Webinar

Agile SE Processes 205: Agile SE in the Future of Systems Engineering (FuSE)

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Rick Dove
Anthem, AZ, dove@parshift.com, 575-770-7101
Independent Operator
Chair: INCOSE WG for Agile Systems & Systems Engineering

Agile 205 webinar slides: Agile SE in the Future of Systems Engineering
Agile 204 webinar slides: Agile SE Life Cycle Model
Agile 203 webinar slides: Agile SE Agility as a System
Agile 202 webinar slides: Agile SE Continuous Integration
Agile 201 webinar slides: Agile SE Problem Space Requirements
Agile 106 webinar slides: Agile System/Process as Risk Management
Agile 105 webinar slides: Agile System/Process Operational Awareness
Agile 104 webinar slides: Agile System/Process Engagement Quality
Agile 103 webinar slides: Agile System/Process Design Principles
Agile 102 webinar slides: Agile System/Process Design Requirements
Agile 101 webinar slides: Agile System/Process Architecture Pattern
(updated asynchronously from time-to-time)

Abstract: Agility in the future of systems engineering is a journey, not a destination. This webinar will explore the nature of that journey, getting started, and a near-term roadmap.

The Future of Systems Engineering (FuSE) is an INCOSE-led collaborative initiative pursuing INCOSE's Vision 2035 and beyond.

One of the Grand Challenges in the Vision is "Systems engineering anticipates and effectively responds to an increasingly dynamic and complex environment."

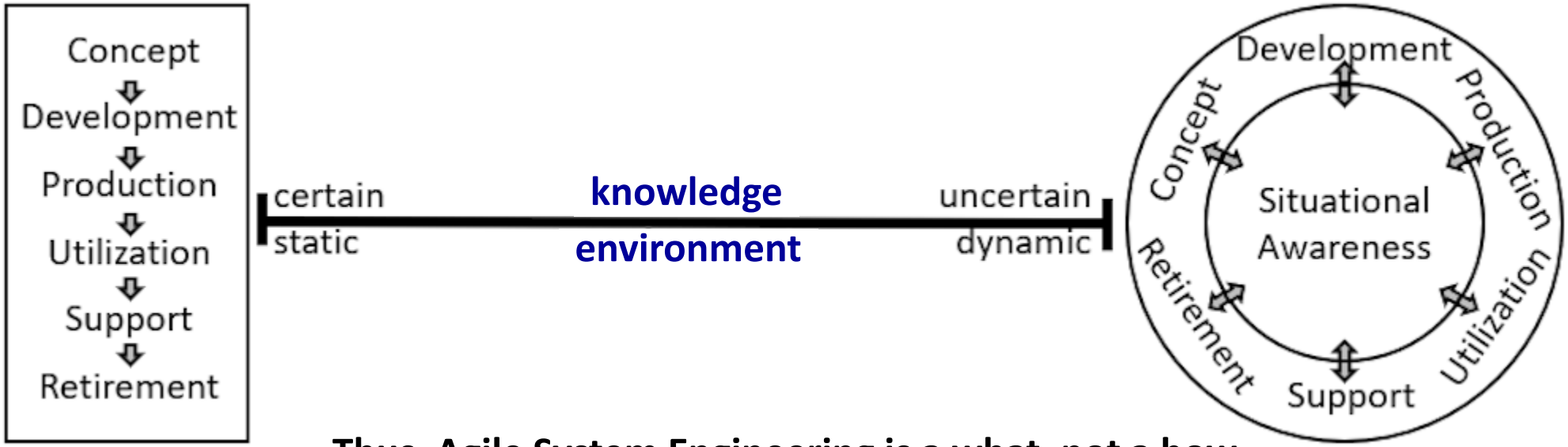
Agile systems engineering is a method for creating and evolving systems and subsystems when knowledge is uncertain and environments are dynamic.

This presentation explores the FuSE Agility topic area across nine strategy concepts in the current roadmap and eight core concepts for getting started.

Strategy concepts were identified in collaborative workshops as foundational early stage practices ready for broader development and application. Core concepts were more recently identified in preparation for developing an Agile SE Primer.

Systems Engineering Life Cycle Spectrum – Sequential to Agile

Agile systems engineering is a principle-based method for designing, building, sustaining, and evolving systems when knowledge is uncertain and/or environments are dynamic.



Thus, Agile System Engineering is a what, not a how.
There are many hows, principally focused on the development phase,
e.g.
Evolutionary Development
Iterative Incremental Development (IID)
Incremental Commitment Spiral Model (ICSM)

and also many focused on a single engineering domain,
e.g.
Scrum, Kanban, XP, and DevOps.

