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Agile Systems Engineering Life Cycle Model for Mixed Discipline Engineering

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Agile Systems Engineering Life Cycle Model (ASELCM)

An INCOSE Project to…

- ❑ **Discover generic principles/patterns that are necessary for effective agile systems engineering of SW/FW/HW projects**
- ❑ **Publish informative case studies**
- ❑ **Build evidence-based generic agile-SE life cycle model to inform effective implementation – as an INCOSE Product**

And …

- ❑ **Provide material for next INCOSE Handbook revision**
- ❑ **Influence published standards evolution**

Value Proposition for Agile Systems Engineering

Faster, lower cost system development?

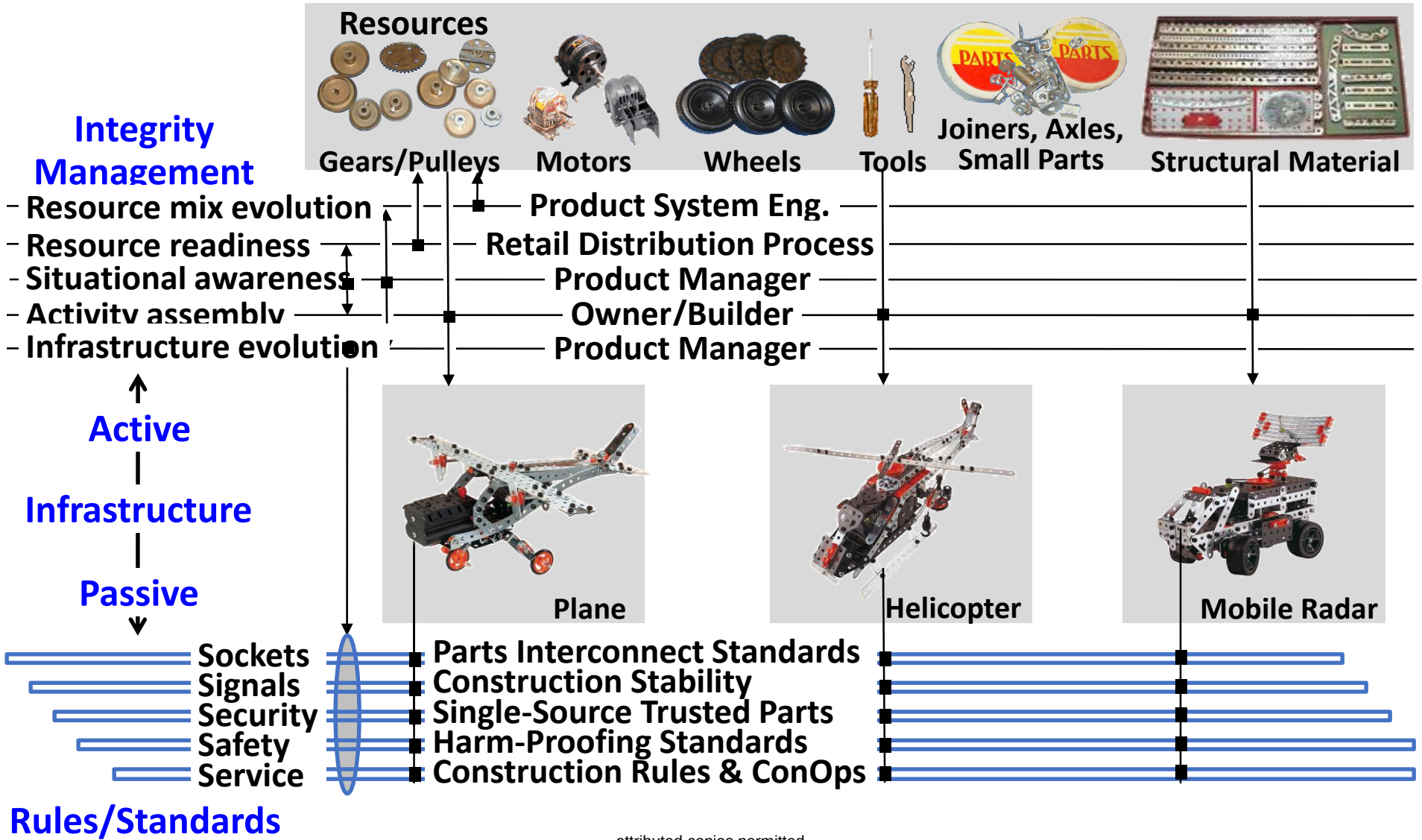
An appealing argument, at the business level.

