Setting Current Context for Agility in the Future of Systems Engineering

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Abstract. Agility in the Future of Systems Engineering (FuSE) is one of the topic areas under the INCOSE FuSE initiative. A roadmap for near-term improvement, presented at the 2021 INCOSE International Symposium, offered nine strategic concepts appropriate and ready for further movement toward standard practice. Initial work in that direction enticed several practitioners and researchers to address selected concepts in this special issue of the INCOSE INSIGHT publication. The purpose of this lead-off article is to provide a contextual backdrop for the articles that follow.

Introduction

The Future of Systems Engineering (FuSE) is an INCOSE led multi-organization collaborative initiative that identified several specific project areas to pursue. For the FuSE Agility area a collaborative team was formed with representation from INCOSE's Agile Systems & Systems Engineering Working Group, Lockheed Martin, NASA, Northrop Grumman, Raytheon, and U.S. Department of Defense. Team workshops held biweekly from June to November in 2020 deliberated on objectives and appropriate strategic foundation concepts for near-term systems engineering agility improvement; and assembled the concepts as a synergistic roadmap (Figure 1) suitable for immediate development and deployment attention (Willett et al. 2021).

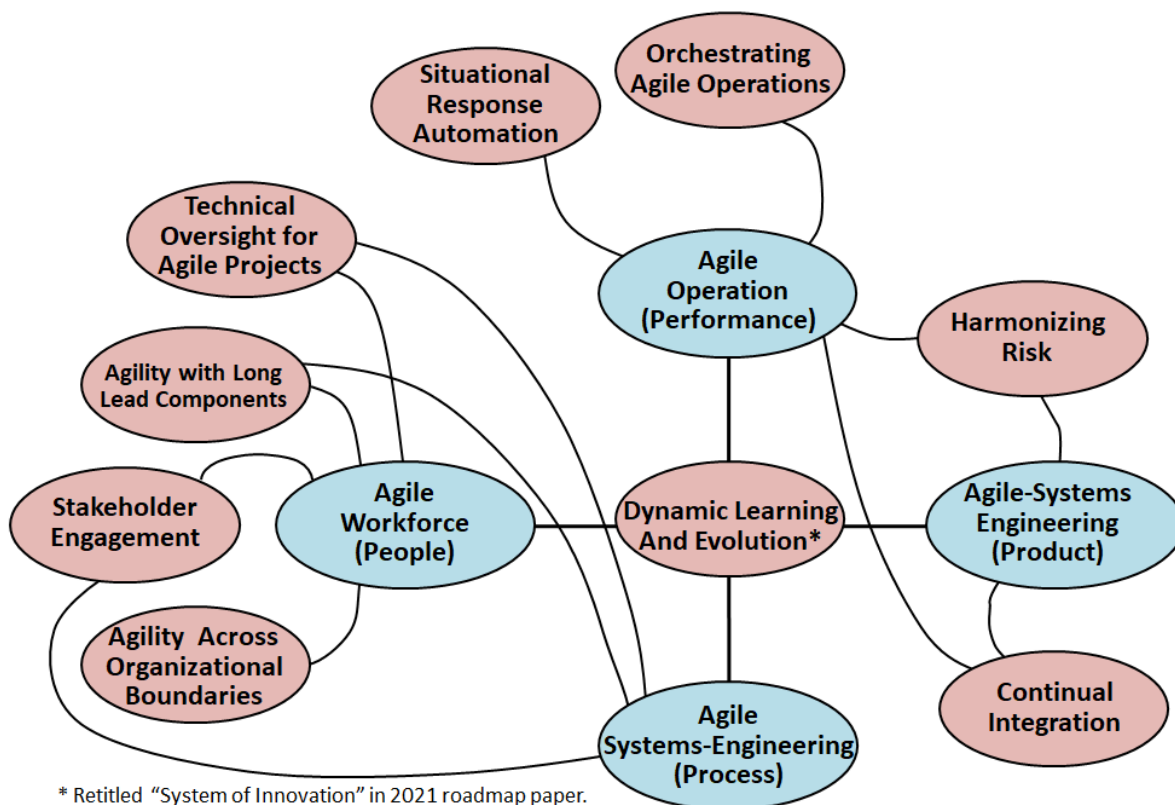* Retitled "System of Innovation" in 2021 roadmap paper.

Figure 1. Synergistic linkage among nine strategic foundation concepts and four objectives.

Figure 1 links the foundation concepts to the objectives in a strategic activity web of non-dependent synergistic relationships. Linkage lines have no arrowheads as objectives give purpose to concepts and concepts give means to objective accomplishment. The purpose of the linkage display is to show principal relationships

among concepts and objectives; encouraging developers and implementers to emphasis and strengthen these relationships. As concepts get developed and implemented, additional links will emerge. Figure 1 is not intended to depict a comprehensive agility strategy; but rather a set of foundation concepts for agility improvement appropriate for the near term.

More recent work socializes the roadmap concepts and attempts to instigate strategy and practice development. One activity toward those ends is this issue of *INSIGHT* magazine, with a series of articles exploring one or more of the foundation concepts in a variety of systems engineering contexts. The purpose of this lead-off article is simply to provide a contextual backdrop for the articles that follow.

