



**2021**  
Annual **INCOSE**  
International Workshop  
Virtual Event  
January 29 - 31, 2021

Premier Systems Engineering Workshop

MBSE Transformation

# The Cobbler's Kids Need New Shoes

---

[www.incose.org/iw2021/](http://www.incose.org/iw2021/)



# MBSE Transformation Foundational Strategies



1. **CHALLENGE:** The rate of discipline speciation & emergence is exceeding the rate of standardized discipline integration. The result is knowledge losses, under-utilization of new disciplines and untapped system lifecycle productivity gains.
2. **SOLUTION:** MBSE is uniquely positioned to be the lead strategy for solving the discipline integration problem.
3. **EXECUTION:** The "MBSE Transformation", as with any transformation, should be driven by a **Transformation System** that is not typically managed as a system in most enterprises. Thus, an organizational design change intervention is required.

**1. MBSE should be used to develop the "Transformation System".**

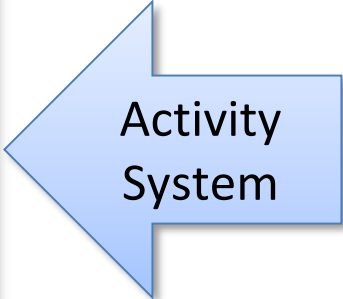
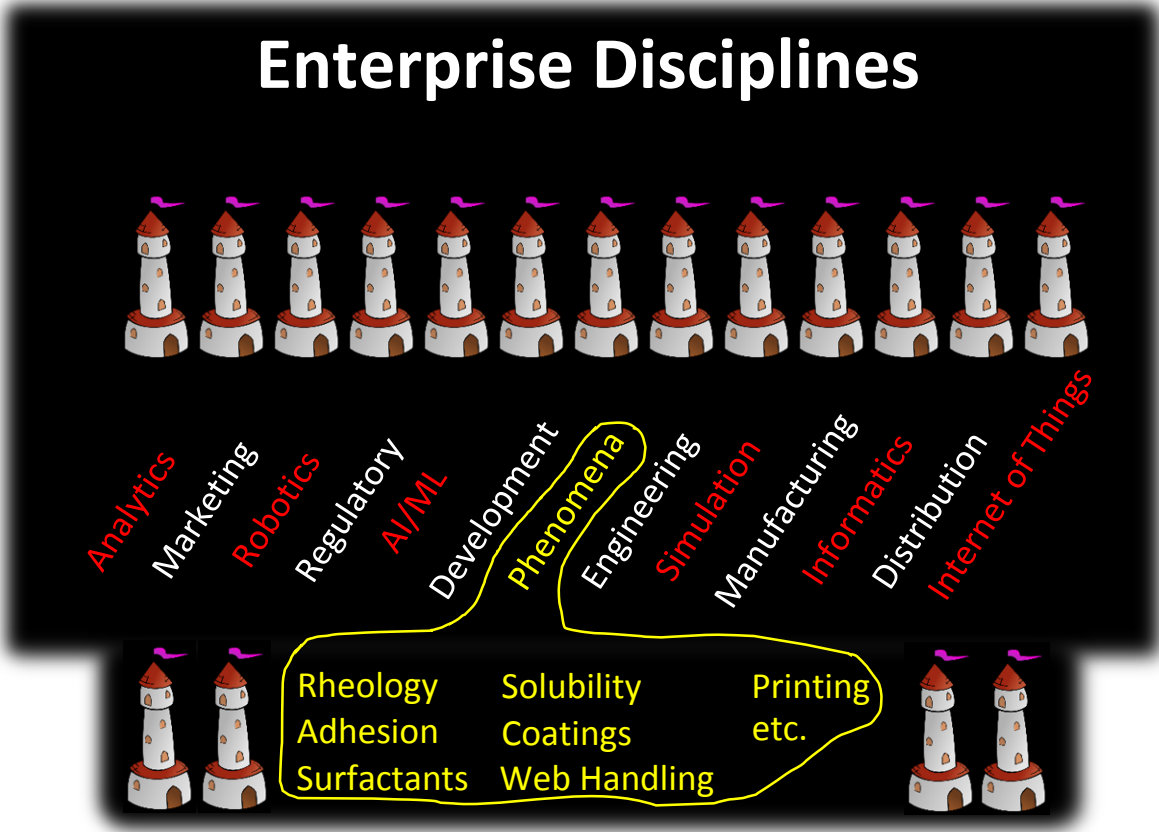
**2. A universal standard model may be useful.**

