What is Systems Engineering?

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Outline

• What is Systems Engineering?
  – Different Things to Different People…

• Share 3 Perspectives
  – A Process View
  – A Whole System View
  – A Whole Life View
Systems Engineering?

- 10 Systems Engineers in a room
  - 20 definitions of SE!

- INCOSE
  - At least 3 definitions

- It can be a Process, Approach, Discipline or a set of Competencies
  - It can include or exclude specialist systems related areas – e.g. HF, EMC, Safety
  - It overlaps significantly with PM – e.g. Change Control, Risk Management, Information Management
  - It is done by Engineering Managers and/or Project Engineers
Royal Academy of Engineering

• “There’s a great deal of pointless and near-theological debate about systems terminology

• It’s about designing systems that work!”
Process View (ISO 15288)

Special Processes

Enterprise Processes

Portfolio, Programme & Project Processes

Service Delivery & Operational Processes

Supply Network Processes

Utilisation & Support

Retirement

Concept

Development

Production

Acquisition

Supply

Validity

Maintenance

Operation

Disposal

Architectural Design

Integration

Transition

Verification

Validation

Requirements Analysis

Stakeholder Requirements Definition

Resource Management

Information Management

Configuration Management

Control

Assessment

Planning

Risk Management

Lifecycle Management

Investment Management

Enterprise Management

Policy & Strategy

Tailoring

Engineering & Technical Processes

Enterprise Management

Portfolio, Programme & Project Processes

Service Delivery & Operational Processes

Supply Network Processes

Utilisation & Support

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Policy & Strategy

Tailoring
**Scope of VLUP**

- **Victoria Line Schematic**
  - Overall Line 22.5 Kilometres long
  - Upgrading Signalling 2005-2011
  - 630V DC Traction System
  - New fleet of 47 x 8 car trains
  - Anticipated Service Level requires:
    - 43 Trains (Peak)
    - 29 Trains (Off-Peak)
  - Stations Served 16
  - Stations Managed by BCV 11
  - Depots 1
  - Major Power Upgrade
  - OPO
  - Connect
  - Track renewal

**New SER at each station on the line and NPD**
“Systems Engineering is cursed by the fact it has refined and become defined by the use of process to leverage benefits” – John Thomas, INCOSE President Elect
The Genesis of Systems Engineering

- Early electrical and electronic system
- General Systems Theory
  - Von Bertalanffy, 1968

- Explosion in computer/software/telecommunications systems in the 50 years has favoured the former
  - system synonymous with computer
Traditional Non-Systemic Approach
Systemic Approach
Systems Thinking

Causal Loops

End Game

Lateral Thinkers

Mediators

Soft Systems Methodology

Don’t treat a problem where it is found

Inquisitive into the whole

Optimise parts does not optimise whole

Simplify Complexity

Architecture

System Dynamics Modelling

See details in context of the whole

Plan Design Enable
Eric Honour – Successful Programmes
Focus on Mission/Purpose Definition
Technical Leadership

As exercised by the Systems Engineer, is crucial to the success of each programme role

John Thomas, INCOSE President Elect
Atkins Approach

What if you’re an Asset Owner?
Whole Life – Whole System

Articulate need for change

Define benefits

Characterise capability

Design capability

Define component requirements

Deliver components

Focus on value

Realise benefits

Use

Accept capability

Integrate capability

Focus on purpose

Focus on solution

Ring’s Value Cycle

Developed by Duncan Kemp, DfT
Articulate need for change

Realise benefits

Focus on value

Focus on purpose

Focus on solution

Integrate capability

Accept capability

Use

Define component requirements

Deliver components

Define benefits

Characterise capability

Design capability

Current Underground services are overcrowded and stunting London economic growth

• Improved London economy
• Better passenger experience

• Increase capacity by 10%
• Increase reliability by 10%
• Reduce whole life costs by 30% (maintenance, energy, etc.)

• Reliably 30 TPH
• Low energy/high capacity rolling stock
• Increased station throughput

• Rolling stock
  • Dwell time 45 seconds
  • ...
• Signalling
  • Headway

Plan Design Enable

Developed by Duncan Kemp, DfT
Define benefits

Characterise capability

Design capability

Define component requirements

Deliver components

Articulate need for change

Focus on value

Focus on purpose

Focus on solution

Integrate capability

Accept capability

Use

Realise benefits

Economy growing
Commuter numbers increasing

• Passengers on the train
• Peoples behaviour changing

• Demonstrate
  • Reliability
  • Capacity
  • Whole-life Cost

• Initial capability
  • 24 TPH
  • …
  • Final capability

• Buy rolling stock
• Upgrade stations
• Install signalling

Plan Design Enable

Developed by Duncan Kemp, DfT
Ring and V

Client side SE

Systemic and Systematic

Supplier side SE (the V model)
Questions?

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Plan Design Enable