering in Automotive Industry Progress and Next Steps**  
*Andrew Howells, Manoj Lad & Ian Aitchison (Changan UK R&D Centre),*

The Systems Engineering capability of Changan UK (CAUK) has grown since the last presentation at ASEC [Howells2015]. This paper explores the continued development and implementation of MBSE initially based on the ACRE approach, in the Changan automotive powertrain environment. The areas of discussion are based on 4 main areas:

- **Pushing the boundaries of Systems Engineering Practice**  
  Changan UK (CAUK) have developed the Changan Approach to Systems Engineering (CHASE). This has evolved to incorporate functional safety, diagnostics and advanced documentation.

- **Realising the value of SE**  
  The CHASE approach now enables the company to track the progress of technical development through the release of technical design specifications (TDS) documents. Significant improvements have been made against traditional project management methods.

- **Applying SE in Context**  
  The MBSE approach developed by CAUK is currently being applied to current and future Hybrid powertrain projects.

- **The evolution of a systems engineer**  
  The approach being led by CAUK is now being adopted by HQ and the world wide engineering centres. Our key message is: for the successful implementation of a MBSE process the people and the process needs must come first, the tools should be developed to meet these needs.
### Making Claims - The Evidence Pattern
**Simon Perry & James Towers (Scarecrow Consultants Ltd)**

In Systems Engineering, making claims is common. There are many types of claims that can be made, such as those for safety cases, claims about the way a project is managed, claims about testing etc. In general, apart from claims made in safety cases, such claim-based argumentation is often done in an ad hoc fashion and almost never using a MBSE approach.

Such model-based approaches do exist, for example Goal Structuring Notation (GSN) and the Object Management Group’s Structured Assurance Case Metamodel (SACM). However, both these notations and approaches have a strong emphasis on “formal” assurance and either mean learning / using a new notation (GSN) or are rather heavyweight in terms of the number of concepts (SACM). As part of INCOSE UK’s MBSE Working Group’s enabling patterns work stream, members of the group felt that an easy to use evidence pattern would be useful, that could be employed to make any kind of claim-argument-evidence assertion, not limited to assurance and safety cases. The result of this work is the Evidence Pattern, already being used by members of the working group in the rail and automotive domains.

The pattern is based around the concept of a claim made about a subject. Such a claim is supported by arguments that are, in turn, reinforced by evidence. Any item (a claim, argument, evidence or the links between them) can have counter-claims made about them and can also be further supported by additional claims. The Evidence Pattern defines four viewpoints that must be realised to produce valid evidence-argument-claim chains and the presentation will describe each of these viewpoints, showing how they are defined using MBSE techniques and giving examples of their use. Discussion will also be made regarding tailoring of the pattern, to add additional concepts (such as integrity of evidence and assumptions).

---

**Academic Research Showcase Poster Competition**

We are pleased to announce that we will once again be holding an Academic Research Showcase poster competition, and there will be posters on display at the event. Delegates will have the opportunity to read the posters and discuss the research findings with the poster authors throughout the event.

This year, Dyson have kindly offered to sponsor the Academic Showcase. They are supplying some mystery prizes for the competition winners and will be presenting them at the end of the first day.
<table>
<thead>
<tr>
<th>PM - Session 2.3: Evolution of Systems Engineers and SE Organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>13:30 - 14:15</strong></td>
</tr>
</tbody>
</table>
| **Network Rail Infrastructure Projects**  
*Kevin Gedge & Darren Jowett (Network Rail)* |

The Network Rail (NR) Infrastructure Projects Engineering function (IP ENG) was established in January 2016 to provide engineering leadership and a functional home for all engineers in IP. It was created to improve and provide consistency in engineering assurance; compliance with legislation and respond to the lack of a whole systems approach to engineering across NR IP.

This paper explores the development of the IP-ENG function and its focus on Systems Engineering, Systems Engineering competencies and the desire to embed Systems Thinking and knowledge across all IP engineers (circa 1500 individuals) as well as down through the supply chain. The paper focuses on the policies and standards that were developed to augment this ‘systems approach’ across IP and how they build on the demonstrated successful application of Systems Engineering across a small number of NR IP projects.

