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Effective Hardware-Software Agile Systems Engineering at SSC-Pac

Managing Awareness in a CURVE-y World

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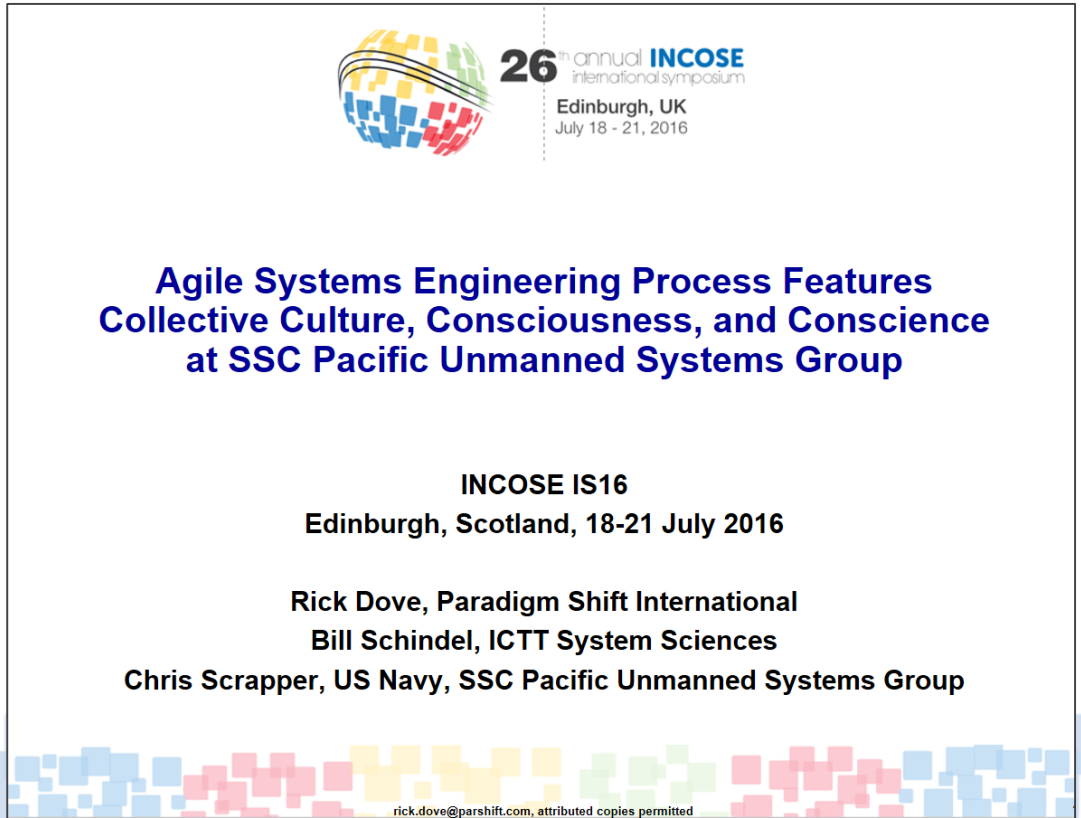
Abstract

SPAWAR System Center Pacific (SSC-Pac) in San Diego established a capability to facilitate agile development of unmanned systems. As one of the case study workshops of the INCOSE Agile Systems Engineering Life Cycle Model (ASELCM) Discovery Project, SSC-Pac provides an example of the challenges of “CURVE” and the issues of “Awareness” in addressing them. The model-based ASELCM Pattern helps us analyze this example beyond the context of agile software methods. This analysis illustrated different perspectives on enabling, exploiting, and balancing Awareness, including issues of networks versus hierarchies, teaming and leadership, pattern exploitation, model uncertainty, and optimal estimation and control.

Acknowledgement

This material discusses limited subsets of the more complete INCOSE Case Study site co-authored with Rick Dove and Chris Scrapper.



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- Designing, implementing, and evolving agile SE in the presence of CURVE
- ASELCM Pattern, System of Innovation, and S3
- CURVE requires awareness: Of both S1 and S2
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Case study: CURVE and SE Agility

- SPAWAR System Center Pacific (SSC-Pac) in San Diego established an Unmanned System Integration, Test, and Experimentation (UxSITE) capability to facilitate agile development of unmanned systems:
  - One of the case study workshops of the INCOSE Agile Systems Engineering Life Cycle Model (ASELCM) Discovery Project.
  - An example of the challenges of “CURVE” and the issues of “awareness” in addressing them….

