

Enabling and Facilitating Engineered Sustainability

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**28 July Plenary
Engineering Sustainable Systems and Technology**

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Assertions

**Sustainable systems are living systems
capable of
responding effectively
to their environment.**

**They are reactively resilient
and
proactively evolutionary.**

They are complex adaptive systems of systems.

This is the essence of agility.

Background

In The '90s we analyzed hundreds of real-world systems that exhibited agility, asking how they did that, and converged on fundamental patterns that fit the facts.

**We are doing it again, now,
analyzing real-world processes that exhibit agility,
asking how they do that, and
converging on fundamental behavior patterns,
that fit the facts.**

No conjecture, no kinda good idea, no opinion.

CURVE

Internal and external environmental forces that influence system-behavior dynamics.

Capriciousness: unanticipated system-environment change

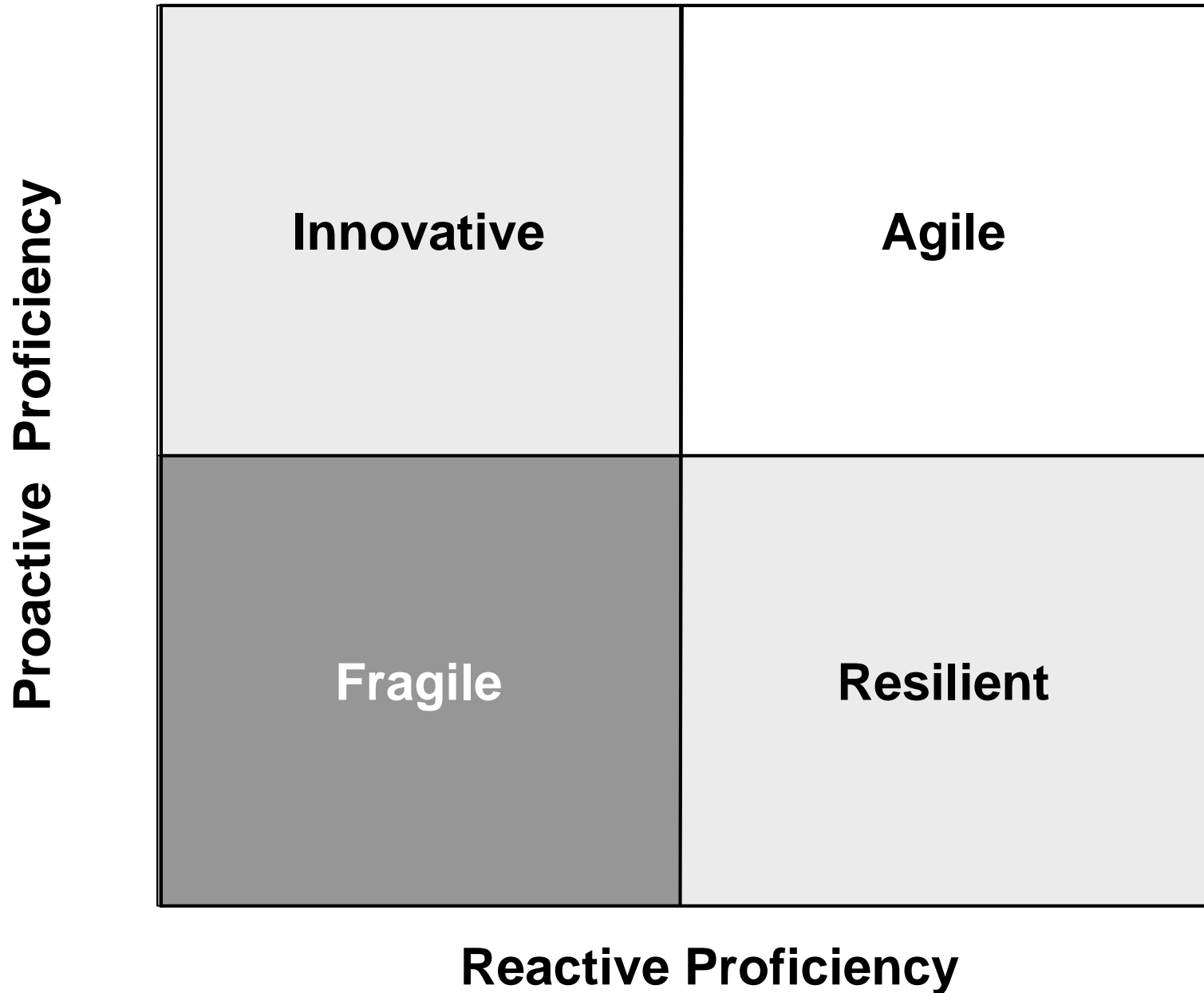
Uncertainty: kinetic and potential forces present in the system

