Limitations of Systems Approaches, Methods & Models in Addressing Challenges in Complex Environments

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Bounding the discussion

- Please feel free to ask questions as we go
- I will move forward after each slide has been up for 2-3 minutes
  - There are only 16
  - I would like time to harness some of your observations, challenges in a final 10 minutes
- What I present and discuss here is a personal view, based on my ‘weltanschauung’ and within the constraints of my current underpinning knowledge & understanding

Introduction

- President INCOSE UK
  - Agile
  - Sport
  - Decision-making/Organisational Capability
  - Improving systems awareness
- Principal Engineer Dstl
  - Assured Autonomous Resupply
  - Mounted Close Combat
  - System Engineering Capability Development
  - Enterprise Resilience

Systems - a mechanism to explore complex problems in order to better understand them and do something to improve the situation (Flood & Carson)

Systems Engineering - a framework to build fit for purpose systems

INCOSE – A better world through a systems approach

A not-for-profit membership organization founded to develop and disseminate the interdisciplinary principles and practices that enable the realization of successful systems

Founded 26 years ago, over 11,000 members, in over 100 Chapters worldwide

Mission

To address complex societal and technical challenges by enabling, promoting, and advancing Systems Engineering and systems approaches

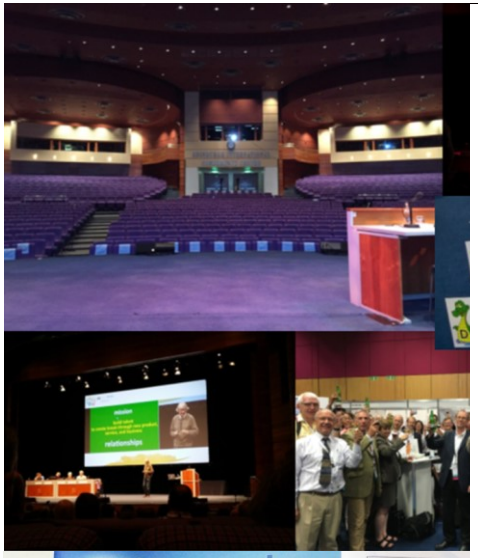
Goals

- To provide a focal point for dissemination of systems engineering knowledge.
- To promote international collaboration in systems engineering practice, education, and research.
- To assure the establishment of competitive, scale-able professional standards in the practice of systems engineering.
- To improve the professional status of all persons engaged in the practice of systems engineering.
- To encourage governmental and industrial support for research and educational programs that will improve the systems engineering process and its practice.

INCOSE UK

- >1000 individual members
- 37 Corporate members - UKAB
- Professional Development
  - Registration
  - Certification
- Technical Working Groups
- Publications
- Events
  - ASEC
  - Training Day
- International and EMEA Sector
- STEM

- **Volunteer Driven**
  - local and working groups
  - Support teams for Council members
  - UK Council roles

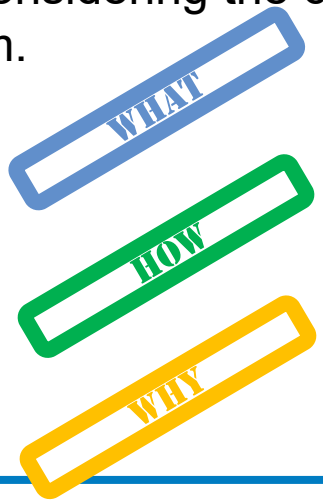


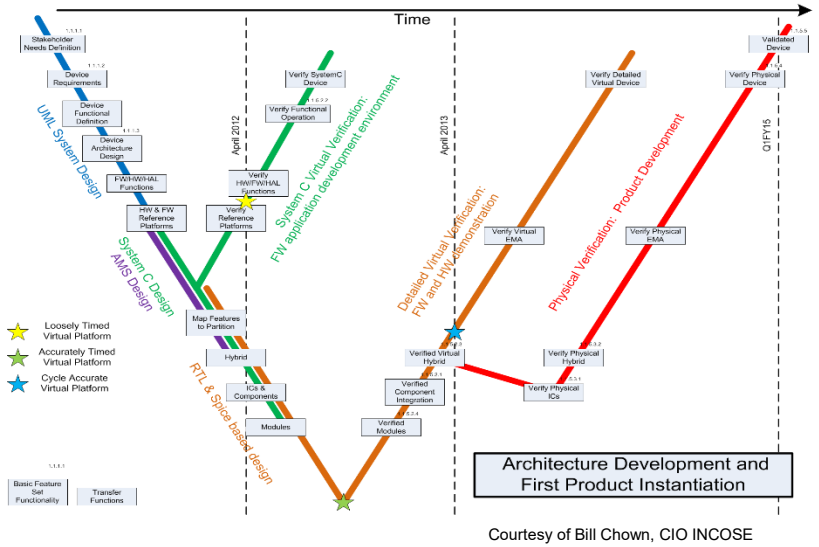
Key Systems Engineering Goals

- Provide a structured process for integrating and linking requirements, schedule, decision milestones, and verification
- Enable the project team to work to a single, integrated set of requirements and processes
- Enable integration of the system at the requirements and design stages (before sunk costs) rather than waiting until hardware and software is available
- Reduce unplanned and costly reengineering necessary to resolve omissions and integration difficulties

Systems Engineering – As is…

An interdisciplinary approach and means to enable the realisation of successful systems. It focusses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem.