Designing, implementing, and evolving agile SE in the presence of CURVE

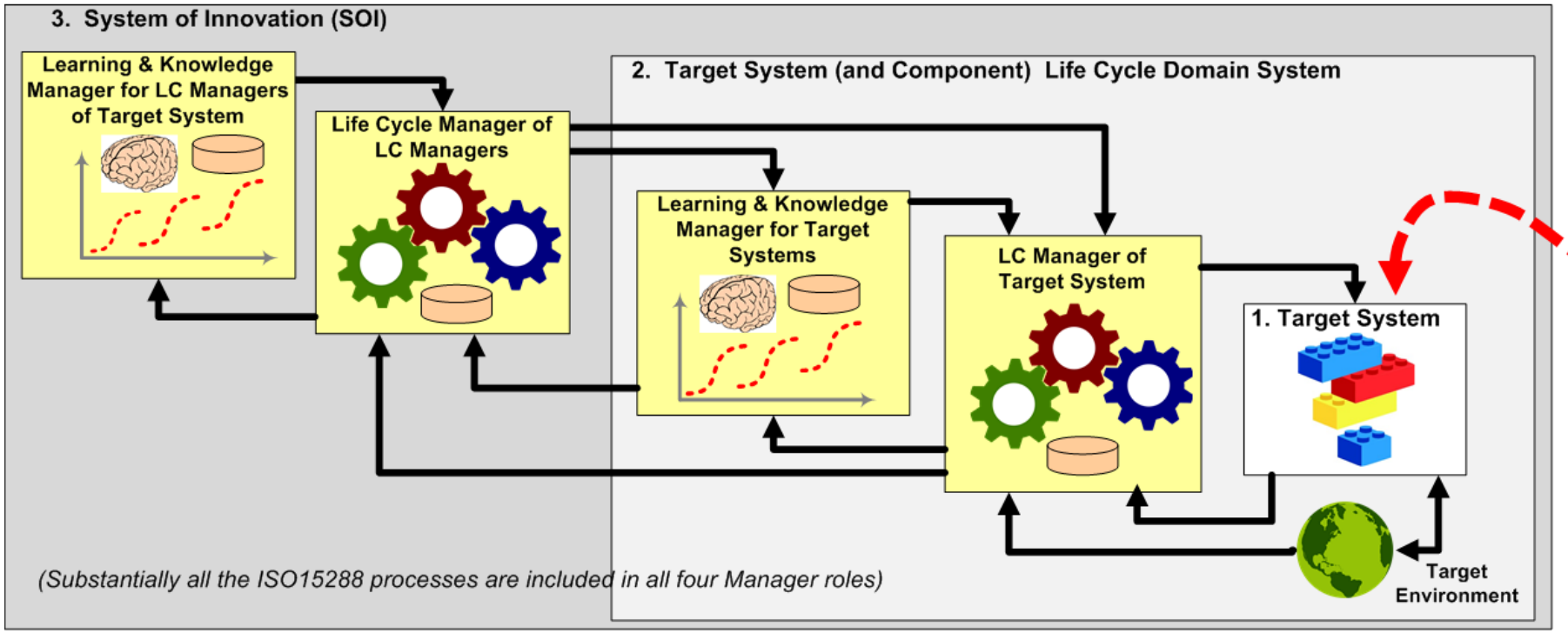
Capricious, **U**npredictable, **R**andom, **V**ariable, **E**volving aspects, such as:

- Missions & Mission Demands
- Available Technologies
- Human and Supplier Capabilities
- Funding

The UxSITE capability supports a portfolio of projects, and has three years of respected and effective results

- **WAVE**: This capability utilizes a unique agile systems engineering process with 6-month overlapping “waves” consisting of four phases: development by multiple-subcontractors, and operational management of systems architecture evolution, capability integration, and validation testing.
- **AWARENESS**: Most notably, the process puts a prime emphasis on enabling and facilitating team effectiveness: creating an embraced culture of engagement, a collective consciousness emerging from comprehensive real-time information support, and a team conscience on a mission for the end users.