Risk: relevance of current system dynamics understanding

Variation: temporal excursions on existing behavior attractor

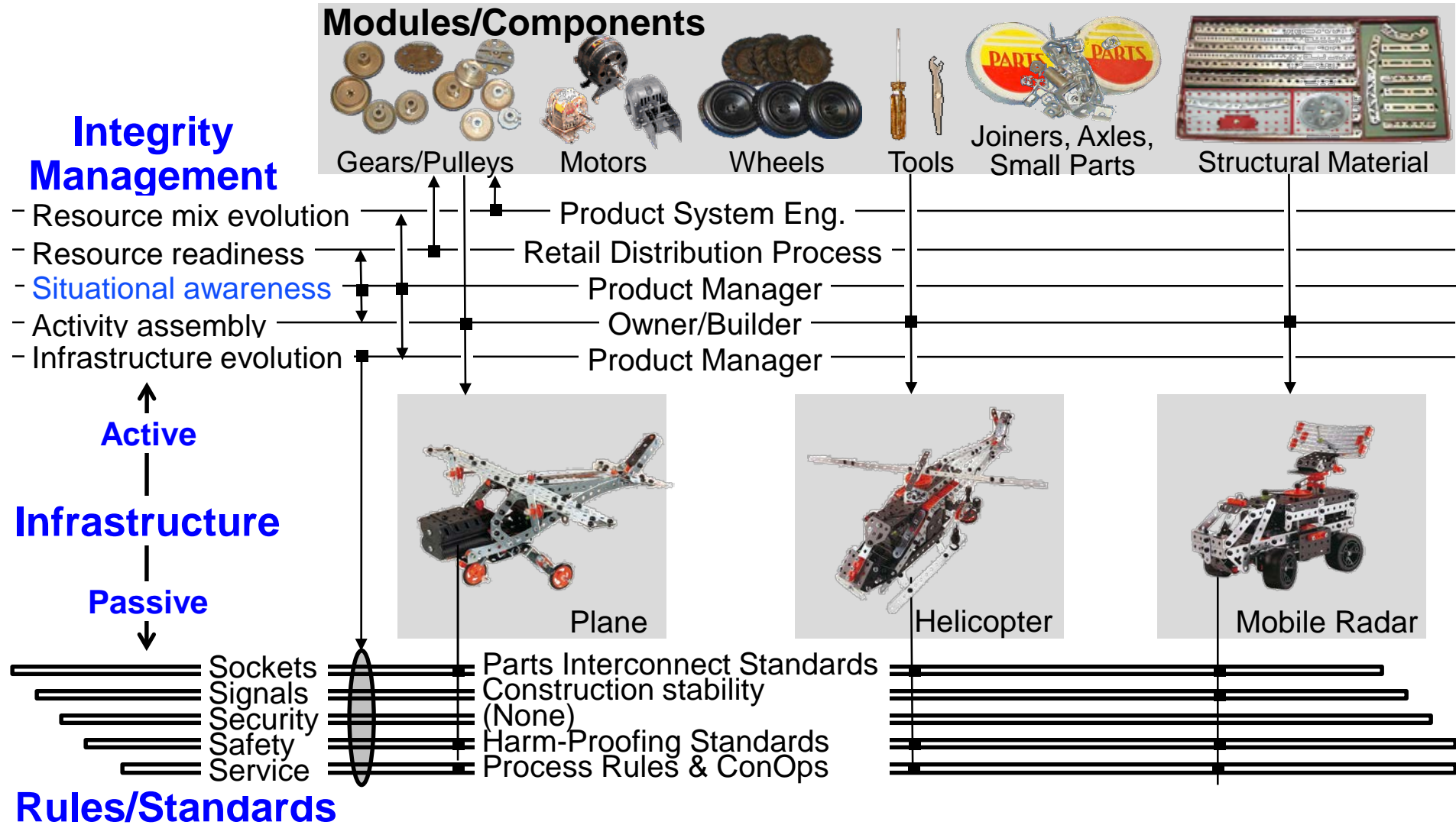
Evolution: experimentation and natural selection at work