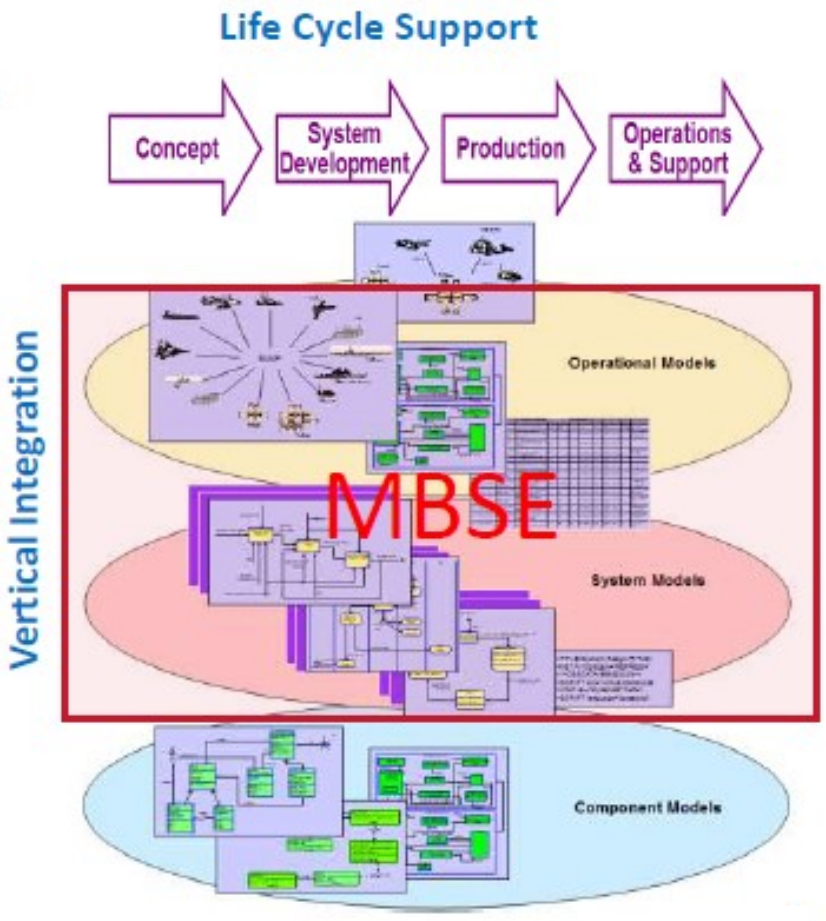


Courtesy of Bill Chown, CIO INCOSE

Emergent themes:

- Interdisciplinary
- Iterative
- Sociotechnical
- Wholeness

Model-based Systems Engineering – the to be?



Graphics © Laura Hart LMCO 2015

"Model: – A simplified version of a concept, phenomenon, relationship, structure or system – A graphical, mathematical or physical representation – An abstraction of reality by eliminating unnecessary components – The objectives of a model include; • to facilitate understanding • to aid in decision making, examine 'what if' scenarios • to explain, control, and predict events

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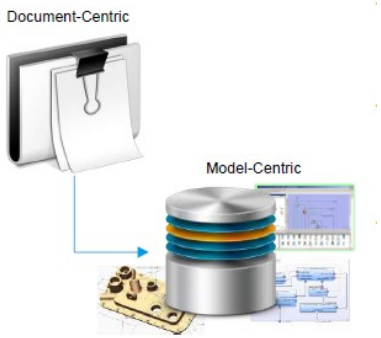
"Model-Based Engineering (MBE): An approach to engineering that uses models as an integral part of the technical baseline that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle."

Final Report, Model-Based Engineering Subcommittee, NDIA, Feb. 2011

"Model-based systems engineering (MBSE) is the formalized application of modelling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."

INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02, Sep 2007)