But to achieve this,
a different value proposition is needed at the engineering level:

Minimization of project risk and rework.

Agile Architecture Pattern (AAP) Enables Agility
Notional Concept: System Response-Construction Kit

Details in www.parshift.com/s/140630IS14-AgileSystemsEngineering-Part1&2.pdf



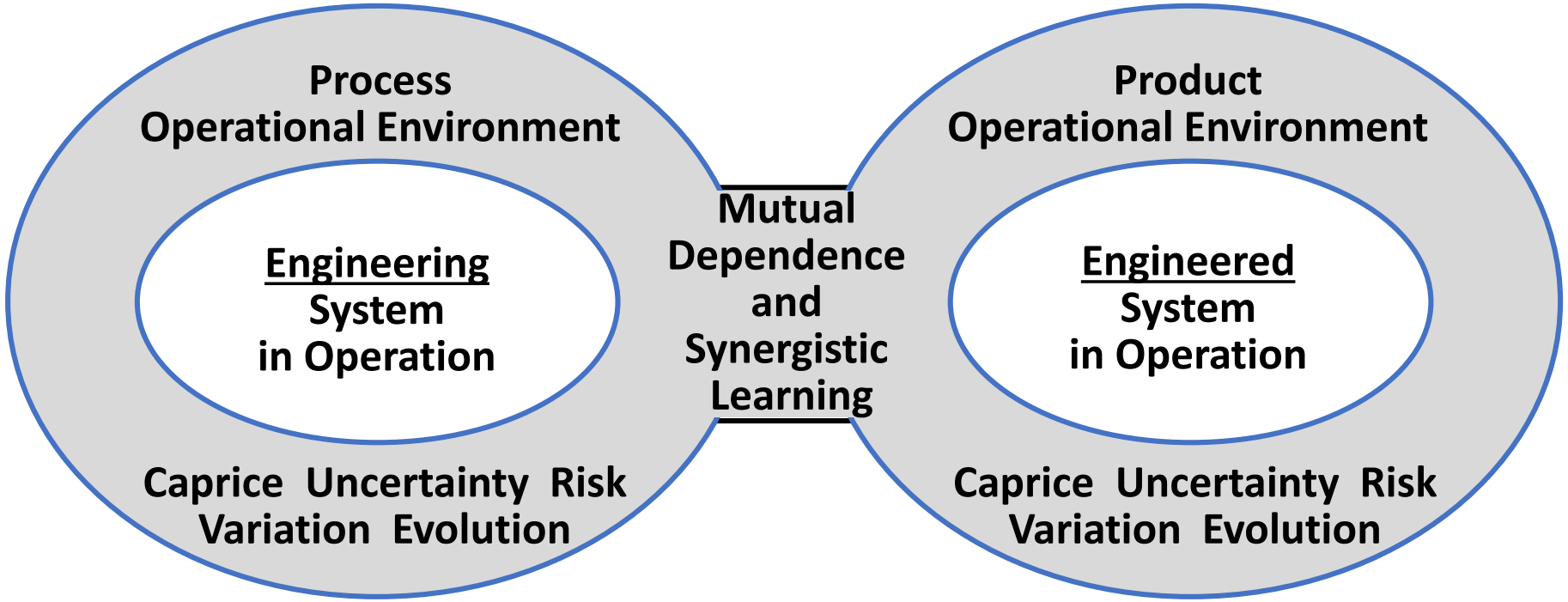
Sustaining Agility Requires …

- Proactive awareness of situations needing responses
- Effective options appropriate for responses
- Assembly of timely responses

Five Agility-Sustaining Responsibilities:

1. Resource Mix Evolution
2. Resource Readiness
3. Situational Awareness
4. Response Assembly
5. Infrastructure Evolution