Response in 2 Dimensions



Iconic Agile Architecture Pattern

System Response-Construction Kit



Agility-Enabling Structural Patterns

1992+ Confirmed Discovery Research

Reusable

- **Encapsulated modules**
- **Facilitated interfacing**
- **Facilitated re-use**

Reconfigurable

- **Peer-peer interaction**
- **Deferred commitment**
- **Distributed control & information**
- **Self organization**

Scalable

- **Evolving infrastructure standards**
- **Redundancy and diversity**
- **Elastic capacity**

Agility-Facilitating Behavior Patterns

2016 Working Hypothesis (to be confirmed/denied/augmented)

Monitoring

- External awareness
- Internal awareness
- Sense making

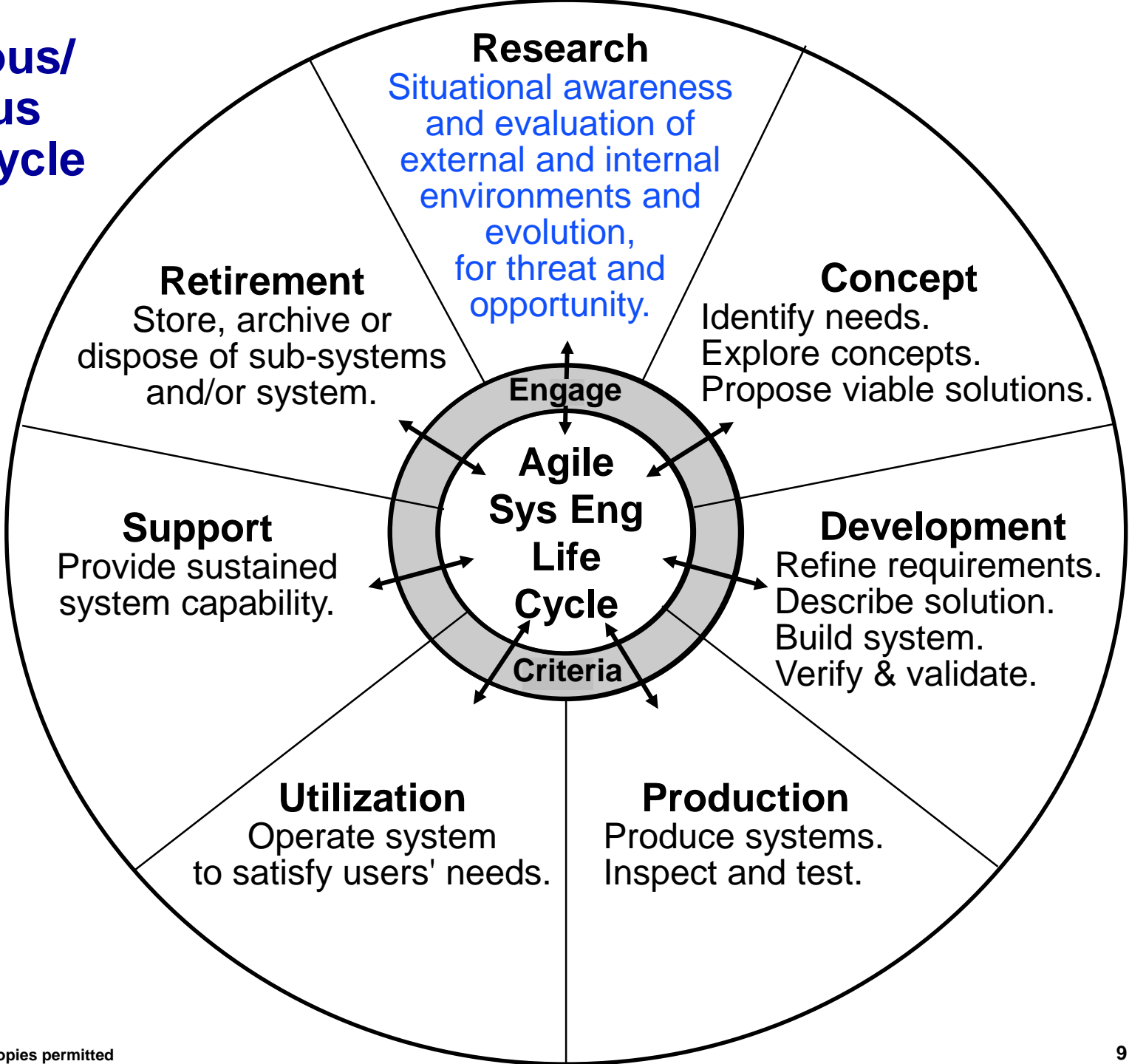
Mitigating

- Decision making
- Action making
- Action evaluation

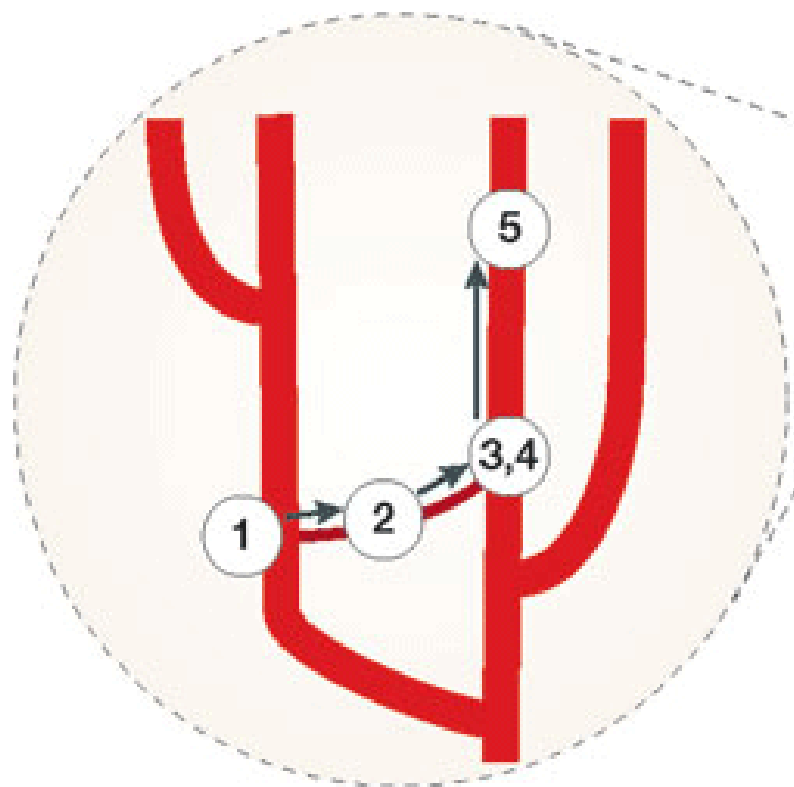
Evolving (improves above)

- Experimentation (variations on ConOps)
- Evaluation (internal/external judgement)
- Memory (current ConOps)

