Systems Engineering for Infrastructure Projects

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Systems Engineering Approach

- Poor Scope Definition
- Working in Discipline Silo’s
- Poor Sharing of Lessons Learned and Best Practice
Example of Systems Learning Need

**Activities**

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<tr>
<th>Requirements Analysis</th>
<th>INCOSE Competence</th>
<th>BT Competence: Entrance Systems</th>
<th>BT Competence: Onboard Train Control</th>
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<td>Systems Thinking: Systems Concepts</td>
<td>Vehicle Integration</td>
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<td>Systems Thinking: Super System Capability Issues</td>
<td>Total System Integration</td>
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<td>Systems Thinking: Enterprise and Technology Environment</td>
<td>Requirements Management</td>
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<td>Holistic Lifecycle View: Determining and Managing Stakeholder Requirements</td>
<td>1C_06 Operability</td>
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**Vehicle Engineering**

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**Systems Integration**

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**Cab & Saloon Systems/Mechanical**

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**Allocation and Design**

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A better railway for a better Britain
# Systems Engineering Capability

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<td>Specialist Professional Discipline Competencies</td>
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**Behavioural Competencies**
- Drive for Results
- Initiative
- Teamwork
- Making Decisions
- Continuous Improvement

**Cognitive & Enterprise Competencies**
- Safety
- Ethics
- Problem Solving
- Innovation
**Scope Definition**

- New Requirements Management Policy Issued
- Mandates use of DOORS
- Training of 270 trainers complete, c3000 by end 2016
- Piloted on ECML & Thameslink
- Risk Assessment Process for Requirements Maturity
Engineering Lifecycle Developed
Technical Stage Gate Reviews

- Engineering Assurance Function
- Risk Based Approach
- Expert Peer Review from Across NR & External where Needed (inc. Suppliers, Maintenance, etc.)
- Technical Stage Gates identified in Engineering Lifecycle
- Supporting Checklists & Guidance
- Risk Assessment of Checklist Items not Fully Closed
- Piloted on Crossrail West & Heathrow ETCS

| Has an asset condition report been completed issued with an allowance made in the programme for all special working arrangements identified? | Asset Condition Assessment Report (SICA): The purpose of this product is to record the existing condition of the assets which will be involved in the investment scheme. Asset Condition Report (Alterability): The purpose of this product is to record the existing condition of the assets which will be involved in the investment scheme for alterability (including but not limited to Power Supplies, Existing Transmission Systems, Data). |
| Have all Correlation Requirements been considered and programmed? | The purpose of the Correlation report is to confirm the status of the existing infrastructure, highlighting any deficiencies that may also need addressing. |
| Has an IDC process been agreed between all stakeholders? | The purpose of the IDC/IDR is to integrate all the multidisciplinary elements of design. Form B/Forms 2 & 3 - Final design: To certify the design in accordance with all statutory safety standards requirements. Form Bs (Forms 2&3 for Civils) are required to be integrated under IDC and IDR. Geotechnical Survey to reduce the risk of unexpected ground conditions increasing the cost of structural foundations and other work associated with signals and locations. |
| Has an agreed Design Interface Schedule or equivalent been agreed between all disciplines and populated to ensure timely availability of engineering | A Design Interface Schedule (DIS) or Give / Get Dates are defined so that all engineering disciplines are aware of the requirements of the interfacing designers and are then able to undertake design integration activities correctly i.e. IDC / IDR. |
Interface Management

- Project Engineering Handbook to Provide Guidance
- Requirements Flowed Down from System to Sub-system to Component / Data
- Interface Matrices
- Interface Control Documents
- Interdisciplinary Design Reviews
- Interface Schedules
- Adopted on Thameslink Project

[Images of trains and interfaces]
New Product Reliability

Identify Core Sub-System Building Blocks (PBS) – *(Note: Will include Sub-system FMEAs)*

Component 1 – Standard Module: Demonstrate Proven Service History

Component 2 – New Module: Tech Readiness Level Risks

Component 3 – New Software Code: Tech Readiness Level Risks

Component 4 – New Software Code: Tech Readiness Level Risks

Product Sub-System Level FMEA

Identify all sub-system Interfaces

Combined Supplier-NR Reliability Risk & Op Register

Integrated V&V Plan (Supplier & NR) inc. Testing

Integrated Software Programme + Diagnostic

Prognostics / Condition Based Maintenance

Problem:

- Machine
- Environment
- Man
- Material
- Method

Why Analysis

- 5 Why Analysis

- 4 Why Analysis

- 3 Why Analysis

- 2 Why Analysis

- 1 Why Analysis

Analyze the root causes of the non-conformity and prioritize corrective actions to prevent future occurrences. Use the Fish Bone diagram to facilitate understanding the various factors contributing to the issue.
Summary

- Network Rail is Adopting a Systems Engineering Approach to Project Delivery
- New Engineering Lifecycle Developed
- ‘Hard’ Technical Stage Gates with Risk Assessment
- New Requirements Management Policy
- Interface Management Guidance Created
- New Competency Framework including INCOSE