Two different systems with synergistic dependencies
(a first principle)



You can't have
an agile engineering process
if it doesn't engineer an agile product
(and vice versa)

ASELCM Project Findings

The IS19 paper discusses:

1. **Agile SE Life Cycle Model Framework**
2. **CURVE Framework Characterizing the Problem Space**
3. **Operational Principles**
4. **ASELCM Pattern of Three Concurrent Systems**
5. **Concept of Information Debt**
6. **General Agile SE Response Requirements**

Above covered in the IS19 paper

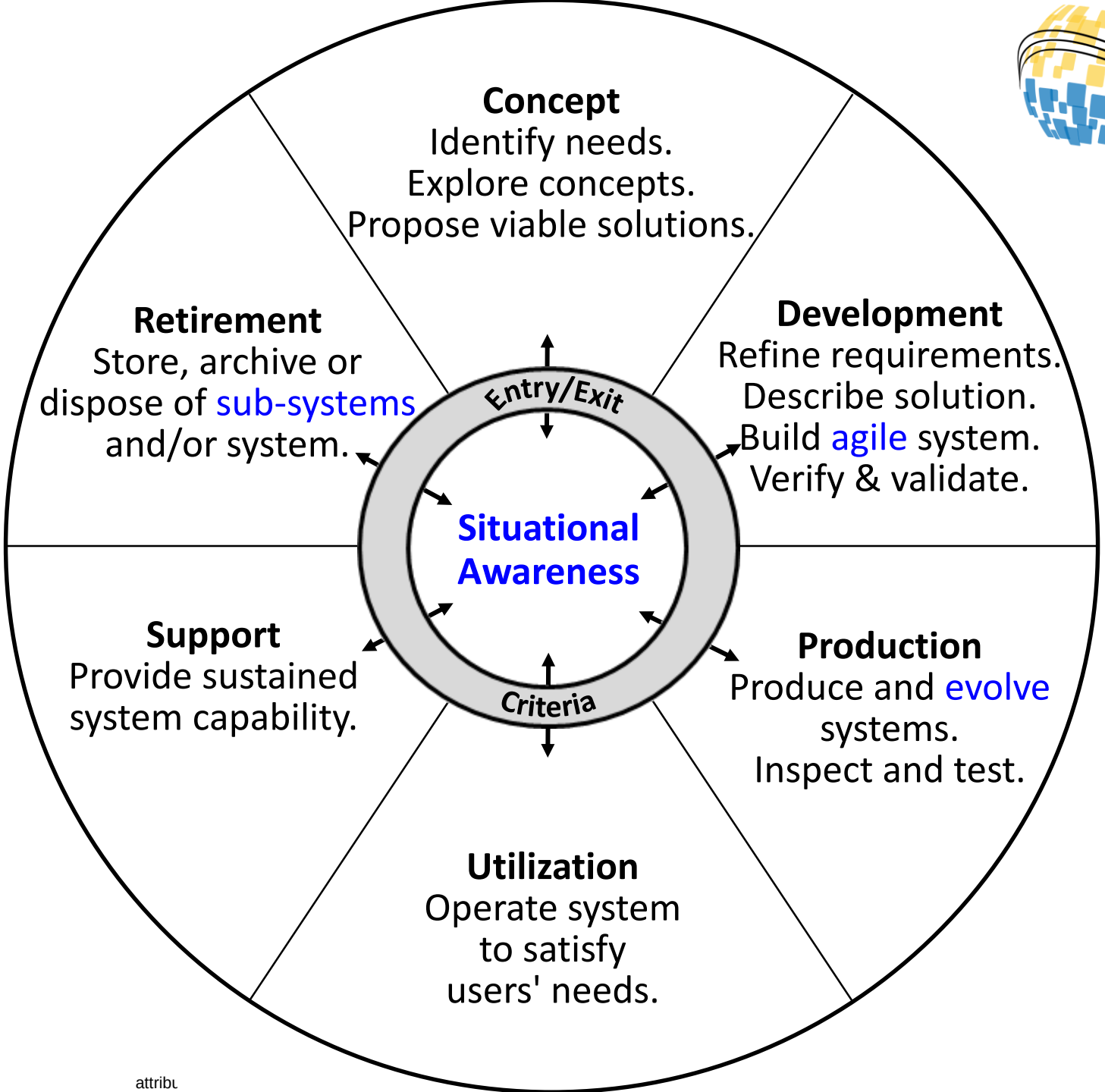
Here we add a 7th finding:

