

INCOSE UK Rail Interest Group 22nd June 2010

2nd Railway Systems Engineering Workshop

Workshop Notes

The Workshop was divided into three sessions, each associated with a theme. In each session there were a number of presentations followed by an open discussion. Copies of the slides of each presentation were available to participants.

These brief notes record some of the points made in the three discussion sessions. They are offered as an *aide memoire* for participants; there is no expectation that they will provide those who were not there with a comprehensible account. While some of the points made reflected a general consensus between participants, this is not necessarily true for all of them. We record points without attempting to show how much support there was for each.

Notes in square brackets are remarks added by the note takers to try to aid understanding.

These notes were compiled by Bruce Elliott, Alan Knott and Colin Wood. Please send any questions or corrections to Bruce Elliott at bruce.elliott@arbutus-tc.co.uk.

Introductions

The chair for the event welcomed all participants. He was particularly pleased to see a large Dutch contingent again. He asked that participants keep in mind the fact that difficult times not only lead to challenges but also create opportunities for change.

Theme 1: A Strategic Necessity?

Are there occasions where the decision to invest in SE is not a matter of cost-benefit analysis but of absolute necessity – there is no alternative? These presentations will suggest that there may be such occasions.

The following presentations were made:

- **“Getting more from rail for less money”, Duncan Kemp, Lead Systems Engineer DfT Rail Group**

Notes:

Duncan provided the keynote introduction.

Duncan reminded participants of the economic and fiscal context behind the necessity for rail engineering to reduce the cost of the railway to taxpayers whilst maintaining safety, capacity, customer satisfaction, reliability. Duncan suggested that SE had an important role to play in achieving this objective. Duncan observed that clarity on roles was also important and asked: who was the Design Authority for the GB Railway?

- **“Last is First: Systems Engineering - a UK plc Perspective, Terry Hill, Chairman, Global Transport Market, Arup Group”**

Abstract:

The UK is a rich source of anecdotes and hard facts that demonstrate the pitfalls of disconnected serial project design and planning, and is also home to some of the best examples of joined up parallel-processing success stories. Systems Engineers must assert their place as being not just being central to value creation, but engaged and directive from a project's outset. This means bringing creativity to the successive stages on the route to outstanding project performance. Remember, creating systems that work brings tremendous value and satisfaction to owners, designer, builders, operators and users. Here is the dilemma: those who will take control of the system must have their say at conception, and these activities are often years apart. Commissioners must also be initiators.

Notes:

Terry introduced himself as a Civil Engineer who admired SE. Terry suggested six principles that underpinned the successful application of SE:

1. Define the purpose
2. Think holistic
3. Follow a discipline procedure
4. Be creative
5. [Don't forget the] People
6. Manage the relationships

Terry referred to the [excellent] paper 'Creating Systems that Work' produced by the Royal Academy of Engineering [and available from www.raeng.org.uk].

Terry recalled an engineering organisation he had visited where the engineers worked for most of the day in their own offices but, at every coffee break gathered together to discuss drawings. He suggested that this was “integration by coffee break” and that we need to design our organisations in order to enable SE.

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- **“Enabling innovation in the GB rail sector: A systems approach”, Charles Boulton, Arthur D. Little Ltd**

Abstract:

Implementing the Railway Technical Strategy will require technological innovation. However there is a perception that the GB rail industry has a conservative attitude towards innovation. The presentation will describe a study commissioned by the Technical Strategy Advisory Group to analyse and validate the systemic barriers to innovation and identify actions for improvement. The approach used invoked systems thinking to model the cause-effect linkages leading to innovation barriers across the sector. The results of the analysis suggest that a key enabler for radical innovation is to establish a system leadership and sponsorship function for GB rail.

Notes:

Charles reported that the study had identified three classes of barrier to innovation:

1. Lack of a holistic “Systems View”
2. Weaknesses in organisation processes, competence, culture
3. Poor implementation risk management

Charles suggested that people can innovate, overcoming barriers, if they understand the need and can make a commercial return at an acceptable risk but that it was difficult to foresee and to realise equitably the benefits in a complex, fragmented system. One of the report’s recommendations for overcoming these barriers was to introduce a better systems context for innovation with systems sponsor and systems leadership functions.