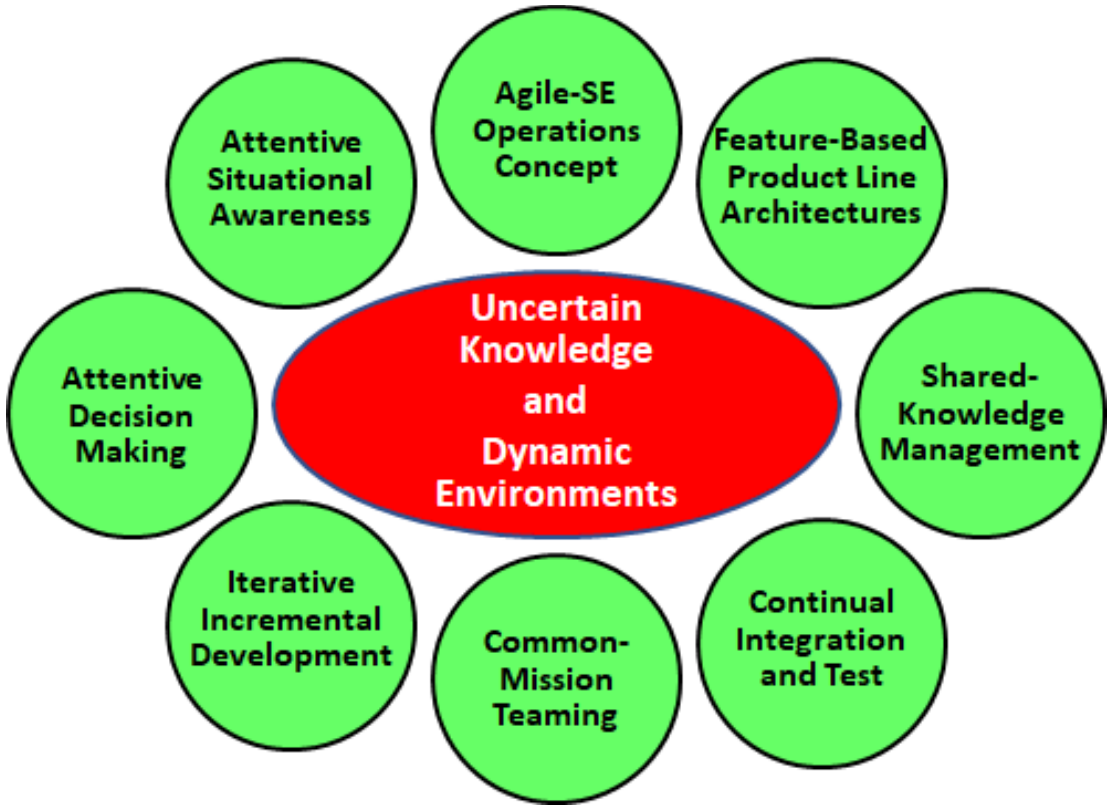
Two Parts

Getting Started – Core Aspects

Maturing and Evolving – Improvement Roadmap

Agile SE – Core Aspects

Individually each of these aspects can offer improved ability to deal with uncertain knowledge and dynamic environments



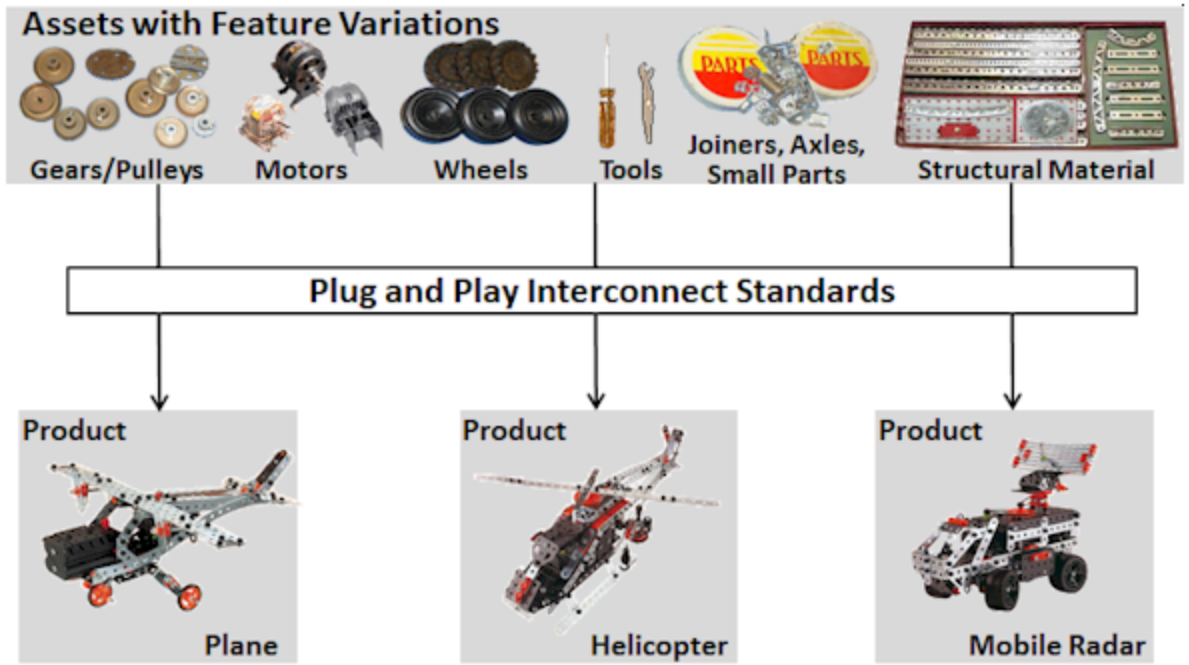
Big bang concurrent implementation is not necessary.
Incremental adoption can accommodate incremental appetites.