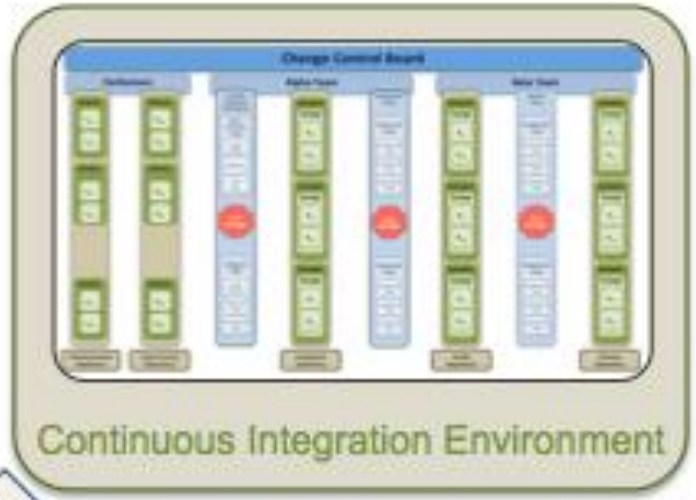
ASELCM Pattern as a framework to analyze the case study—especially the nature, capabilities, relationships of three systems:



UxSITE System 3 models of System 2

System Engineering Plan

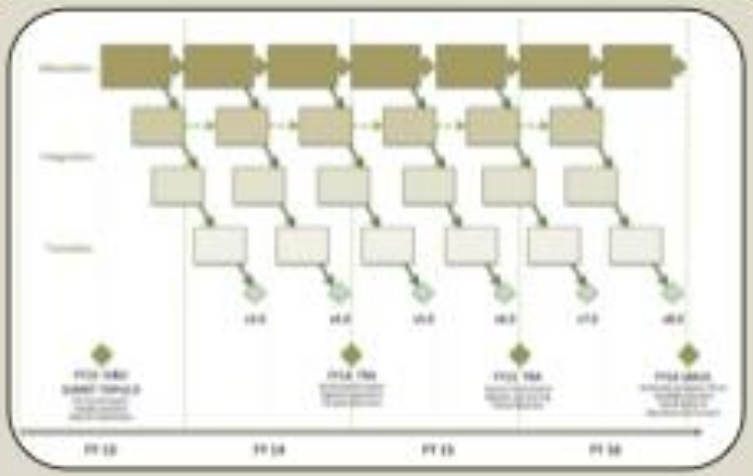
Modular Open Architectures



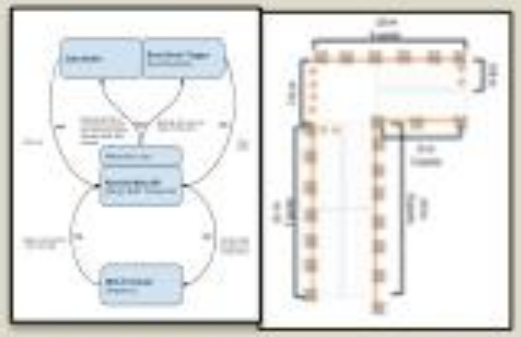
Continuous Integration Environment

Vision

CONOPs, Requirements, & System Definition



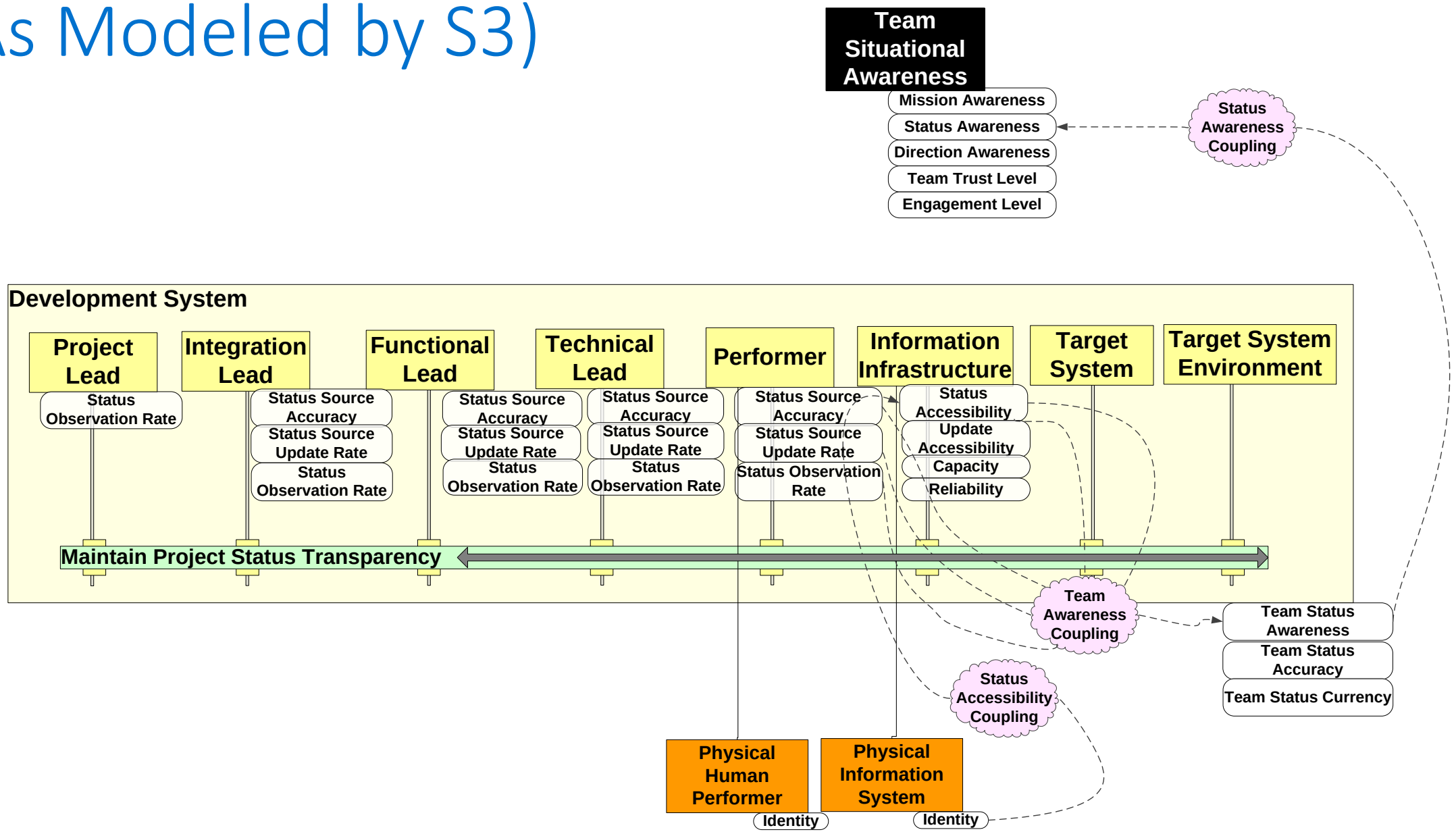
Integration Strategy



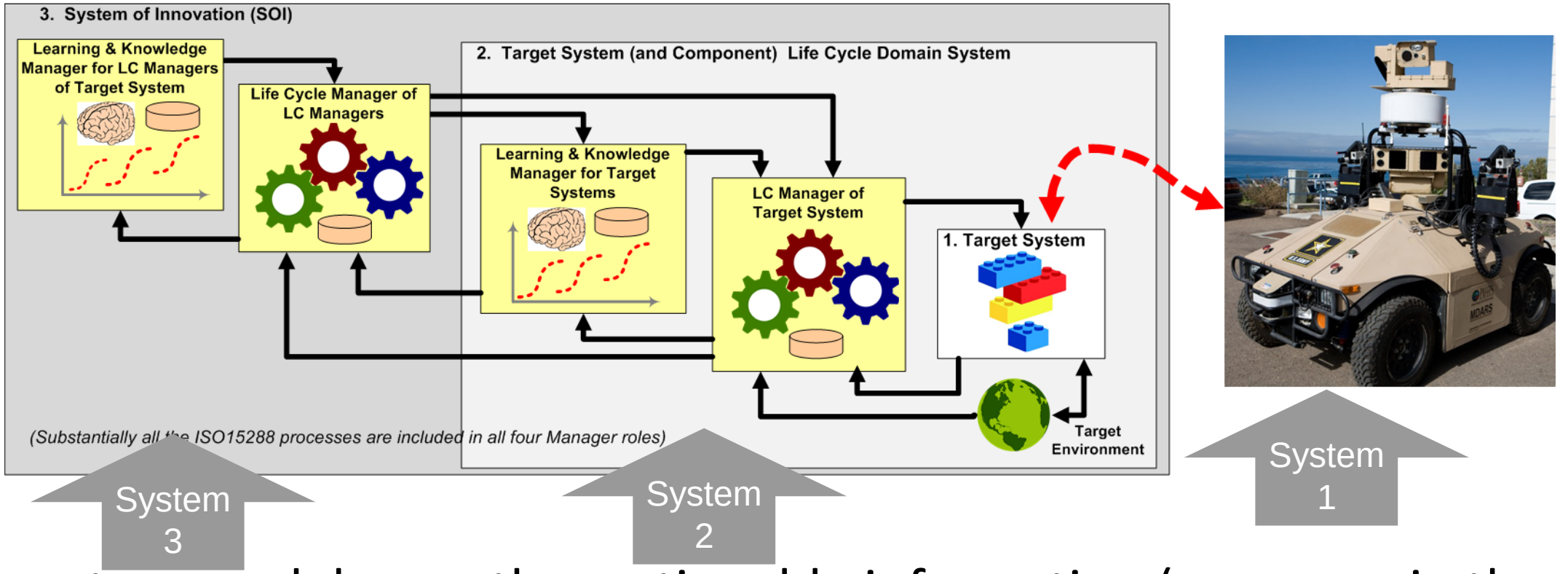
Test & Experimentation