The paper takes an in depth look at the integrated engineering lifecycle (iELC) - which has been in development since 2015 - and how this provides engineering assurance in response to the high level risks identified within NR IP including:

- Project outputs not satisfying project requirements because of inadequate requirements management, blurred accountabilities and a lack of governance and scalable end to end Engineering processes
- A Systems Engineering approach not being applied to infrastructure changes on the railway due to a lack of an integrated engineering approach and Systems Engineering expertise within the industry

The iELC does for the first time provide a step change in the way projects are delivered, putting Systems Engineering and integration at the forefront with a configurable phased lifecycle approach, which aligns with the policy for management of Network Rail projects, ISO/IEC15288:2015 as well as improving integration between engineering and non-engineering activities following the key principles of collaborative working within Building Information Management (BIM).

| **14:15 - 15:00** |
| **The Evolution of a Systems Engineer**  
*Paul Davies, thesystemsengineer.uk* |

The premise of the paper is that the evolution of an SE has to balance his or her educational background; their personal career arc; and the state of readiness and prioritised needs of the employing organisation.

Evolving an organisation towards the adoption of Systems Engineering, and evolving junior engineers into fully-fledged systems engineers, is all about change. Rule 1 of Change Management is “Follow the Money”; organisations typically only change their processes in response to clear evidence of where they are losing money. Whilst there is strong research on the best ROI of individual SE practices, there is a “natural” order of organisational adoption based on emerging clarity of money-losing waste.

There is a definable set of knowledge, skills and experience that SE-mature employers want from MEng graduates in SE, or from single-discipline graduates on completion of an SE-oriented Graduate Training programme. Many of these skills are missing from current undergraduate engineering programmes.

Young engineers with different educational backgrounds and initial employment roles may enter SE in different ways, illustrated against a project process flow diagram. There are better mappings of graduates’ backgrounds to entry-level roles, and further roles to fill skillset gaps, than are usually seen in employer organisations and training programmes. In summary, it is shown that organisational evolution and needs, and individual career development in SE, can be better aligned.
### How not to do Requirements Management with Civil Engineers
Or
Embedding Requirements process into Design process on Multi-disciplinary Civil Engineering Projects
Anne Bearne (ARUP)

The topic of this paper is the application of requirements management processes to multi-disciplinary, predominantly civil engineering, design and build contracts in the rail sector. The application of requirements management to civil engineering projects is unusual and is complicated by a reluctance to change existing tried and tested processes. However, rail clients are increasingly demanding proof of requirements compliance on a clause by clause basis, in order for project work to be approved. Additionally key clients in the rail industry, Network Rail and LUL, now have their own requirements processes which mandate implementation of RM on all projects. The challenge has been to find the right process to fit with the types of design process used by often more than 10 different disciplines, whilst achieving value for money and returns through swift approvals.

This paper will explain the development of an understanding of the emergent needs of the rail client, the project team and the designers; discuss the first, traditional, application of requirements management, which failed; and discuss the second method which was successful. The conclusion will define a new way forward in requirements management for civil contracts, namely The Arup Embedded Requirements Process. The philosophy of this new process is to embed the requirements process within the design process and return ownership of requirements to design leaders. This is characterised by design leads leading on categorisation and allocation of requirements and by integrated requirements and design deliverables. This process is now emerging as a standard process for RM within Arup's rail sector for Design and Build contracts.

### Agile SCRUM in Systems Engineering – A Practical Application
Paul Wheway (Thales UK)

Agile methodologies have been used extensively in software development now for a number of years; however, applications in Systems Engineering have been limited. The complex nature of typical Systems Engineering projects is often seen to be a barrier to the adoption of Agile; the traditional V-lifecycle and formal contract milestones do not gel well with Agile working. Furthermore, issues exist in the interface between systems and software engineers, including the misalignment of processes and lifecycles.

