



# **A Systems Engineering Perspective on Innovation**

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for Systems Engineering**

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# Context: Engineering Within DoD



**Systems Engineers creatively apply scientific principles across a **broad portfolio** of weapons, sensors, command and control, logistics, and business systems:**

- To design, develop, construct and operate **complex** systems
- To forecast their **behavior** under specific operating conditions
- To deliver their **intended function** while addressing economic efficiency, environmental stewardship and safety of life and property

- *US Department of Defense is the World's Largest Engineering Organization*
- *Over 108,000 Uniformed and Civilian Engineers*
- *Over 39,000 in the Engineering (ENG) Acquisition Workforce*





# Innovation Defined

[in-uh-**vey**-shuh n]

Noun

1. **Something new** or different introduced
2. The act of innovating; introduction of new things or methods

Dictionary.reference.com

- The process of translating an idea or invention into a good or service that **creates value** or for which customers will pay.
- To be called an innovation, an idea must be **replicable at an economical cost** and must satisfy a specific need.
- Innovation involves deliberate application of information imagination and initiative in deriving greater or different values from resources, and includes **all processes by which new ideas are generated and converted into useful products.**

BusinessDictionary.com

**The ability to do something useful in a new and compelling way.**



# Setting the Conditions



- **The Cropsey Hypothesis**

- Innovation is most likely to occur when dissimilar bodies of information come into contact with each other
- That contact has to be of sufficient duration and intensity for knowledge to transfer from one body of information to another
- Insight results when the new knowledge enables a change in perspective or mental models that was previously unseen or not obtainable