TEMP, Test Beds, Infrastructure & Tools

Agile System 2 Interaction Promoting Awareness (As Modeled by S3)



CURVE demands awareness: Of S1, S2, by S2, S3



Explicit system models, or other actionable information (on paper, in the heads of people, etc.) represent system "awareness", of and by:

S1 by S2: CURVE of the Target System and its Target Operational Environment

S2 by S3: CURVE of the R&D, Production, Distribution, and Support Systems

Multiple perspectives on awareness for agility

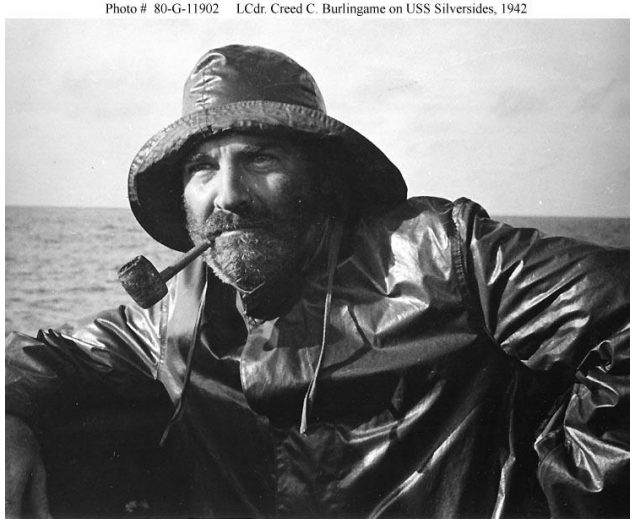