The chair summarised some themes running through the presentations:

- The speakers had made a convincing argument that there were occasions when SE was a strategic necessity. Long projects delivering complex systems need someone to establish and stakeholders’ requirements for the system as a whole, maintain these requirements as things change and check whether they will be met. Without this, stakeholders are likely to be disappointed.
- DfT Rail presumably agrees as it has required that a systems engineer should take a leading role on the Value for Money study.
- However, organisational issues often stand in the way of effective systems engineering.

The following points were made in discussion:

- There was general agreement with the main points made.
- There was considerable interest in how the recommendations from the enabling innovation study would be taken forward and some discussion over how effective they might be.
- A view was expressed that engineers did not all have the communications and people skills that are needed to make SE work.
- It was noted that socio-technical systems (systems containing people and machines) tended to degrade gracefully, which was a strength but also meant that slow degradation might go unnoticed.

Theme 2: Delivering Business Benefits?

A very disparate series of case studies will explore occasions when a systems approach has delivered tangible, if not always quantifiable, business benefits

The following presentations were made:

- **“From business requirements to system performance requirements by railway engineering simulations”, Catherine Norris, Systems Modelling Delivery Manager, London Underground**

Abstract:

In 2004 London Underground set out its vision on the use of modelling and simulation to manage system performance in the paper “Simulating Capability”. This presentation revisits that vision followed by an introduction to the SSR [Sub-Surface Railway] Upgrade Automatic Train Control programme. The generic simulation tool functionality required to support such a programme is discussed as is the unique challenges associated with the use of these tools. How can simulations be used to ensure that the performance requirements specification satisfies the business requirements? What is the system simulation strategy for delivering performance over the project life cycle?

Notes:

Caroline described how simulation was being used as a tool for reducing uncertainty about outcomes through the project lifecycle but acknowledged that uncertainty could not be eliminated. Caroline described a number of challenges that remained to her team but was clear that the modelling was providing valuable support to the SSR upgrade. Optimising the sub-systems of a large complex system individually can never optimise the whole system – railway engineering simulation makes it possible to optimise at the system level.

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- **“Project Evergreen 3: Private sector specification and delivery of enhancement”, Richard Harper, Strategic Development Manager & Stephen Barker, Infrastructure Interface Manager, Chiltern Railways**

Abstract:

In the last 10 years, Chiltern Railways has managed investment of £150m in its railway. Projects Evergreen 1, 2 and 3 incrementally add capacity and capability to match growing demand. Evergreen 3 delivers faster journeys, more capacity and a new route to Oxford. An initial proposition proved undeliverable and alternative solutions were quickly developed and subjected to value engineering before being finalised. This was only possible because of the close working relationships and ready access to systems tools within the team. The mainline element of the project is under way and due for completion by 2011.

Notes:

Richard and Stephen reminded the audience of Peter Parker’s statement that “The railway falls flat on its interfaces”. They described the evolution of the Evergreen 3 scheme as more information became available. Some changes had made it more elaborate; others had cut it back. At every stage, each change was checked back against the business objectives for the project, often using models. The credit crunch had forced a shift of investment from rolling stock to infrastructure.

- **“The application of discrete event simulations to railways - case study: modelling a rolling stock maintenance depot”, Gabriel Smith, Systems Performance Integration Manager, London Underground**

Abstract:

A railway depot is a complex system. The London Underground Neasden Depot is undergoing significant change, including additional stabling and maintenance facilities and new plant, equipment and maintenance processes, in order to accommodate the new Metropolitan Line fleet. The presentation will describe how discrete event simulations have been deployed to inform design, planning, logistics and operational decisions and to answer questions such as: Is the predicted reliability of resources a threat to the operation of the depot? The presentation will discuss the extent to which a depot and its operations can be realistically represented in a model.

Notes:

Gabriel described the application of the ProModel tool to the depot. Gabriel acknowledged that modelling cannot replace detailed train movement planning and that depot operational data is hard to find but concluded that it is possible to model depots as a and that simulation was a useful tool to deliver confidence that LU was building the most economic and efficient technical solution.

- **“Systems engineering a modular signalling solution”, Richard Inglis, Invensys Rail**

Abstract:

It has become increasingly difficult for clients to develop robust business cases to support resignalling schemes and deal with the ever increasing pressure to be more efficient. This presentation will outline the best practice and systems engineering processes Invensys Rail has adopted to deliver a standard modular signalling solution to fit a wide range of applications, whilst being compatible with future ETCS technology. The potential immediate and medium term benefits to clients will also be discussed and how the client could get involved in working towards a cost-effective solution without compromising safety or operational performance.