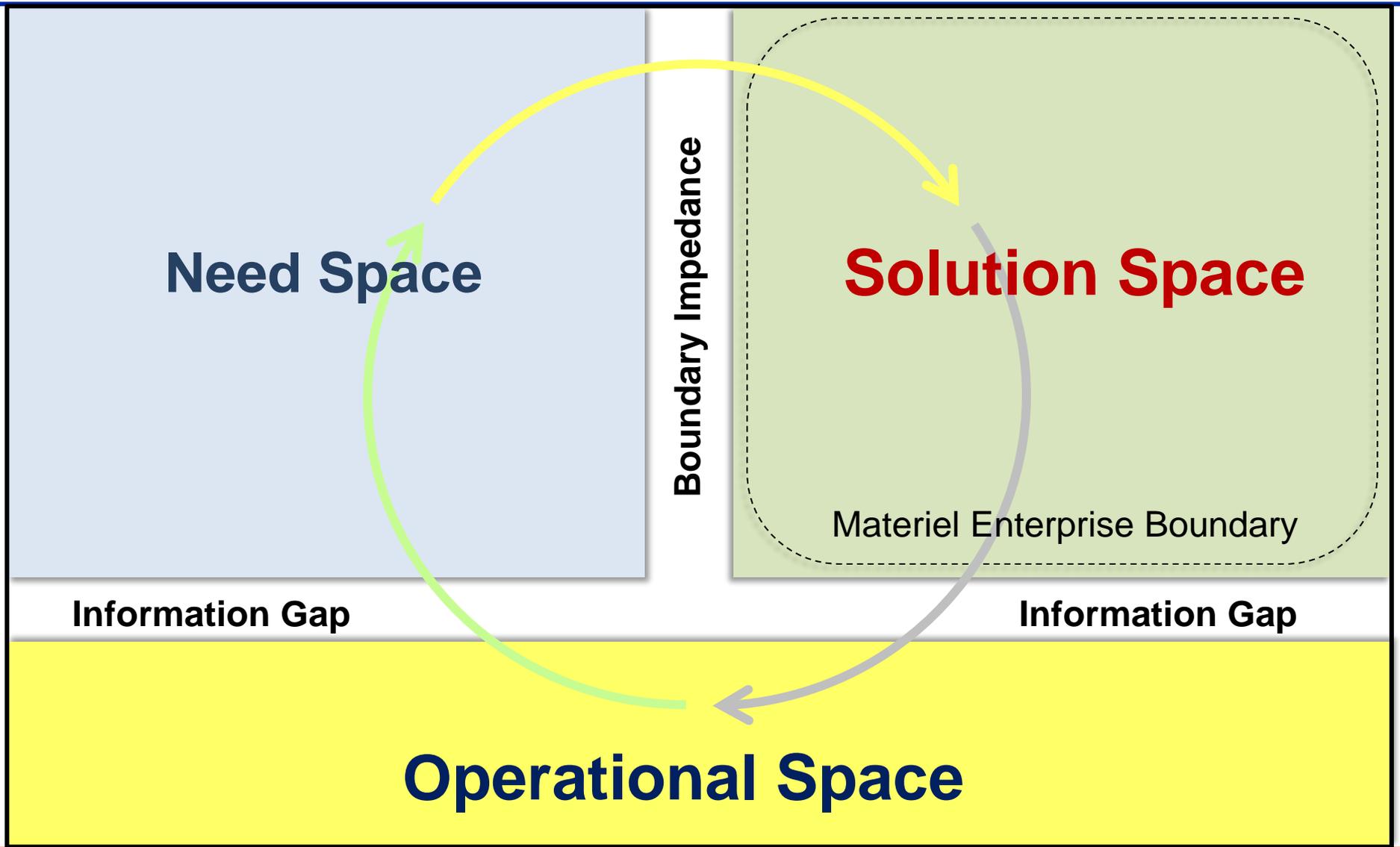
- **Challenges**

- Information is “sticky<sup>1</sup>”
- People naturally seek to reduce their local uncertainty<sup>2</sup>
- “Not Invented Here” syndrome
- Science is universal, Technology is local<sup>3</sup>