Feature-Based Product Line Architectures

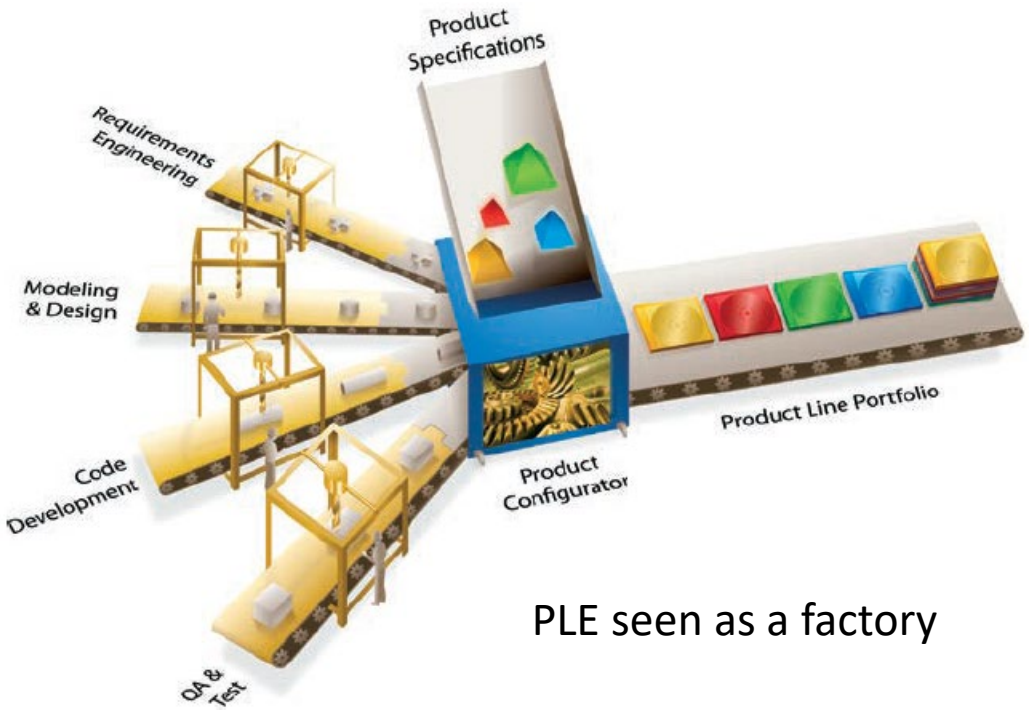
Need: Facilitated product & process experimentation, modification, and evolution

Strategic Intent: Composable/reconfigurable product & process designs from variations of reusable assets

Examples …



Iconic notional depiction of Agile Architecture Pattern



PLE seen as a factory

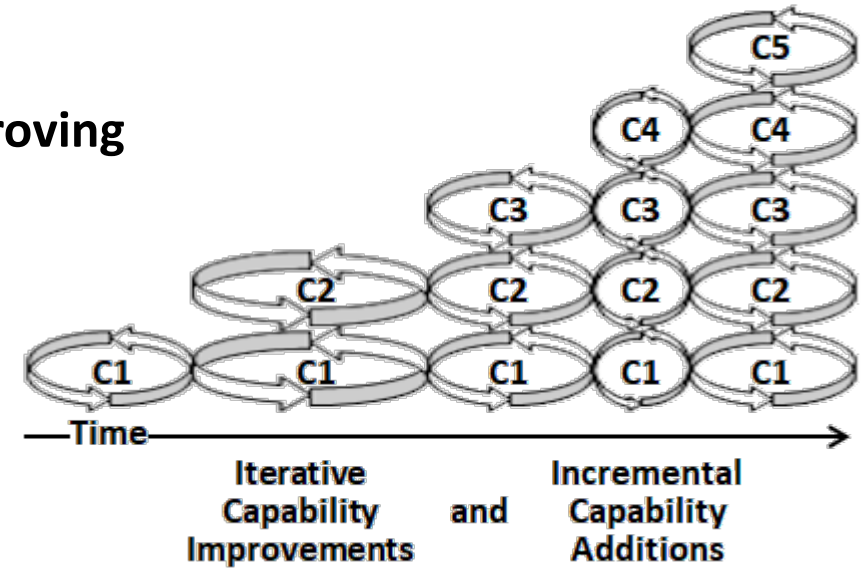
Product Line Engineering Comes to the Industrial Mainstream. Paul C. Clements. INCOSE, INSIGHT, August 2O19, 22:2

Fundamentals of Agile Systems Engineering – Part 1. Rick Dove, Ralph LaBarge. INCOSE, IS14, 2014.

Iterative Incremental Development

Need: Minimize rework and maximize quality

Strategic Intent: incrementally doing, evaluating, correcting, and improving



Examples …

- **Incremental Commitment Spiral Model**
  Using the Incremental Commitment Model …
- **SpaceX: Rapid Prototyping Design Process**
  www.youtube.com/watch?v=SMLDAgDNOhk&list=PL6vdik5frDGVL4USjKgYkJoOb76_7sdkS&index=12
- **SpaWar: Case study**
- **Rockwell Collins: Case study**

Generally increments create capabilities and iterations improve capabilities.