There are multiple ways to pursue awareness for agility:

1. Organizational leadership and management
2. Networks versus hierarchies
3. Experiment and discovery
4. Attention management
5. Pattern exploitation
6. Model VVUQ
7. Optimal estimation and control

“If you want to build a ship, don't drum up people to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea.” --

-- Antoine de Saint-Exupery

Photo # 80-G-11902 LCdr. Creed C. Burlingame on USS Silversides, 1942



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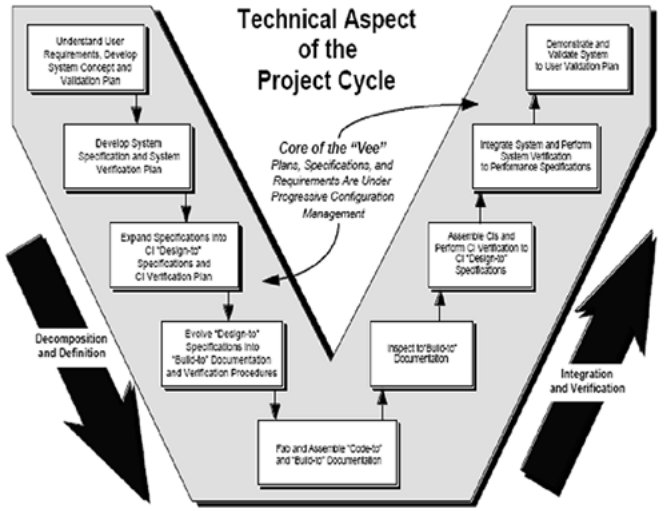