*Source: von Hippel<sup>1</sup>, Katz<sup>2</sup>, and Allen<sup>3</sup>*



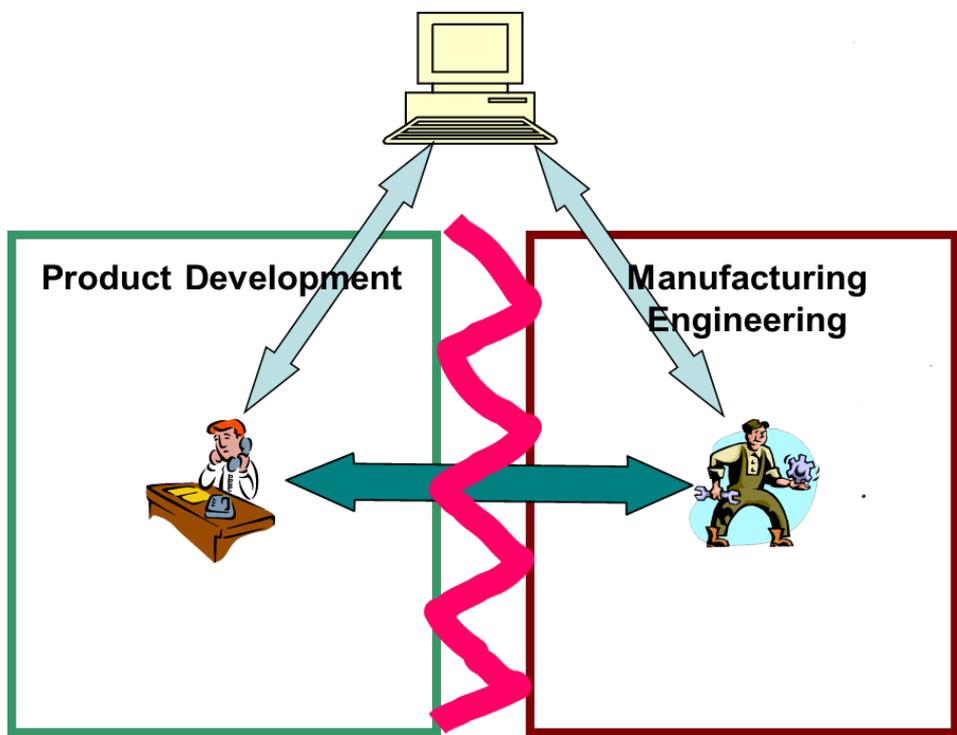
# A Simplified Model



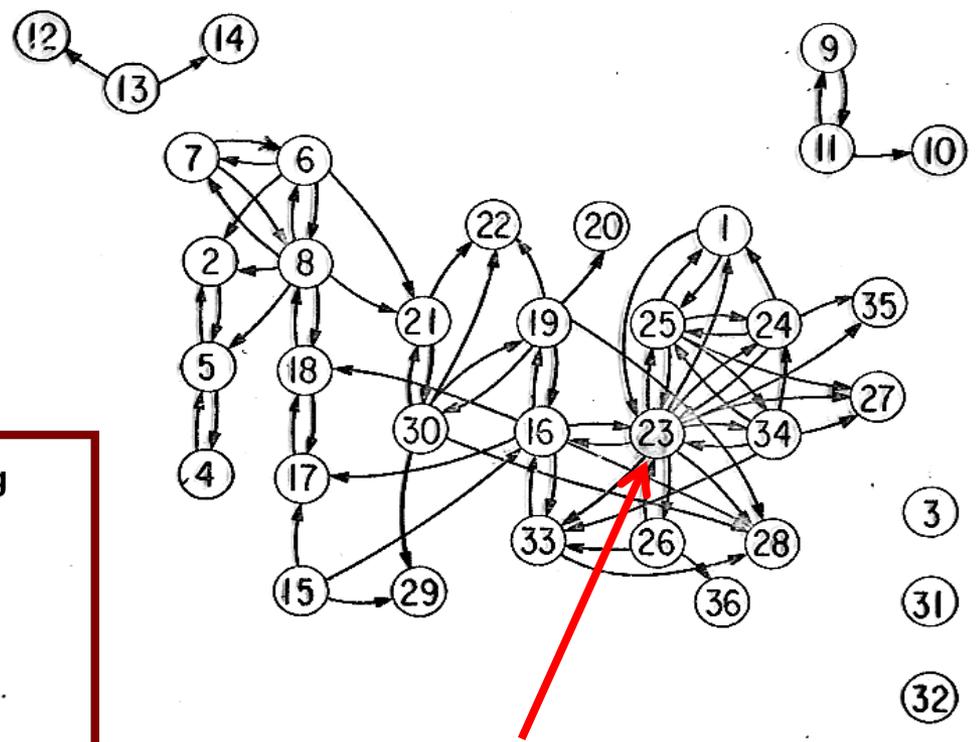