- **Increment cycles are beneficially timed to accommodate coordinated events such as integrated testing and evaluation, capability deployment, experimental deployment, or release to production.**
- **Increments may have constant or variable cadence to accommodate management standards or operational dynamics.**
- **Iteration cycles are beneficially timed to minimize rework cost as a project learns experimentally and empirically.**

Attentive Situational Awareness

Need: Timely knowledge of threats and opportunities

Strategic Intent: Active monitoring and evaluation of relevant internal and external operational-environment factors

Examples …

- **WIP demonstrations and reviews for stakeholder feedback**
- **Periodic SE process-participant evaluations**
- **Continual market evolution evaluation (Rockwell Collins Case Study)**
- **Systematic internet search for pending security and COTS issues (Northrop Grumman case study)**
- **SpaceX constant internet search and rapid evaluation acquisition (Dan Rasky NASA video)**

Source: Smith System - https://blog.drivedifferent.com/blog/six-tips-for-driving-alert

Attentive Decision Making

Need: Timely corrective and improvement actions

Strategic Intent: Systemic linkage of situational awareness to decisive action

Examples …

- **Satisficing – making a timely good-enough decision rather than an optimal time consuming decision**
- **Weekly refactored development planning to accommodate security-threat evolution** (Northrop Grumman case study)
- **SpaceX: "As soon as they would get to, we would joke, 51% probability, they would make a decision and move forward. … You keep making decision after decision after decision. If you find a problem you hadn't anticipated then you backtrack, make another decision and try it again. It allows you to progress very rapidly."**
  (Dan Rasky NASA video)

Common-Mission Teaming

Need: Coherent collective pursuit of a common mission

Strategic Intent: Engaged collaboration, cooperation, and teaming among all relevant stakeholders

Art source: Integrity Management Consulting

Examples ….

- **Integrated product teams**
- **High-performance teams**
- **SpaWar: … of particular note in the SE process was its successful objective and ability to integrate outside contractors as full team members, forming a family-like relationship of all-for-one and one-for-all.** (SpaWar case study)
- **Mine-Resistant Ambush Protected (MRAP) program: Plagued with discordant relationships among a variety of service agencies, contractors, and manufacturers, Paul Mann credits the eventual acclaimed success of the MRAP program to the many people who pulled together in a process that enveloped them all in the mission of program success, rather than local optimization of individual needs or contract performance independent of the affect on all others in the program.** (SpaWar case study)

Shared-Knowledge Management

Need: Participative engagement by internal and external stakeholders

Strategic Intent: Facilitated communication, collaboration, and knowledge curation

Examples ….

- **Periodic status meetings**
- **Information radiators**
- **Single source of truth**
- **Wikis**
- **Collaboration tools**
- **Product Lifecycle Management (PLM) tools**

Continual Integration & Test

Need: Early revelation of system integration issues.

Strategic Intent: Integrated demonstration and test of work-in-process.

Examples …

- **Digital engineering.**
- **Iron bird – a physical system mockup for prototyping and integrating aircraft systems during development.**
- **LVC – Lockheed Martin's ANTE (Agile Non-Target Environment) is used to compose integrated systems consisting of simulated devices, real devices, software work-in-process, and temporary low fidelity proxy devices. Subcontractors are required to provide device simulations to ANTE specs. (LMC Case Study)**
- **"While design and simulation are extremely important at SpaceX, they do not try to perfect a design before they try it. They design, and they simulate, but they also build and test often. They feel that they learn more by building something and pushing it to failure than they would learn in a hundred simulations." (SpaceX's Use of Agile Methods)**

Iteratively Evolving UAV
(SpaWar Case Study)