*"The cobbler's kids need new shoes."*



# CHALLENGE: Integrating New Disciplines

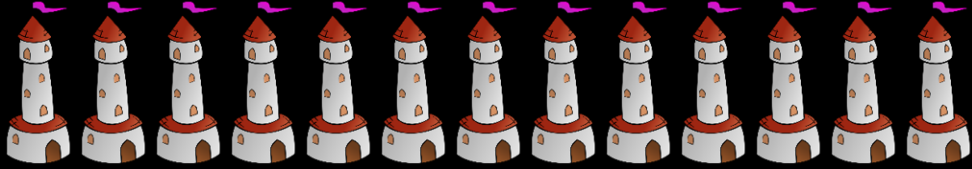
## System of Innovation & Operations





# CHALLENGE: Integrating New Disciplines

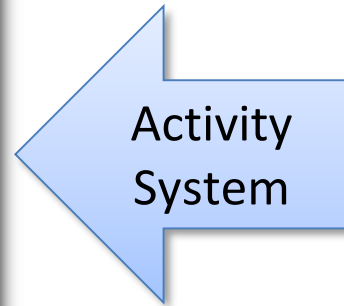
## Enterprise Disciplines



Analytics  
Marketing  
Robotics  
Regulatory  
AI/ML  
Development  
Phenomena  
Engineering  
Simulation  
Manufacturing  
Informatics  
Distribution  
Internet of Things



Rheology  
Adhesion  
Surfactants  
Solubility  
Coatings  
Web Handling  
Printing  
etc.



*Schindel's & Dove's IS2016 "Got Phenomena" paper: "...MBSE/PBSE supports emergence of new hard sciences and phenomena-based domain disciplines."*

SY

26<sup>th</sup> Annual INCOSE International Symposium (IS 2016)  
Edinburgh, Scotland, UK, July 18-21, 2016

### Got Phenomena? Science-Based Disciplines for Emerging Systems Challenges

Bill Schindel  
ICTT System Sciences  
[schindel@ictt.com](mailto:schindel@ictt.com)

Copyright © 2015 by Bill Schindel. Published and used by INCOSE with permission.

**Abstract.** Engineering disciplines (ME, EE, CE, ChE) sometimes argue their fields have "real physical phenomena", "hard science" based laws, and first principles, claiming Systems Engineering lacks equivalent phenomenological foundation. We argue the opposite, and how replanting systems engineering in MBSE/PBSE supports emergence of new hard sciences and phenomena-based domain disciplines.

Supporting this perspective is the System Phenomenon, wellspring of engineering opportunities and challenges. Governed by Hamilton's Principle, it is a traditional path for derivation of equations of motion or physical laws of so-called "fundamental" physical phenomena of mechanics, electromagnetics, chemistry, and thermodynamics.

We argue that laws and phenomena of traditional disciplines are less fundamental than the System Phenomenon from which they spring. This is a practical reminder of emerging higher disciplines, with phenomena, first principles, and physical laws. Contemporary examples include ground vehicles, aircraft, marine vessels, and biochemical networks; ahead are health care, distribution networks, market systems, ecologies, and the IoT.

