Systems Engineering in Network Rail Infrastructure Projects

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Why Bother?

- Sept 2014 - NR Reclassified as Public Sector Body
- £38Bn Investment in Rail
- On-time, to Cost and Quality
- Increased complexity of Railway Infrastructure
- Responding to criticism from reviews
“…the ORR announced… NR could be in breach of its licence after uncovering major flaws in the way projects are costed, managed and carried out. The reasons…include poor setting of project requirements, inadequate governance and inconsistent consideration of safety issues. In addition, ‘the accountabilities of the client, sponsor and deliverer are blurred, as projects move through their lifecycle.’” Railnews (front page), September ‘15

“…[the causes of] cost escalations and delays…include…poor scope definition from the outset and ongoing ‘scope creep’ ” Bowe Review, November ‘15

“There are two principal issues relating to the increased cost…across the portfolio. Firstly, there was inadequate planning and scope definition of a number of projects in their early phases.” Hendy Review, November ‘15

“Lack of Accountability & Capability for Design Integrity (inc. Safety by Design & including Suppliers’ Designs) and Assurance” ORR Criticism of Engineering Assurance in IP
Internal Risks Raised

- **IP-ENG-002**: There is a risk that project outputs may not satisfy project requirements.
  - Cause: Due to inadequate requirements management, clarity regarding accountabilities, governance and scalable end to end Engineering process.

- **IP-ENG-003**: A Systems Engineering approach may not be applied to network change.
  - Cause: Due to a lack of an integrated engineering approach and systems engineering expertise / awareness within Network Rail.

- **IP-ENG-004**: Engineering Verification and Validation processes may not be fully implemented on every Project
  - Cause: Due to a lack of competent resources / project time, Budget constraints and the Verification and Validation process has not yet been developed;
Wider NR developments - People

Role Families

- Strategic Engineering
- Technical Engineering Expert
- Design and Scheme Development
- Project Engineering
- Construction, Test and Commissioning Engineering
- Operational and Maintenance Engineering

Engineering Career Tracks

Project Engineering
This role family is responsible for bridging the boundaries between engineering and project management whilst being part of or leading the team that contributes to the planning, development, design and building of products, railway infrastructure or a larger system.

A Project Engineer optimises the balance between quality, cost and performance, ensuring all work is delivered to schedule.
Systems Engineering with Network Rail Infrastructure Projects

Engineering Director

Technical capability & assurance
- Technical Heads of Discipline:
  - B&C
  - E&P
  - Signalling
  - Telecoms
  - Track
- Standards development
- Engineering assurance

Resource capability
- Competency & discipline management
- Training & development
- Resource planning
- Career & role families
- New entrant programme

Systems capability
- Systems engineering & discipline management
- Information management
- Construction management
- Change & national projects

Infrastructure design group (IDG)
- Programme management office
- Heads of Design:
  - B&C
  - E&P
  - Signalling
  - Track

A better railway for a better Britain
The Engineering framework covers:

- Job specific technical competencies (incl. prof qualifications)
- Role family capabilities
- Common Eng. competencies (e.g. Systems Eng)
- Network Rail (Behaviours, Safety, Risk)

- Defined by IP Disciplines
- Defined by IP/STE/RBC
- Defined by IP/STE/RBC
- Defined across NR
## Systems Engineering Competency Framework

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<td>SE05 - Interface Definition and Management</td>
<td>SE08 - Design for Robustness, Whole System Lifecycle</td>
<td>SE11 - Safety by Design</td>
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<td>SE12 - Modelling and Simulation</td>
<td>SE13 - Systems Integration &amp; Verification</td>
<td>SE14 - Validation, Transition to Operation and Handback</td>
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<td>SE17 - Integration of Specialisms / Managing Stakeholders</td>
<td>SE18 - Progressive Assurance through the GRIP Lifecycle</td>
<td>SE19 - Planning, Monitoring &amp; Controlling SE Activities</td>
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- Based upon INCOSE systems engineering competency framework *(INCOSE-TP-2010-003 – Issue 03, Jan 2010)*
- Tailored to Rail, GRIP and the level of maturity in Systems Engineering within the industry
Process – Requirements Management

Project Requirement Specification (PRS)
One document for concept to detailed design.
Process - iELC Overview

What it is:

- A phased lifecycle (diagram) that sits along side GRIP.
- Engineering phases broadly align with GRIP stages.
- Each phase details potential engineering activities for all project complexities (i.e. a Framework).
- Between each phase sits an Engineering Gate, providing engineering assurance.
Process – iELC Diagram
iELC Engineering Gates

Engineering Gates:

➢ Between each phase sits an Engineering Gate.

➢ Gates ask Plain Language Questions (PLQs).


➢ Gates focus on providing Engineering Assurance for new IP Engineering Director, as part of the new Central Engineering Assurance function.
Tools – MDL & PCAT

Master Deliverable List (MDL)

- The MDL is a comprehensive list of deliverables used to guide projects throughout design and delivery.
- Uses ‘Disciplines’, GRIP stages to denote what is required when

Project Characterisation Tool (PCAT)

- The PCAT assists a project in developing a project specific deliverables list.
What Next?

- Further roll out of SE techniques from IP to our clients
- Improved Requirements decomposition, traceability, collation of evidence and V&V

KG master model

- Stop talking about ‘Systems Engineering’
Thank you

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