# Bridging the Information Gap

Common Model to reduce communication ambiguity



Interpersonal communication network in a small lab

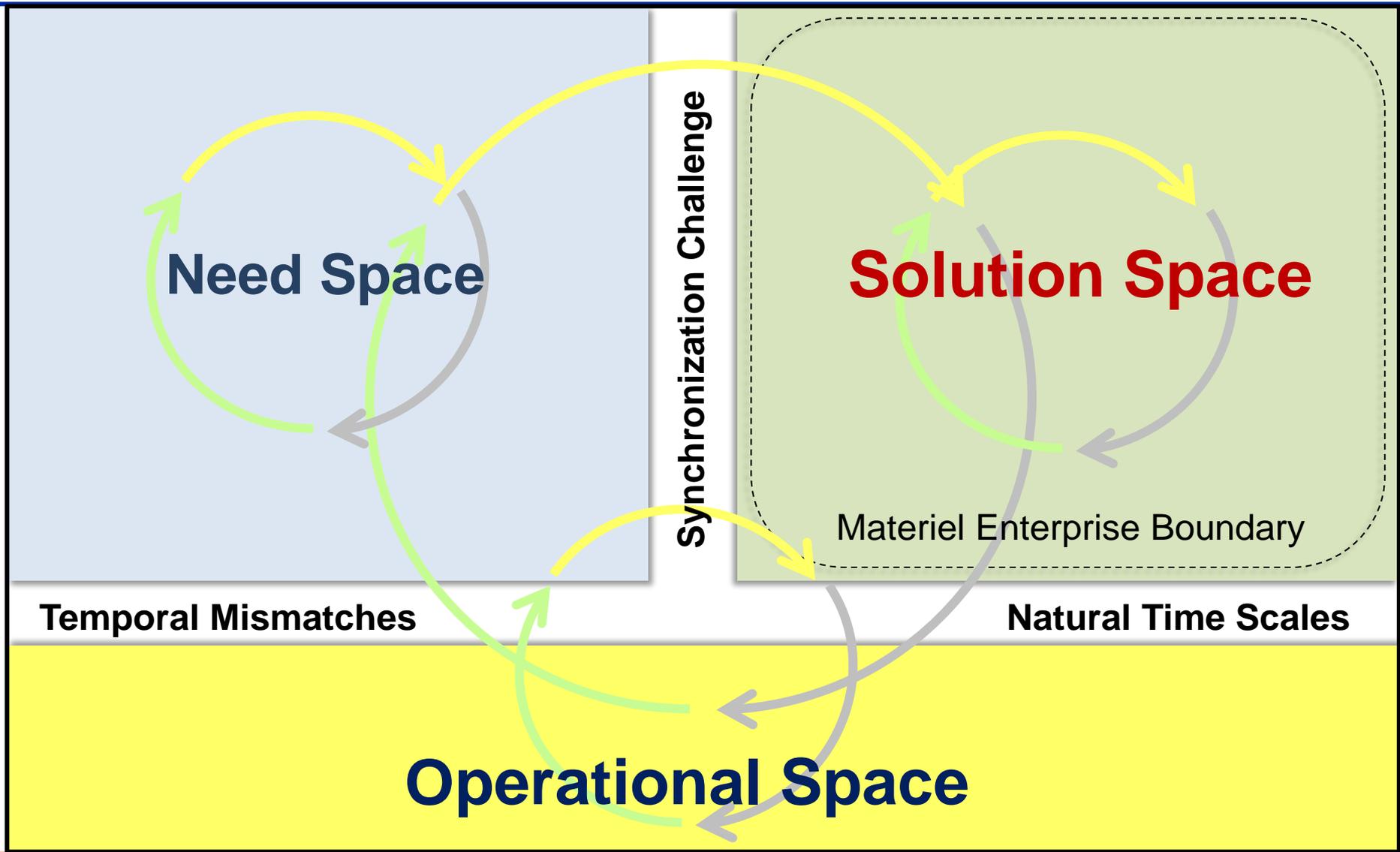


Who is this person?