#### 1. Introduction

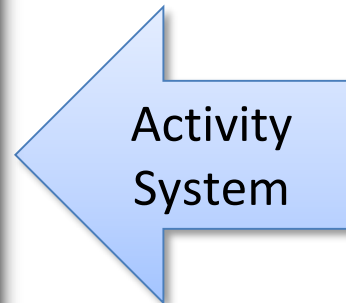
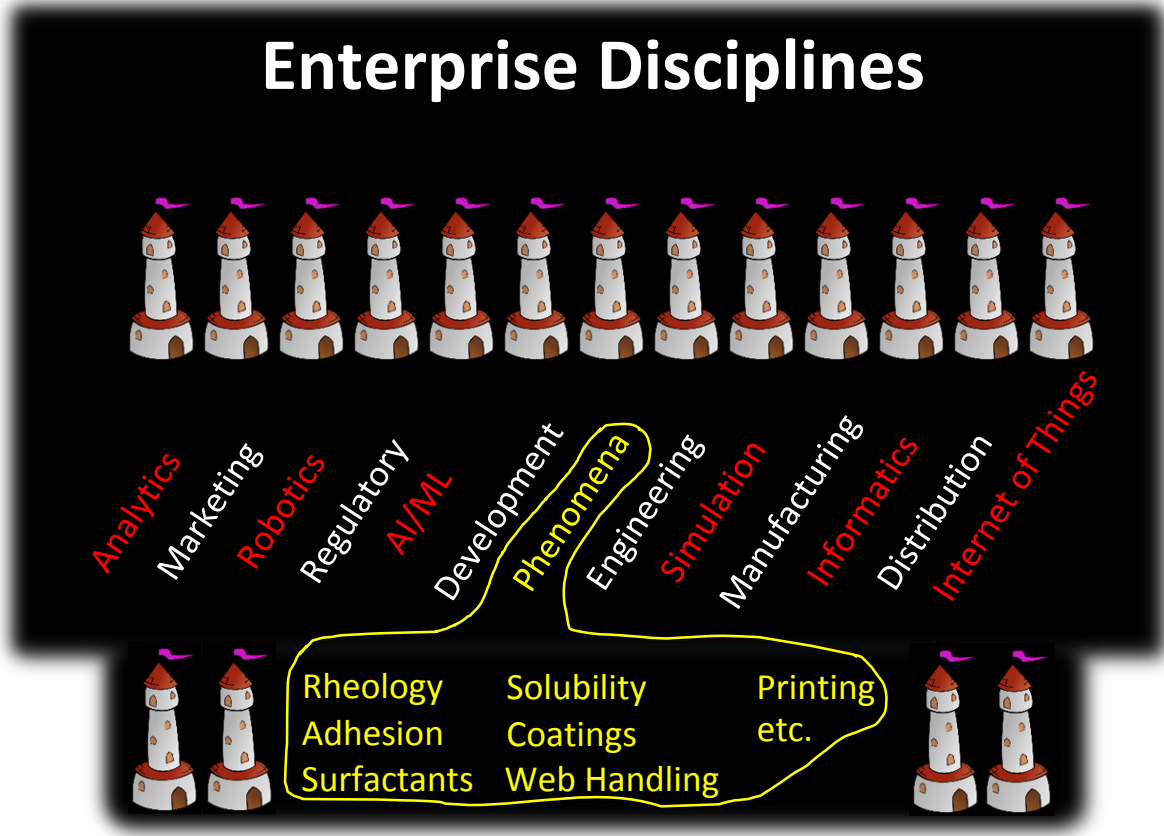
As a formal body of knowledge and practice, Systems Engineering is much younger than the more established engineering disciplines, such as Civil, Mechanical, Chemical, and Electrical Engineering. Comparing their underlying scientific foundations to some equivalent in Systems Engineering sometimes arises as a dispute, concerning whose profession is "real" engineering based on (or at least later explained by) hard science, with tangible physical phenomena, and accompanied by physical laws and first principles. This paper argues for a different