To try and mitigate these issues and investigate the challenges, the Systems Engineering elements of a Software dominant project were approached with an Agile / SCRUM methodology. The application of the principles of Agile to Systems Engineering are explored herein, through real world experience on a live project. As a part of this approach, co-engineering is a theme that arises and applies to Agile working. This co-engineering helps to develop solutions that are both buildable and understood by all of the team.

The approach taken, with a phased introduction of this method of working, lead to positive results and benefits being realised both in terms of demonstrating that an Agile SCRUM approach can work for Systems Engineering in these types of projects and in breaking down barriers between different disciplines.

This paper outlines the approach taken for adoption, outcomes and the lessons learnt of this work. The paper shows how the Agile SCRUM approach can be applied to software dominant projects in a practical manner and how this could be extended further to projects where software is only one element.
Registration and Event Prices

Registration

Visit our online registration facility at www.ASEC2016.org.uk. Here you can register for the event, book accommodation and pay by card through a secure payment facility with Lloyds Cardnet via SagePay. Options to pay by cheque or company order are also available.

If you are unable to take advantage of our on-line registration facilities, please contact the INCOSE UK Secretariat either by email at enquiries@incoseonline.org.uk or by telephone via 01460 298 217 or fax at 0845 280 5304.

Prices and Accommodation

The event prices for INCOSE UK members are:

<table>
<thead>
<tr>
<th></th>
<th>1 Day</th>
<th>2 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member Rate</td>
<td>£300</td>
<td>£550</td>
</tr>
<tr>
<td>Student / Senior Member</td>
<td>£150</td>
<td>£275</td>
</tr>
</tbody>
</table>

Non-members are welcome, but you will be charged an additional £105 (VAT exempt) that will give you the benefits of INCOSE membership for 12 months from registration. Student membership for non-members is an additional £35 (VAT exempt). The senior rate only applies to those already registered as INCOSE Senior members.

Prices include lunch and morning and afternoon coffee on each day.

Overnight accommodation is available at the event venue and must be booked with the event registration. Accommodation costs £120 per night (dinner, bed and breakfast) and is charged at cost, so there are no discounts or concessions. All pricing information is available on the event website.

Non-residents who wish to attend the Conference Dinner will be charged an additional £35.00

All prices quoted here are exclusive of VAT (add 20%).

Associate or Certified Systems Engineering Professionals (ASEPs or CSEPs)

INCOSE Associate or Certified Systems Engineering Professionals (ASEP or CSEP) receive 1 PDU (Professional Development Unit) for every hour they attend the conference (up to a max 120 PDUs). Furthermore, if you are already an ASEP or CSEP, but are not currently a member of INCOSE, joining INCOSE when registering for ASEC 2016 will earn you an additional 5 PDUs for your year of membership.

About INCOSE

The International Council On Systems Engineering (INCOSE) is a not-for-profit membership organisation founded to develop and disseminate the interdisciplinary principles and practices that enable the realisation of successful systems. INCOSE has grown significantly since its formation in 1990.

Today, there are nearly ten thousand members representing a broad spectrum— from student to senior practitioner, from technical engineer to programme and corporate management, from science and engineering to business development. Members work together to advance their technical knowledge, exchange ideas with colleagues and collaborate to advance Systems Engineering.

In the UK, membership numbers have grown steadily, with 50 at our inaugural event in September 1994 in Shrivenham, rising from 350+ members in 2003 to over 950 members at the end of July 2016. A key goal for INCOSE UK is to achieve a steady and sustained increase in the number of members, further broadening the base of the membership to include new industrial domains.

INCOSE UK’s governance arrangements include an Advisory Board, which has now grown to almost 40 organisations from across industry, government and academic, spanning both traditional and non-traditional Systems Engineering domains.

Venue and Travel Information

The venue for ASEC 2016 will be the The Scarman Training and Conference Centre, University of Warwick, Scarman Road, Coventry, CV4 7AL (postal purposes only) or CV4 7SH (SatNav).

Car Parking

Free car parking is available in a car park to the rear of the venue.

Directions

For detailed directions, see the venue website: http://www.warwickconferences.com/guests/scarman

Registration now open - please book early

Please use the online facility at www.ASEC2016.org.uk to register and pay for your attendance.