7. **Continuous Integration Platform**

Agile SE Life Cycle Model Framework

Asynchronous/Concurrent Stages.
Consistent with
ISO/IEC/IEEE 24748-1:2018

Situational Awareness Engages System Evolution Stages/Tasks



CURVE Framework for Characterizing the Problem Space

Internal and external environmental forces that impact process and product as systems

Caprice: unanticipated system-environment change
(randomness among unknowable possibilities)

Uncertainty: kinetic and potential forces present in the system
(randomness among known possibilities with unknowable probabilities)

Risk: relevance of current system-dynamics understanding
(randomness among known possibilities with knowable probabilities)

Variation: temporal excursions on existing behavior attractor
(randomness among knowable variables and knowable variance ranges)

Evolution: experimentation and natural selection at work
(relatively gradual successive developments)

Operational Principles

Sensing (observe, orient)

- External awareness (proactive alertness)
- Internal awareness (proactive alertness)
- Sense making (risk & opportunity analysis, trade space analysis)

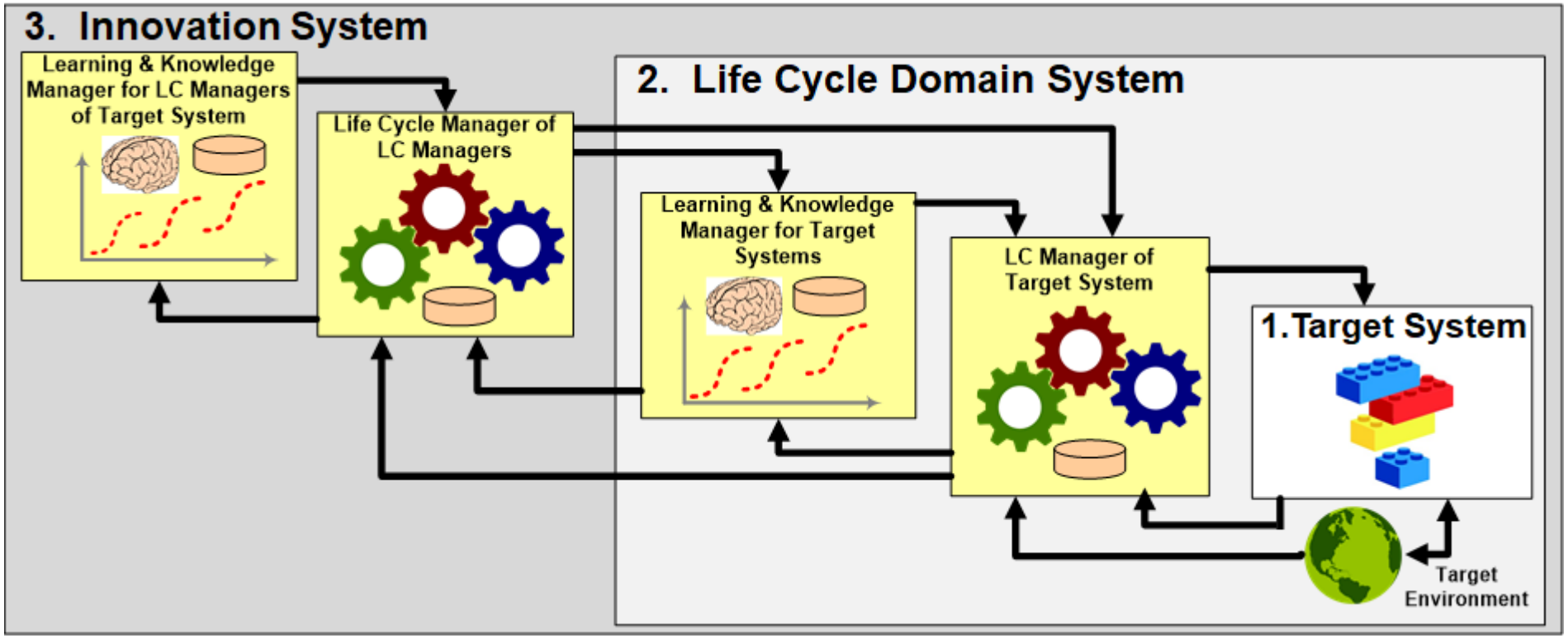
Responding (decide, act)

