Leveraging lessons learned from cross-domain SE implementation for transportation applications

Transportation Panel Session

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A little about Shoal ...

• A systems engineering firm based in Australia and the United States
• We focus on early-stage design
• We help our clients –
  • Articulate strategic aims and business goals
  • Understand and document operational needs, constraints and priorities
  • Capture and translate the problem space into basis for generating alternative solutions
  • Validating proposed solutions address the problem / strategic & operational needs
• We apply systems modeling tools & techniques
  • Using well-known systems engineering techniques and concepts in a fully-traceable, iterative process
What various industry domains have in common from an engineering perspective

COMPLEXITY AND CHANGE
Complexity in relationships are often hidden. Inconsistencies result in problems.
Change

Common to all

- Pervasiveness of software-intensive systems
- Faster technology refresh cycles
- Population growth

Common to some

- Population shift back into cities
- Decay of infrastructure in many Western countries
- Move back to public infrastructure
What lessons are applicable? No surprises, really ...

LESSONS (BEING) LEARNED
Primary lessons from our work

1. Identify the system boundary at the highest *useful* level

2. Apply lifecycle concepts at the highest *useful* level

3. Use systems modelling to help understand complexity and communicate issues
Universal design questions

• **Why** does it do it?
  • goal and objectives => mission

• **Who** uses it? Who is impacted by it?
  • organization elements and relationships

• **Where** is it used?
  • locations, logical and / or physical

• **When** is it used?
  • time, sequence, major events, cycles

• **How** is it used?
  • processes and procedures, behavior

• What is in it & what does it do?
• How is this achieved?

Problem Definition
  Operational Analysis
  “Black Box” context analysis

Solution Concept
Solution Design
Where is the (useful) system boundary ... or boundaries?

1. THINK HOLISTICALLY
Hitchins’ five-layer model
(Cook, 2003; incorporating Hitchins, 2007)

Layer 1 Product Level
Layer 2 System Level
Layer 3 Business Level
Layer 4 Supply Chain Level
Layer 5 Socio-Economic Level

Strategic Planning
Capability Design
Capability Acquisition and Through-Life Support

SoSE suited to very high levels of complexity

25 year Needs analysis
10 years Before EIS
Entry into Service (EIS)
Support
Disposal

SoSE & Enterprise SE
Traditional SE

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From strategy to system

Take ‘corporate’ guidance (Defence White Paper, Govt direction on shipbuilding, etc.) and translate to concept then to acquisition specifications
Diagram adapted from CDI – Systems Engineering
Applied to Navy surface fleet

High Level/Strategic Guidance (DWP, DPG, FMOC, IOCD etc.)

Surface Combatant Force 2025-30 Operational Concept Document (OCD)

Evolving Strategic Needs/Capability Gaps/Deficiencies

Joint Force Integration/Interoperability Needs

ANZAC Class FFH FPS
Hobart Class DDG FPS
Future Frigate FPS

CIWS FPS
SM-2/ESSM FPS
MH-60R FPS

Related ‘Internal’ Projects/Systems

DNPS Framework Surface Combatant FPS

Related ‘External’ Projects/Systems
Very Fast Train

How would our lifestyles, population distribution, energy use and economy evolve if we had a fast rail link on the eastern seaboard?

Where is the useful system boundary?
2. APPLY LIFECYCLE CONCEPTS

The role of Systems Engineering in Enterprise Asset Management
New York MTA’s EAM Program follows SE governance approach for complex programs

CEO/Executive Committee
EAM Portfolio
Executive Program Management
HQ, Agency & IT Programs
Projects
Work-Packages

* Sponsor likely to be long-term owner/operator for Infrastructure.

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TfNSW’s systems lifecycle approach

Adapted from Transport for NSW AM Framework Overview V1.0
Where can systems approaches be applied in an Asset Management context?

- Support organisational objectives
- Portfolio return on investment, compliance & sustainability
- System performance, cost & risk control
- Life Cycle Activities: efficiency & effectiveness

Corporate/ Organisation Management

Manage Asset Portfolio

Manage Asset Systems/Networks

Manage individual Assets over their Life Cycles

Enterprise Systems Engineering

Project Systems Engineering

➢ At all levels, especially at early stages of the lifecycle
Use systems modelling to help understand complexity and communicate issues

3. SYSTEMS MODELLING
Systems modeling enables understanding

• Provide data organization and structure
• Depict relationships
• Highlight and prioritize key data
• Various views provide perspective, synthesis

• Generates collective meaning
One model – many views
Benefits of systems modelling

• Coherency and consistency
  • Inter-relations inherent
  • Completeness and consistency

• Traceability & defensibility
  • Where did this come from?
  • What does it impact?
Benefits of systems modelling

• Adaptability and sharing
  • Common understanding
  • Customize views as necessary

• Model re-use
  • Reduce early-stage cost & schedule
  • Understand changing context
  • Recognise similarities and differences across enterprise
Example agency Capability Design model. Links agency strategy, operations, and integrated agency systems to the delivery of enhanced capability via capital projects.
Discussion
The End

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