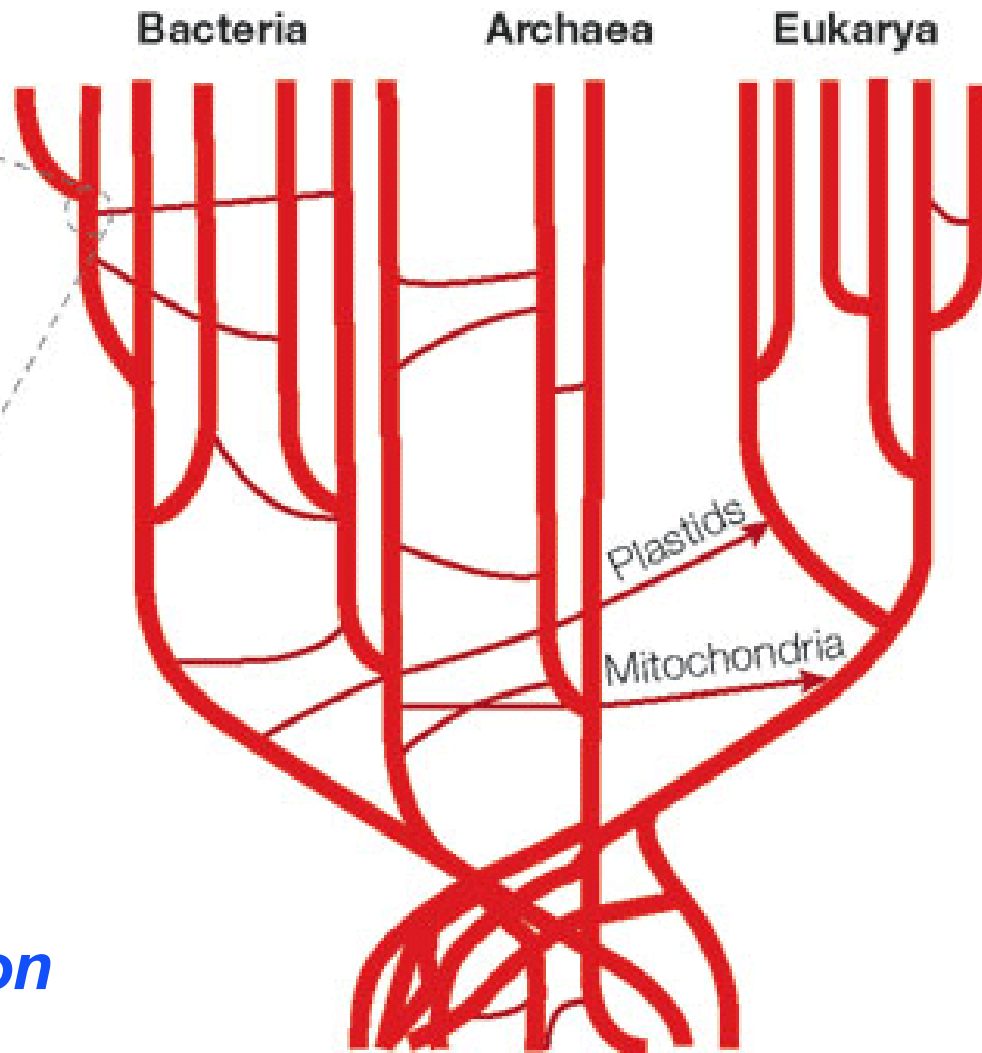
Asynchronous/ Simultaneous Agile Life-Cycle Framework



Evolution and Innovation



Horizontal Gene Transfer



Common ancestral community of primitive cells

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Credit: Smets, Barth F. and Tamar Barkay. 2005. Horizontal gene transfer: perspectives at a crossroads of scientific disciplines. *Nature Reviews Microbiology* 3, 675-678 (Sep 2005)

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“Horizontally derived variation is the major, if not the sole, evolutionary source of true innovation.” Carl Woese

At Home in the Universe?

Life might be defined fundamentally as evolution.

The universe evolves.

Evolution requires change, survival, memory, and time.

**Organismic life has memory in the genetic code,
guided by natural selection over time.**

**Non-organismic life has memory in trajectories of physical
change, guided by the relationship of forces present,
and the affects of time on those relationships.**

Sustainable Enterprise?

(collective human endeavor)

Wikipedia

US “democracy”

Open systems development

Enterprises age/evolve on a trajectory

How old is the oldest Enterprise?