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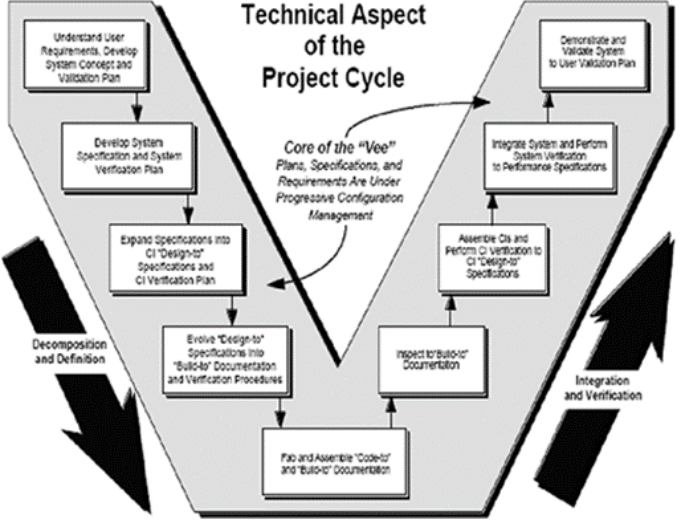
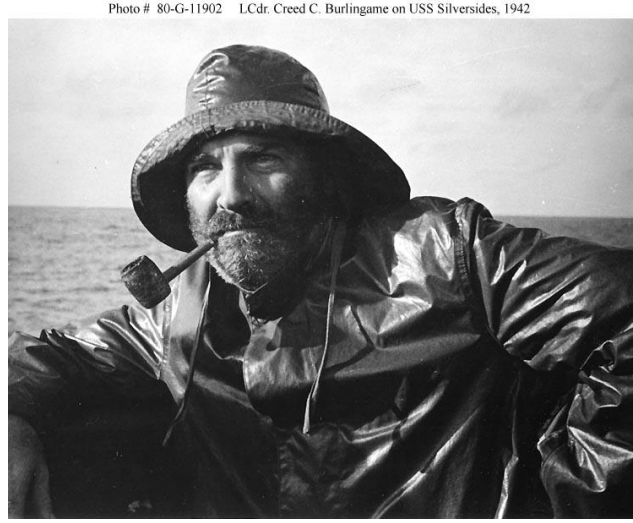
Illustration: Astute-class submarines at the BAE Systems' Barrow-in-Furness, Cumbria site.

“Systems engineering is an interdisciplinary field of engineering and engineering management that focuses on how to design and manage complex systems over their life cycles. At its core, systems engineering utilizes systems thinking principles to organize this body of knowledge. Issues such as requirements engineering, reliability, logistics, coordination of different teams, testing and evaluation, maintainability and many other disciplines necessary for successful system development, design, implementation, and ultimate decommission become more difficult when dealing with large or complex projects. Systems engineering deals with work-processes, optimization methods, and risk management tools in such projects. It overlaps technical and human-centered disciplines such as industrial engineering, mechanical engineering, manufacturing engineering, control engineering, software engineering, electrical engineering, cybernetics, organizational studies and project management. Systems engineering ensures that all likely aspects of a project or system are considered, and integrated into a whole.” -- Wikipedia, Systems Engineering



Hierarchy *vs* Awareness



- The SE problem environment inherently imposes hierarchy in S1 & S2.
- Time urgency encourages concurrency across levels—even if inconsistent.
- CURVE further reduces certainty that different levels align without some iteration.
- CURVE increases the need for Awareness to span levels.
- Collective team Awareness is enhanced by leadership and management, technical as well as social networking systems, learning and recognition of patterns.
- Top level agility is coupled to lower level process parameters in those areas.

Insights

The SSC-Pac Case Study, analyzed by the ASELCM Pattern, illustrates:

1. Because of CURVE, SE agility demands dynamic awareness about S1 and S2.
2. The SE problem environment inherently imposes a degree of S1 & S2 hierarchy.
3. Awareness can be selectively allocated locally versus globally, even dynamically.
4. Within hierarchy, locality (or globality) of awareness is a (dynamical) balancing act, performed by Attention Management.
5. Organizational leadership and management skills enable part of this awareness.
6. Social networks (IT, human, otherwise) enable part of this awareness.
7. The recognition of patterns compress the bandwidth demands of awareness.
8. Model VVUQ supports the credibility of awareness in an noisy world.
9. Optimal estimation and control informs action in a CURVE-y world.

References

1. Dove, R., Schindel, W., and Scrapper, C. 2016. “Agile Systems Engineering Process Features Collective Culture, Consciousness, and Conscience at SSC Pacific Unmanned Systems Group.” *Proc. of INCOSE 2016 International Symposium*, Edinburgh, UK, July.
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