Objectives and Concepts

FuSE Agility objectives and strategies will continuously evolve. The initial team identified four objectives as timely and appropriate:

1. Agile systems-engineering (adaptable processes).

2. Agile-systems engineering (adaptable products)

3. Agile operations (adaptable performance)

4. Agile workforce (adaptable people).

All of these objectives have some limited or narrow-domain practice; but none are in standard practice.

Criteria for foundation concepts was established as follows:

- Concept has relevance to systems engineering considerations.

- Concept can provide new and useful value to the state of practice.

- Concept value proposition articulation is in systems engineering terms.

- Concept has notional support in a referenceable knowledge base.

- Concept does not yet have sufficient published exposure for broad-based actionable systems engineering consideration.

- Concept implementation could be now.

- Concept is principally about what to achieve and why (strategic intent), rather than how (prescriptive tactics), though notional examples of how can augment understanding.

A brief synopsis of the concepts follows in Table 1. The team developed the entries in Table 1 as general notions to help orient the nature of each concept. The team did not and does not intend to limit or constrain concept-development thinking, rather, to point the thinking in the intended direction.

Table 1. Brief Synopsis of FuSE Agility 2021 Roadmap Concepts

Concept	General Problems to Address	General Needs to Fill	General Barriers to Overcome
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.

Concept	General Problems to Address	General Needs to Fill	General Barriers to Overcome
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.
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.
Agility Across Organizational Boundaries	Incompatible siloed cultures and languages.	Common language; less handoffs; product-based teams; common metrics.	Functional organizational silos.
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.
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 before hardware is ready.
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.
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.
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.

In Conclusion

The roadmap concepts address four objectives. One objective is called out as *agile systems-engineering*, the others are there, from our FuSE perspective, to enable and support agile systems-engineering (hyphens to distinguish the process from the product objective).

The roadmap is about Agility in the Future of Systems Engineering – it was created by people who have already started down that road, people with experience in agile systems engineering who have discovered where the pavement ends and the going gets rough.

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

Agile systems engineering is best understood in contrast to sequential systems engineering in how the two relate to the system life cycle spectrum. Figure 2 shows pure forms of these two life cycle models in terms of their activity phases and data flows. All systems engineering life cycle models fall somewhere between the two ends of the spectrum, depending upon the process-encoded degree of attentiveness and responsiveness to dynamics in knowledge and environment.
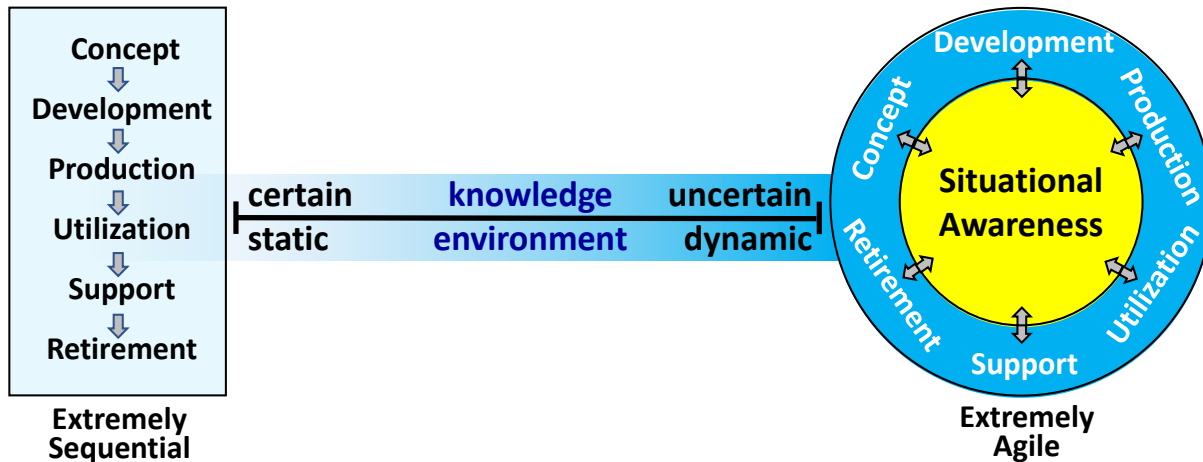

Figure 2: Systems engineering lifecycle spectrum – sequential to agile.

References

Willett, K. D., R. Dove, A. Chudnow, R. Eckman, L. Rosser, J. S. Stevens, R. Yeman, and M. Yokell. 2021. Agility in the Future of Systems Engineering (FuSE) – A Roadmap of Foundational Concepts. Paper Presented at the 31st Annual INCOSE International Symposium, Virtual: July 17-22.

Bio

Rick Dove is an unaffiliated independent operator. He chairs the INCOSE working groups for Agile Systems and Systems Engineering, and for Systems Security Engineering; and leads both the Security and Agility projects for INCOSE's initiative on the Future of Systems Engineering (FuSE). He is an INCOSE Fellow, and author of Response Ability, the Language, Structure, and Culture of the Agile Enterprise.