- Decision making (timely, informed)
- Action making (invoke/configure process activity for the situation)
- Action evaluation (validation & verification)

Evolving (improve above with more knowledge and better capability)

- Experimentation (variations on process ConOps)
- Evaluation (internal and external judgement)
- Memory (evolving culture, response capabilities, and process ConOps)

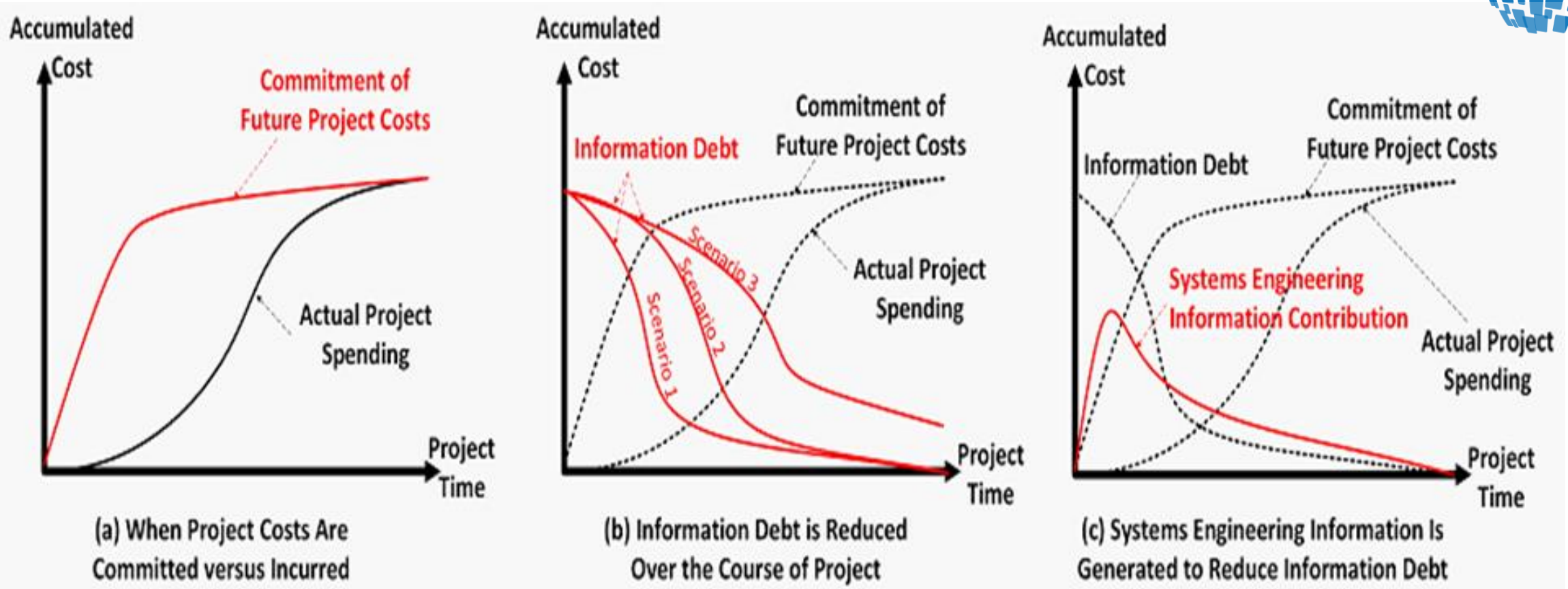
ASELCM Pattern of Three Concurrent Systems



- System-1 is the target system under development.
- System-2 includes the basic systems engineering development and maintenance processes, and their operational domain that produces System-1.
- System-3 is the process improvement system, called the system of innovation that learns, configures, and matures System-2.