# CHALLENGE: Integrating New Disciplines

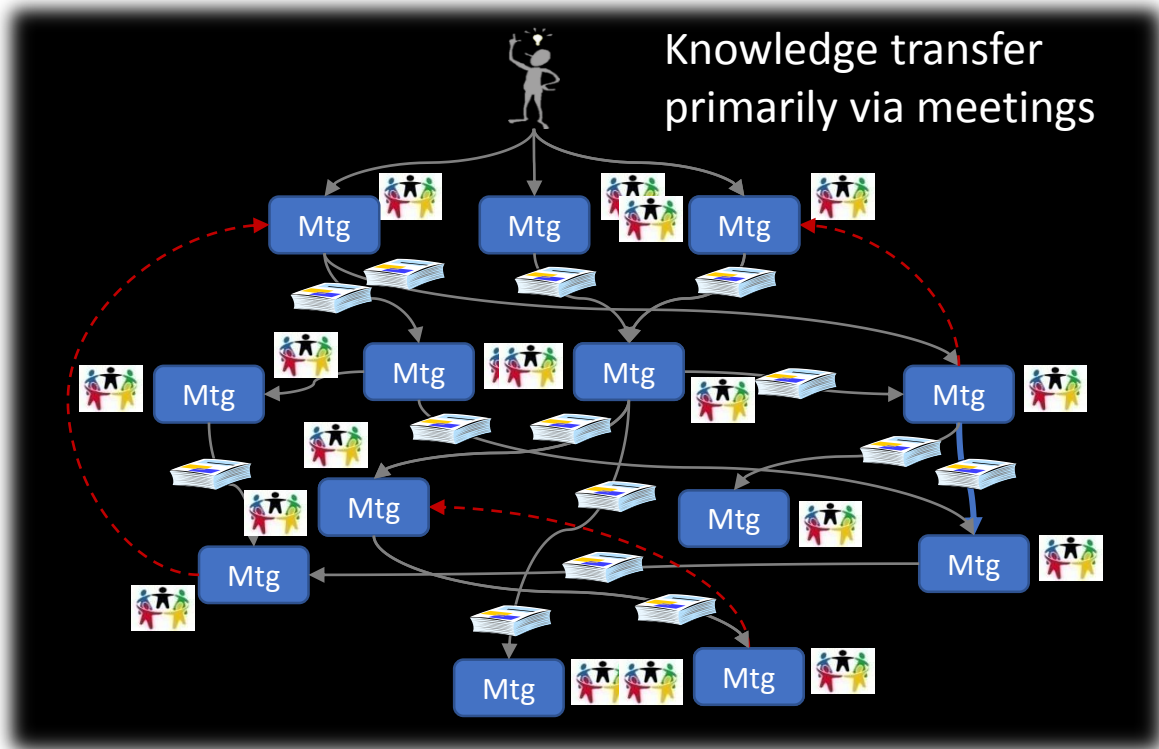
## System of Innovation & Operations





# Knowledge Transfer Primarily via Meetings

## System of Innovation & Operations

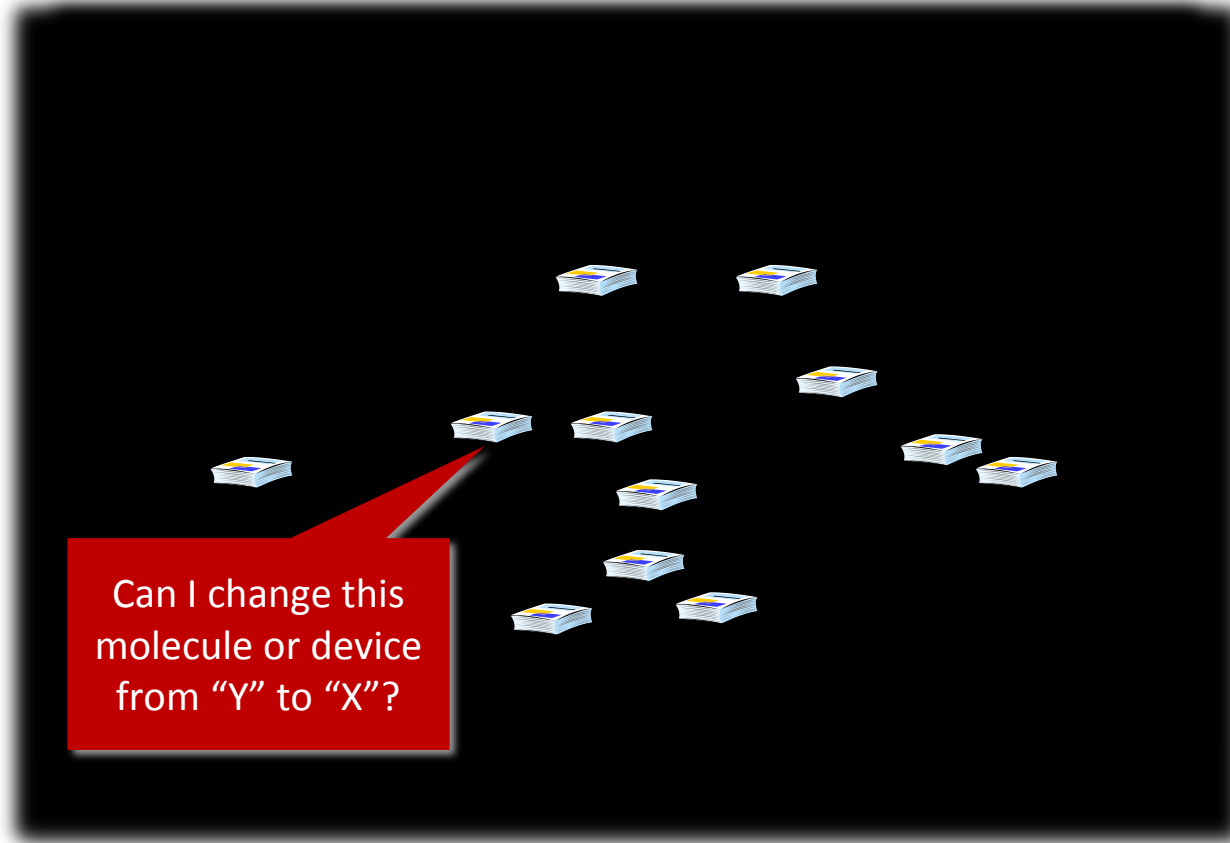


Activity System





# Result: Cross-Discipline Knowledge Losses



- **Loss of Tribal Technical Knowledge**
  - science
  - heuristics
- **Loss of Basis for Decisions**
  - Requirements, Targets & Limits
  - Chemical or Equipment Selections
  - Trades on performance, cost, agility, etc.

# MBSE Transformation Foundational Strategies



1. **CHALLENGE:** The rate of discipline speciation & emergence is exceeding the rate of standardized discipline integration. The result is knowledge losses, under-utilization of new disciplines and untapped system lifecycle productivity gains.