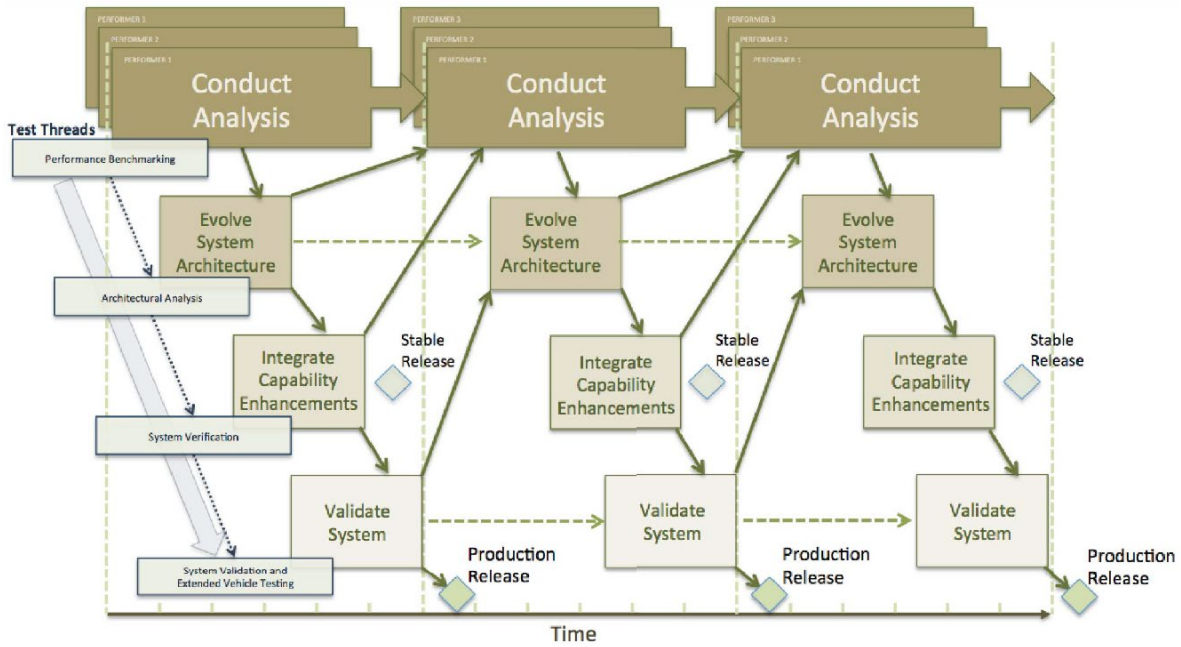
Agile-SE Operations Concept

Need: Stakeholder alignment on system engineering methods and purpose

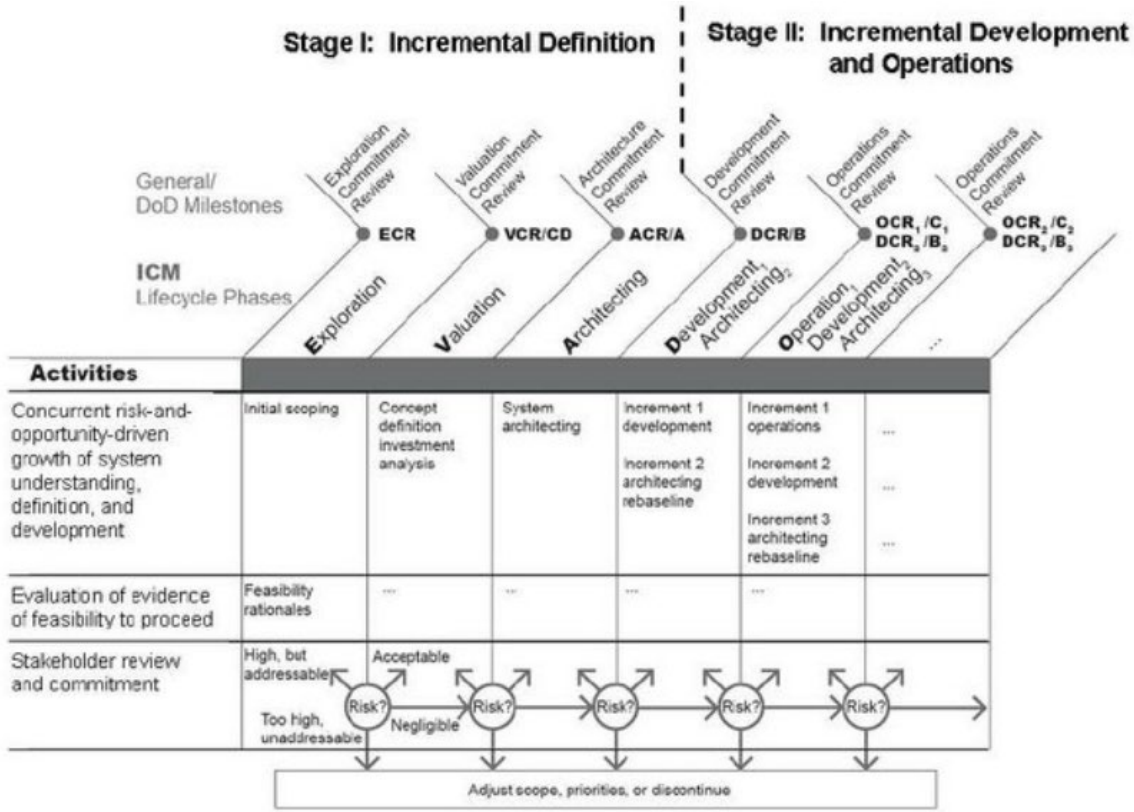
Strategic Intent: Training and documentation on intended systems engineering work flow

Examples …

- **WAVE and Incremental Commitment Spiral Model**



'An implementer's view of the evolutionary systems engineering for autonomous unmanned systems'
Chris Scrapper, Ryan Halterman, Judith Dahmann. IEEE Systems Conference, 2016



'Using the Incremental Commitment Model to Integrate System Acquisition, Systems Engineering, and Software Engineering,'
Barry Boehm, Jo Ann Lane, CrossTalk, October 2007.

Maturing and Evolving – Improvement Roadmap

Agility in the Future of Systems Engineering (FuSE)

An INCOSE-led collaborative initiative pursuing INCOSE's Vision 2035 and beyond

About the Future

We don’t have to guess about the future…

“The [near term] future is already here, it’s just not evenly distributed” (William Gibson)

We can see that future by looking at…

cause: the evolution of engineering and systems operational environments

effect: what innovative entities are doing and maturing in response

Context: Agility in the Future of Systems Engineering

INCOSE IS21 paper: Agility in the Future of Systems Engineering (FuSE) a Roadmap of Foundation Concepts

What good will look like:

1. **Agile systems-engineering: apply agile tactics, techniques, and procedures throughout system lifecycle. [process]**
2. **Agile-systems engineering: operational systems adaptable to predictable and unpredictable change. [technology]**
3. **Agile-operations: achieve composable workflows to sustain value-delivery under adverse conditions. [environment]**
4. **Agile-workforce: achieve dynamic adaptability; skills, knowledge, and efficacy. [people]**