The Innovation System is responsible for situational awareness and evolution, the provider of operational agility.

Concept of Information Debt



Future costs of a project become committed early by SE decisions. One of the traditional arguments for early stage SE investment.

Will project end with outstanding information debt: a "working system" but an interest penalty caused by shortage of needed information?

SE information must be generated (e.g., reqs, architectures, risk assessments, etc.) early enough in the project.

General Agile SE Response Requirements

Domain		Response Requirements
Proactive	Creation	•Opportunity & risk awareness •Response actions/options • Acculturated memory • Decisions to act
	Improvement	•Awareness/Sensing •Memory in culture, options, ConOps • Action/option effectiveness
	Migration	•New fundamentally-different types of opportunities and risks
	Modification (Capability)	•Actions appropriate for needs •Personnel appropriate for actions
Reactive	Correction	•Insufficient awareness •Ineffective actions/options • Wrong decisions
	Variation	•Effectiveness of actions/options •Effectiveness of evaluation
	Expansion (Capacity)	•Capacity to handle 1-? actions simultaneously
	Reconfigu-ration	•Elements of an action •Response managers/engineers

Continuous Integration Platforms - Context

Agile SE processes deal with changing knowledge and environment.

- **They learn and employ that learning during SE process operation.**
- **They modify/augment product-development work-in-process.**

Integration Platforms for Agile SE employ/enforce AAP Structure

Agile software development processes (silently) rely on AAP platforms.

- **Program code development employs an object-oriented AAP development platform (e.g., C++, Java, Eclipse).**
- **Web code development employs a loosely-coupled modular AAP inherent with hyperlinked web-pages.**

Agile hardware development doesn't have off-the-shelf AAP platforms.

- **Proprietary Product-Line-Engineering employs AAP.**
- **Proprietary Open System Architecture (OSA) employs AAP.**
- **Proprietary Live-Virtual-Constructive platforms employ AAP.**

Agile Systems Engineering Goals

produce an innovative result,

produce a “success-assured” result,

produce a sustainable result,

rapidly.

Rework is the bane of Rapid.

Continuous Integration Platform

Need: Minimize rework (common value across all disciplines).

Intent: An agile Continuous Integration Platform (CIP),
that enables and facilitates…

- An asynchronous continuous test capability (less rework).
- Early detection of integration issues (less rework).
- WIP feedback demos to users/customers/management (less rework).
- DevOps/DevSecOps collaborative development interaction (less rework).
- Alternative/prototype experimentation (less rework).
- A set-based knowledge-development test stand (less rework).

Less rework is a value common to all engineering disciplines.

Continuous Integration Platform Examples

SpaWar Case Study – two+ unmanned ground vehicles with continuously evolving devices and device wip for multiple simultaneous projects.

Rockwell Case Study – every project has an Integrated Computing Platform – a Rockwell-built scalable circuit card rack with supporting power and cabling that can accommodate multiple evolving circuit boards (FPGA dev boards, prior developed boards, wip boards), and interface with external devices and computers for evolving software and firmware.

Lockheed IFG Case Study – Agile Non-Target Environment (ANTE). Conceptually similar to a Live, Virtual, Constructive (LVC) environment, used to compose an integrated system early. ANTE integrates simulated devices, real devices, lower fidelity COTS proxy devices, IFG software work-in-process, and operators. Subcontractors are required to provide device simulations to ANTE specs.

Northrop Grumman Case Study – a software SoS hub developed with a DevOps, Scrum and SAFe-like operational model on an Eclipse platform, in two-week development and test sprints that produce a user demonstrable wip capability.

VSILs (Virtual System Integration Labs) – so called because they employ a mixed simulation and real device integrated wip system, and/or employ internet connected remote devices and simulations at different physical locations.

INCOSE ASELCM "Product" in Process

First draft for review targeted for end of 2019.

Reviewers will be invited from an international cross section of INCOSE-member organizations.

Principle review questions:

1. **is this useful to your organization,**
2. **what parts are most useful,**
3. **what would improve usefulness.**

Final draft for INCOSE publication targeted for end of 2020.