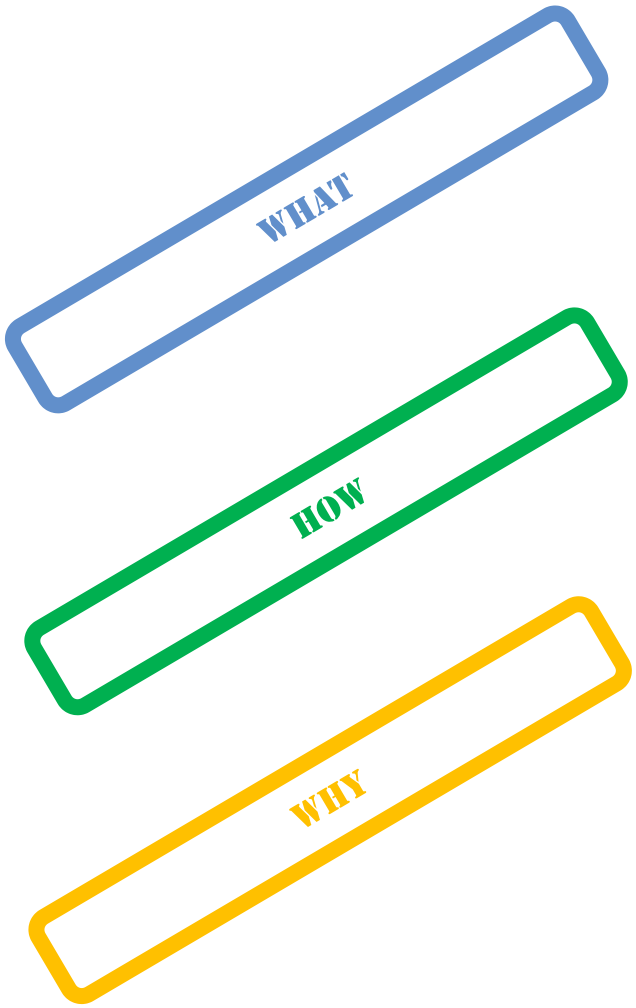


- Drive a consistent specification
- Analyse & interrogate system design
- Automate!!!

Limitations of Systems Engineering

- Current state of the Art
  - Document centric
  - Rigid process
- Transition to Model-Centric approaches
  - Automation
  - Simulation
- Complexity of man-made systems
  - Enterprises
  - Mega Systems
  - Human Activity Systems

Uncle Tom Cobley & All SE



- Agile
- System of Systems
- Capability
- Service Systems
- Lean
- Enterprise……

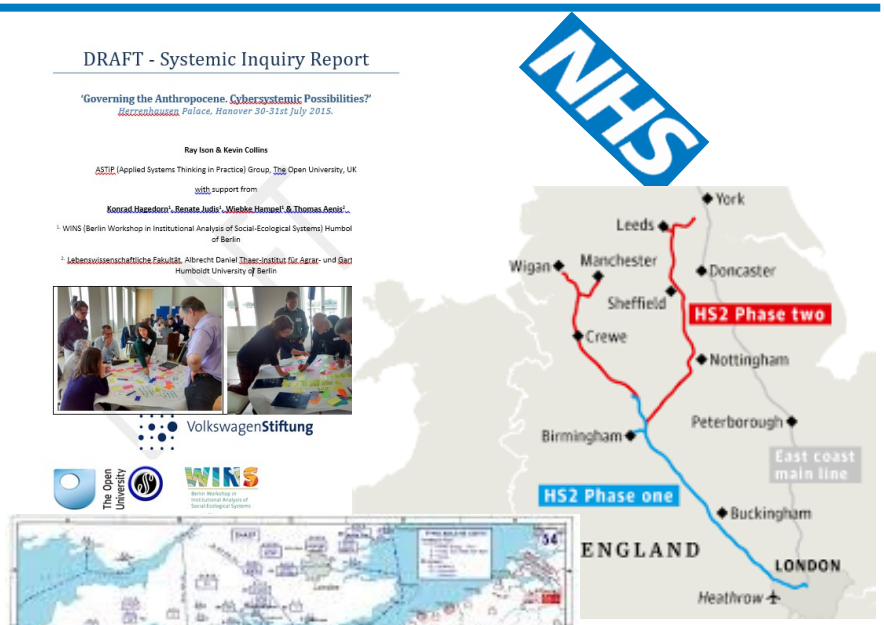
Problem space

Issues such as the Anthropocene are testament to the complexity of the issues with which systems people (Thinkers, Practitioners, and Engineers) are having to address.

The nature of the systems we need to create are more interdependent with complexity inherent and require transient and agile approaches.

However, no matter the approach, method, methodology or model our interventions often fail to lead to the implementation of systems that resolve these complex problems, even if used appropriately.

This does not mean these approaches are wrong or even flawed, simply that no single philosophy, applied in isolation, can address the variety of complexity.



Systems & Systems Engineering

- Systems Science, Thinking, aids understanding of the problem space…….

- If you need to build or produce a System, an artefact, product or service…….

  - You need to Validate it & Qualify it as 'fit for the purpose it is intend for' – for the whole of its life!

  - If it needs manufacturing you need to repeat production with the same level of confidence in X,000th off the line as the 1st off the line – assurance!

Modern Complex Problems

- Anthropocene/Healthcare/Mega Cities
- Intelligent Autonomy/"Human-on the-Loop" (AI, Neural Networking, Mission Command)

Why do we think that any one approach, in isolation, will solve the problem?

By solve I don't mean identify potential solutions but mitigate the problem so that it is no longer a problem!

So What is needed?

What's required – Personal view

- Collaborative responsiveness
  - synthesis of principles; I need all the systems approaches, methods, models to have utility (i.e. if you need a month think and I don't have it, or can't fund it…..)
- Recognise there are constraints – there is never a blank page!
- Transient lifecycles
- Agile Development (and the system development includes the systems thinking – Agile Systems Thinking?)

Discussion