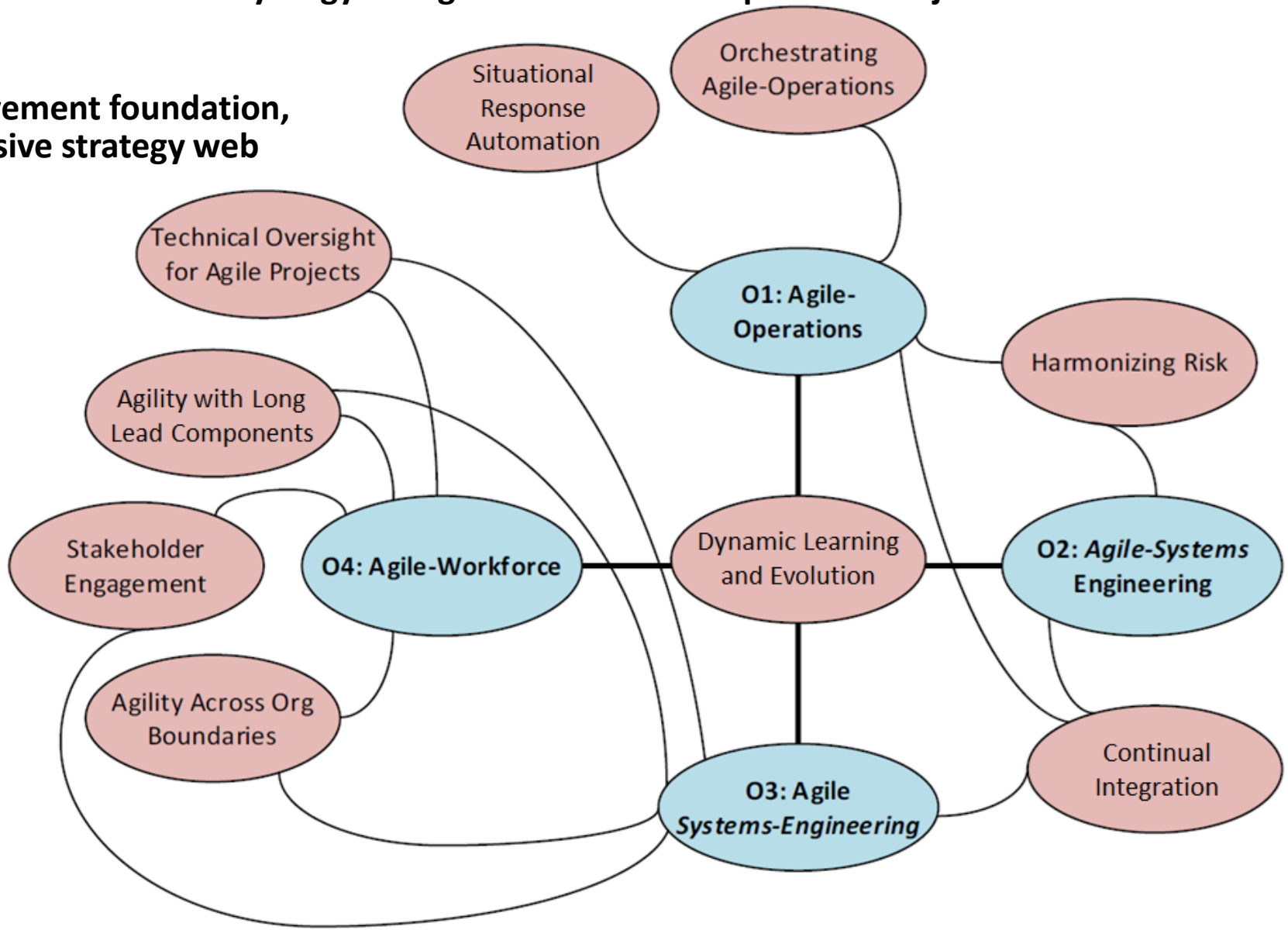
What is stopping us from doing this now:

1. **Narrow agility perception as software development practice.**
2. **Lack of a codified approach for multi-discipline agile systems engineering; e.g., standards, SE methods/guides.**
3. **Insufficient stakeholder engagement in the SE process; agile SE is iterative and prompts attention to hard problems.**
4. **Current acquisition process, contracts, and projects prompt for features and requirements up front rather than evolution of a solution that coincides with evolution of the problem.**

FuSE Agility

Synergy linkage between 9 concepts and 4 objectives

A near term improvement foundation, not a comprehensive strategy web



Note: a few concept titles here have more descriptive wording than in the original paper.