Notes:

Richard described progress on the modular signalling project. Richard suggested that the key to success was importing technology and processes from other industries within an SE context.

The chair summarised some themes running through the presentations:

- In many of the case studies, the value of SE was delivered through “left shift”, identifying issues earlier when they can be resolved at lower cost.
- Modelling was a common method of achieving “left shift” by forecasting properties of the overall system before it was built.
- The business benefits delivered were not all easily quantifiable in monetary terms: obtaining a 30-year franchise was a significant benefit to Chiltern Railway’s business but it would be hard to quantify.
- The business benefits of SE include removing unnecessary “gold plating”.

The following points were made in discussion:

- Although the four speakers had clearly described the application of systems engineering ideas, it was noticeable that the phrase “systems engineering” had been used very seldom. An old question returns: does SE have to be performed by systems engineers?
- Some of the benefits of SE were realised though slaughtering sacred cows and cutting back railway engineers’ pet schemes. This may be a service to the public but we had better not expect to be thanked from all quarters for doing it!

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- It was noted that all the case studies related to engineering-led projects but that there was also scope for operational innovation, for instance the new [no-longer-circular!] LU Circle Line.
- It was also noted that the revolutionary aspects of modular signalling lay in their effects on the signalling installation and testing processes. Richard Inglis had to say twice that the only on-site testing performed was a simple check that everything was wired up because the questioner found this hard to believe. Richard also clarified that this was where the real cost savings were to be found.
- The fact that some of the speakers had been able to put some rough figures on the benefits of the approaches was welcomed but it was suggested that this was the exception rather than the rule and that the SE community needed to be able to quantify the benefits of SE further.

Theme 3: Advancing the practice

Even where systems engineers can demonstrate real business value from investing in their discipline, this is no excuse for resting on our laurels. Like everyone else, there is a continuing requirement to deliver more for less. These presentations will explore the way forward.

The following presentations were made:

- **“Delivering economic and efficient system engineering”, Andy Bourne, Engineering Manager (Train Systems), Tube Lines**

Abstract:

In the current economic environment, system engineers need to be more resourceful than ever both in the way they practice SE and how they present it to senior management and other stakeholders. Using examples of work done in the author's current organisation and projects, areas where opportunities might lie to improve SE delivery in this climate will be proposed, including: removing duplication of effort; optimising the scope of SE; critically examining SE processes; institutionalising lessons learned; critically examining customer requirements; and building resilient teams. Arguments will be proposed that might convince the sceptical stakeholder.

Notes:

Key points that Andy made were:

- SE activities are duplicated across the supply chain and this offers opportunities for reducing the cost of SE but only where there is trust.
- Applying SE to parts of projects that are simple and well covered by standards may not offer a good return on investment
- You have to continually review SE processes, like any other, to weed out low-value activities
- ‘T’ shaped engineers – with broad system understanding of SE and a deep knowledge of particular discipline were valuable

Andy's recommendations included

- Don't oversell the benefits of SE
 - Don't ignore the problems on the horizon – be proactive
 - Keep things simple
- **“Network Rail Application of Systems Engineering to Major Enhancement Programmes”, Giles Thomas, Systems Integration Manager (Thameslink), Network Rail**

Abstract:

This presentation will provide an update on Network Rail's approach to major multidisciplinary enhancement programmes. It will describe an innovation: the creation of an industry system integration body, representing DfT, Network Rail and the train operating companies, to enable integration of new trains, infrastructure, and operations. It will describe evolving approaches to lifecycle management and V&V; and standardised approaches to specification, system architectures and reliability analysis before discussing the creation of a Network Rail systems engineering function. Experiences of these new approaches will be shared using the programmes for Thameslink, Crossrail, IEP and Reading as case studies.

Notes:

Graphical architectural presentations had been found to be of particular value on these projects.

The chair summarised some themes running through the presentations:

- Improving SE practice seems to be as much to do with improving the organisational context within which SE is performed as it is to do with improving the processes themselves.

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- When it comes to improving SE processes, focussing limited resources on the issues where greatest value can be added seems to be key.

The following points were made in discussion:

- Andy's advice not to stick one's head in the sand was supported. All project costs will come under scrutiny. Systems engineers must be prepared
- But there are real opportunities for the resourceful and opportunistic.
- SE must not try to do everything; we should focus on the areas where we can add most value.
- There are now a range of proven tools, particularly in the simulation and modelling areas, which should play their part in an effective SE programme.