Towards Sustainable Systemic Security

Holistic Systems Engineering

Collective Intelligence

Harmony

Self-Organization

Consistency

Distrust

Shape Shifting

Component Conscience

System Conscience

Peer Behavior Judgment

Things to Think About

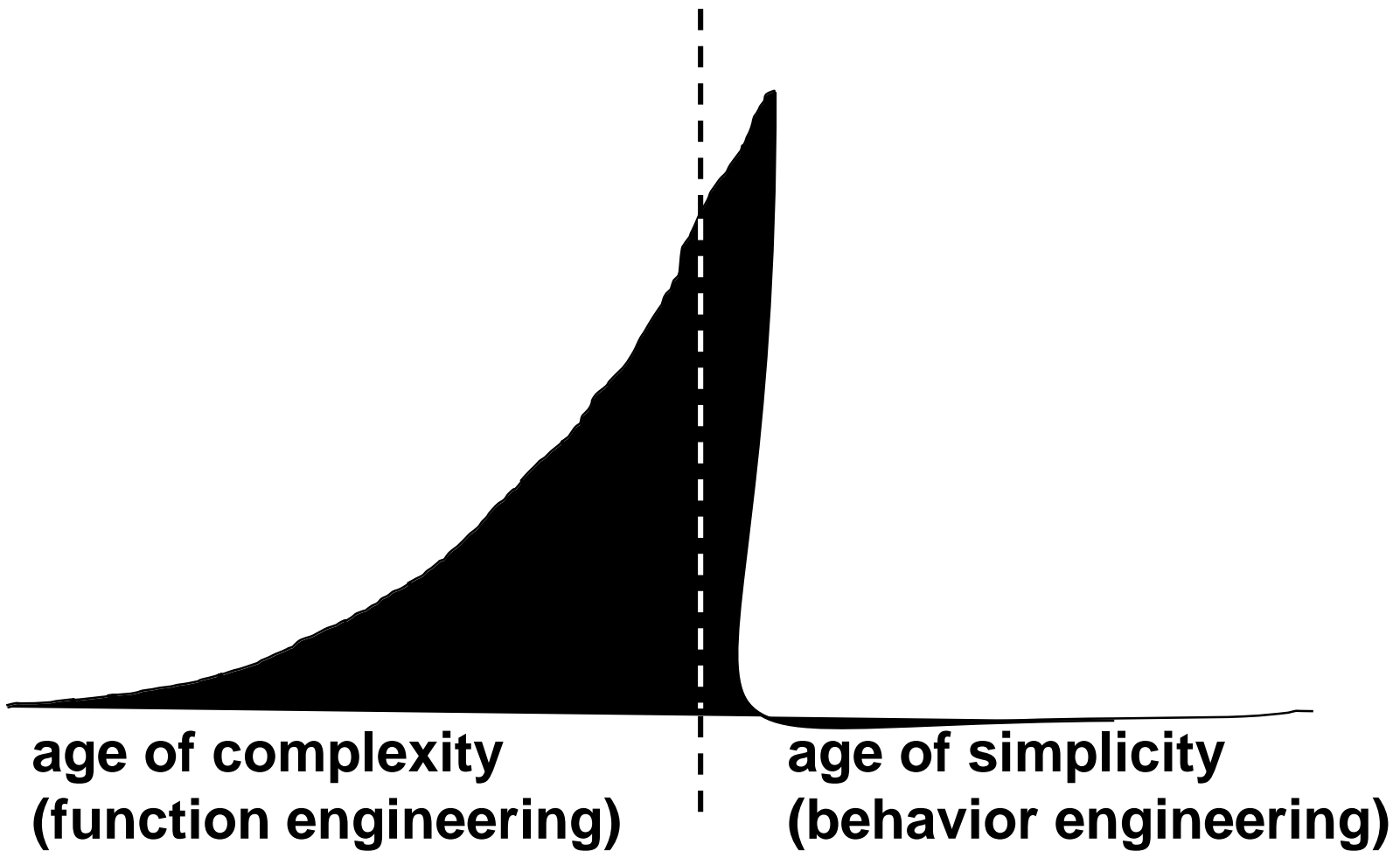
Sustainability is a natural selection fundamental.

**We may not like what is sustained or how it is sustained,
but we have no real controlling say in it.**

All we can do is recognize its laws and harmonize with them.

We can hurry it up, we can slow it up, and we can screw it up.

today we ride the shark fin



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