Source: Tom Allen<sup>3</sup>

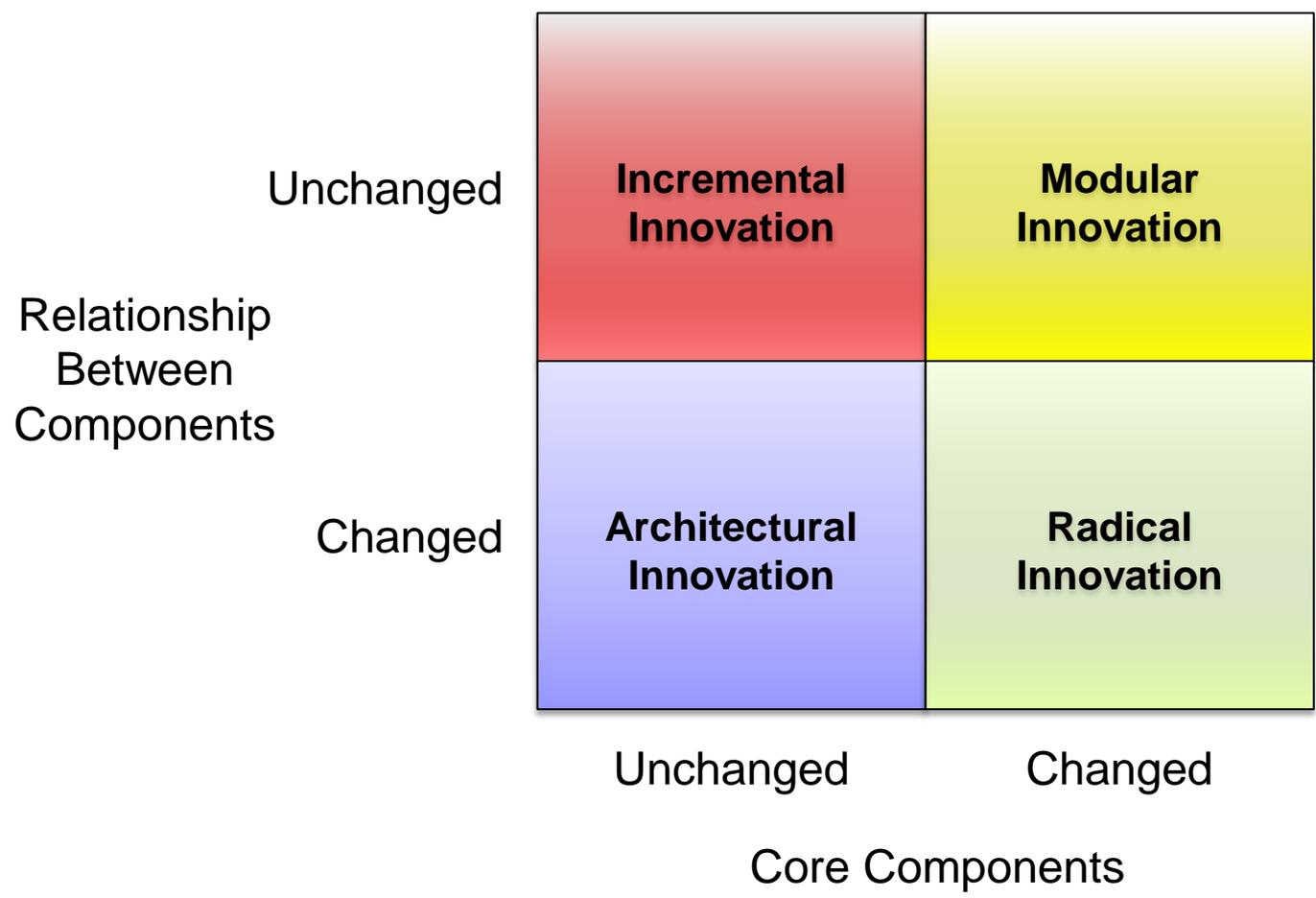


# Temporal Disharmony





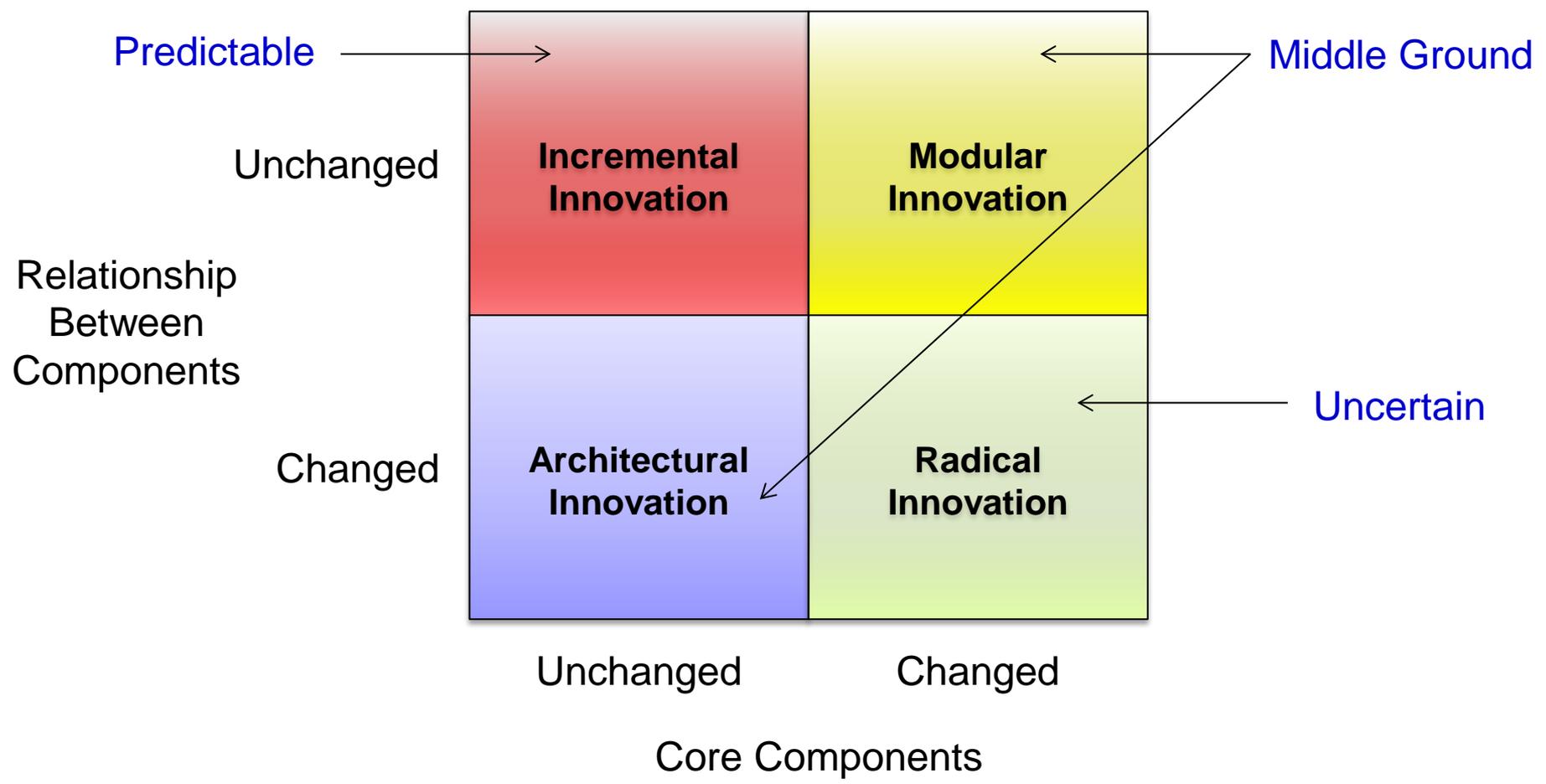
# Types of Innovation



Source: Henderson<sup>4</sup>



# Matching Clock Speeds



Source: Henderson<sup>4</sup>



# The Technology Life Cycle

	Early ferment	Dominant design emerges	Incremental innovation	Maturity	Eclipse or renewal
Demand Opportunity	Lead users, early adopters - high payoff, low switching costs	Early mainstream - usability, cost more important	Mainstream customers - soft factors, aesthetics	Saturation, segmentation, customization	Find <i>new needs</i> or <i>new customers</i>
Business Ecosystem	Many entrants - diverse business models	Decisive battles for leadership	Intensifying competition, early consolidation	Fierce competition, consolidation around majors and minors	
Technological Infrastructure	Make it work - innovate on <i>performance</i> , diverse integrative designs	Select optimal architecture, drive down <i>costs</i> , focus on <i>ease of use</i>	Provide broader offer, rationalize <i>portfolio</i> , build complementary <i>assets</i>	Develop <i>broad portfolio</i> , build <i>platforms</i>	Search for <i>new options</i>

Source: Davies<sup>5</sup>



# Putting it All Together



- **Need to bridge the information gap, both internally and externally**
- **Need common models for knowledge transfer between “sticky information” communities**
- **Need system architectures that account for a wide variety of subsystem time scales**