FuSE Agility Roadmap Concepts

Concept Title	General Problem to Address	General Needs to Fill	General Barriers to Overcome
1. Dynamic Learning and Evolution	Insufficient learning and knowledge management processes; barriers to learned-knowledge application.	Situational awareness and learning embedded in lifecycle processes; timely/affordable learning-application; knowledge management.	Unclear *what to do* or *where to do it* beyond learning ceremonies and contract obligation satisfaction.
2. Technical Oversight	Traditional technical oversight methods are counterproductive in agile programs.	An interactive approach that reveals relevant knowledge for guidance and decision making.	Oversight traditions; standard contract wording; disrespect for oversight.
3. Stakeholder Engagement	Timeliness and depth of stakeholder collaborative engagement.	Discovery of true requirements and integration conflicts.	Time involved; travel cost; inconvenient scheduling; lack of motivation.
4. Agility Across Organizational Boundaries	Incompatible siloed cultures and languages.	Common language; less handoffs; product-based teams; common metrics.	Functional organizational silos.
5. Agility with Long Lead Components and Dependencies	Components and external dependencies with long lead times complicate schedule coordination and disrupt technical performance.	Scheduling and acquisition techniques that better align with agile-SE principles.	[False] justification that long-lead items prohibit the use of agile-SE.
6. Continual Integration	Late discovery of integration and requirements issues.	Minimize risk and rework with fast learning; maximize stakeholder engagement.	Development effort and expense; technologies for integrating/testing software prior to HW being ready.
7. Orchestrating Agile Operations	Coherence among loosely coupled multi-actor outcomes.	Dynamic operational coordination in real-time.	Ability to encode self-learning; adaptive logic as decision-support for people and for autonomous decision making.
8. Situational Response Automation	Decision and action too slow.	Continual dynamic adaptation within cyber-relevant time.	Complicatedness of encoding autonomous governance and adjudication logic and rules; situational awareness that provides necessary inputs.
9. Harmonizing Risk in Agile Operations	Agility focus is principally loss avoidance	Expand awareness and operational realization of both the negative side of risk (loss) and the positive side of risk (opportunity, seek gain, optimize).	Silo-thinking and predominance of looking at risk only in terms of loss.

Wrap Up

Systems Engineering Life Cycle Spectrum – Sequential to Agile

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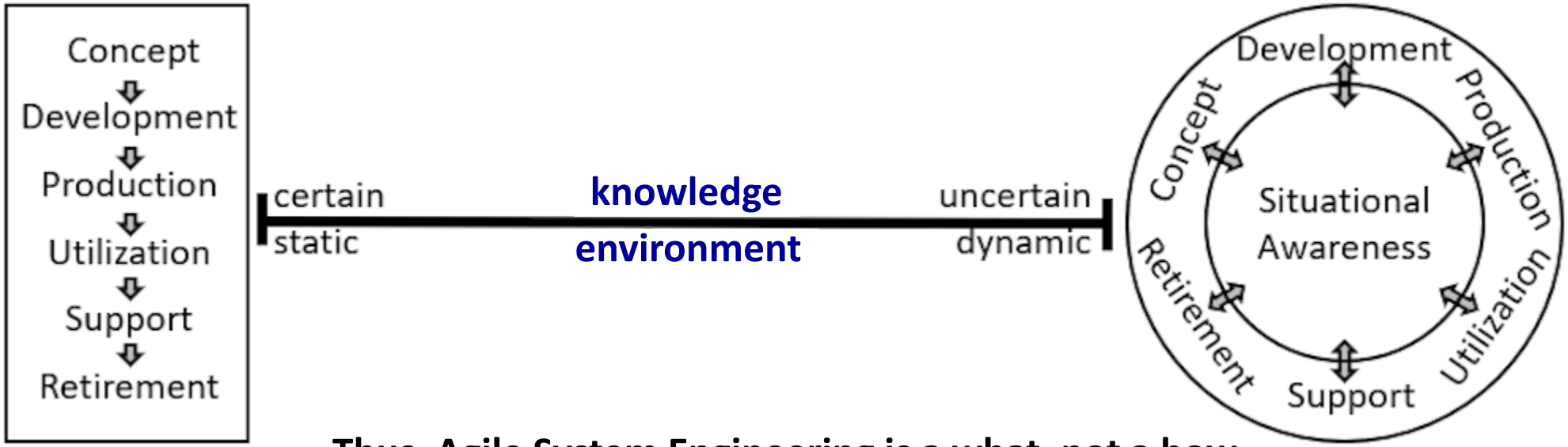