- **Need a variety of innovation efforts focused at different points in the technology life cycle**
- **Need someone with the expertise to do better than random collisions to spark innovative solutions!**



# SE Considerations



- **Model Based Systems Engineering**
- **Engineered Resilient Systems**
- **Open Systems Architecture**
- **Modular Architecture**
- **Tradespace Exploration**

**What design considerations need to be embedded into the **system architecture** to enable innovation on a wider range of platforms and product life cycle stages?**



# Relevant BBP 3.0 Efforts

- Increase the use of **prototyping and experimentation**
- Emphasize **technology insertion** and refresh in program planning
- Use **Modular Open Systems Architecture** to stimulate innovation
- **Reduce cycle times** while ensuring sound investments
- Strengthen **organic engineering** capabilities
- Improve our leaders' ability to understand and mitigate **technical risk**



# Systems Engineering: Critical to Defense Acquisition



***Defense Innovation Marketplace***  
<http://www.defenseinnovationmarketplace.mil>

***DASD, Systems Engineering***  
<http://www.acq.osd.mil/se>



# For Additional Information



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3. Allen, Thomas J. (1984). *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information Within the R&D Organization*. Cambridge, MA: MIT Press
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5. Davies, Michael (2009). *Technology Strategy for System Design and Management*. MIT Course Number 15.965: MIT Open Courseware