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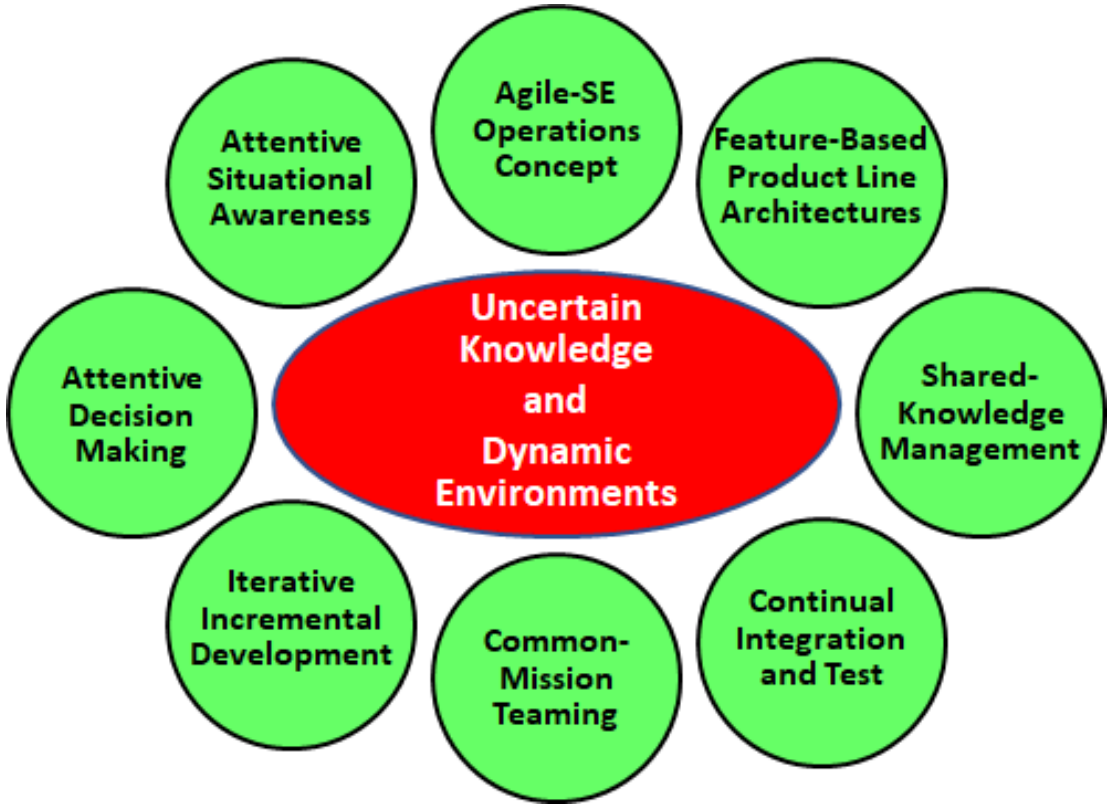
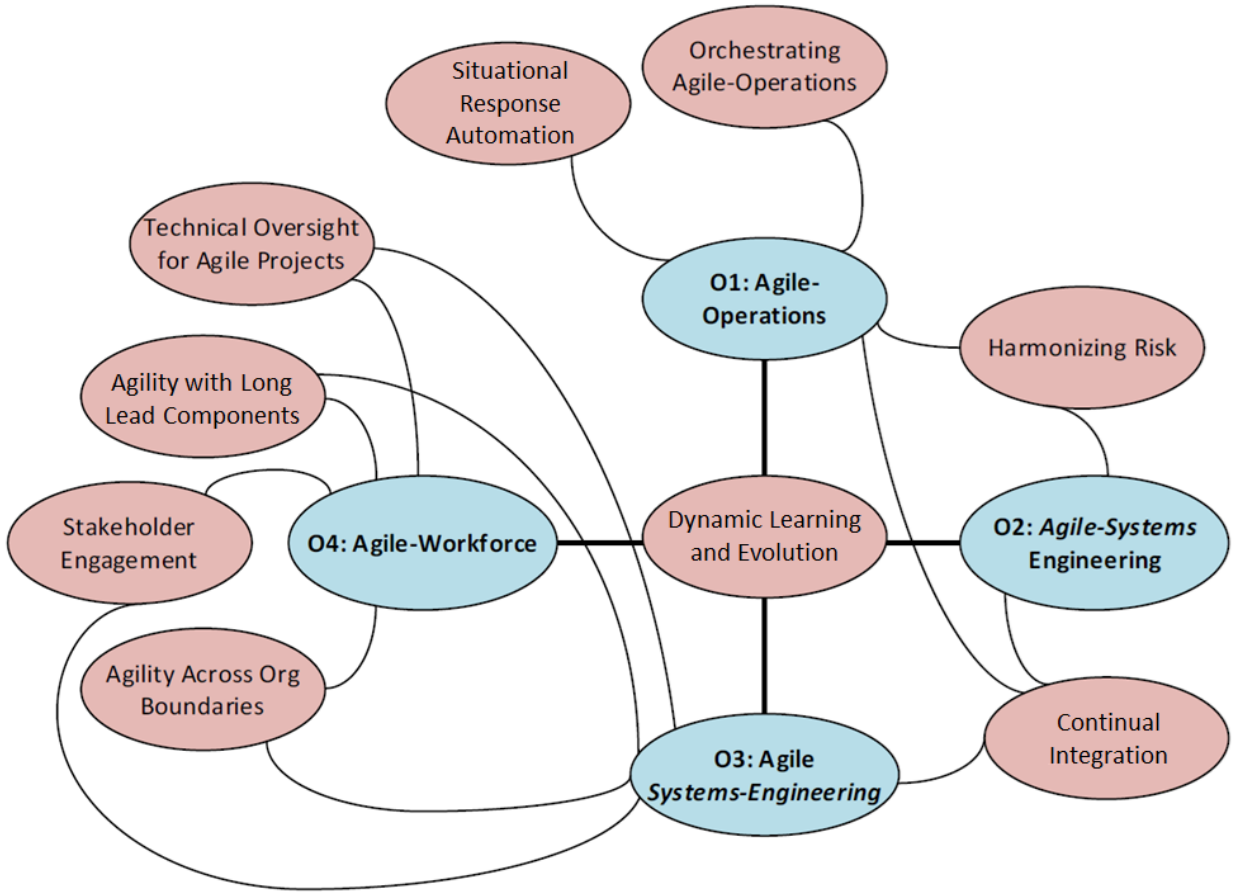
Journey

Getting Started



Maturing & Evolving



Large organizations today have units in both stages

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