2. **SOLUTION:** MBSE is uniquely positioned to be the lead strategy for solving the discipline integration problem.
3. **EXECUTION:** The "MBSE Transformation", as with any transformation, must be driven by a Transformation System that is not typically formalized in most enterprises. Thus, an organizational design change intervention is required.







# Cross-Discipline Knowledge Integration

System of Systems  
(supply network,  
manufacturing process,  
product, etc.)

## System of Innovation & Operations

## Enterprise Disciplines

### System of Systems

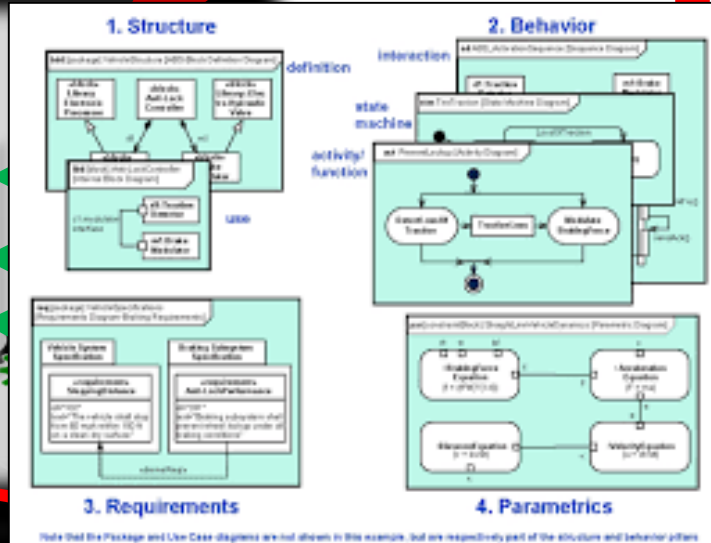
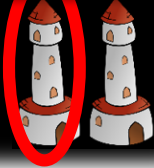
$$\begin{bmatrix} B \\ G \\ R \end{bmatrix} = \begin{bmatrix} \sigma_{xR}^2 & \sigma_{xR}\sigma_{xG} & \sigma_{xR}\sigma_{xB} \\ \sigma_{xR}\sigma_{xG} & \sigma_{xG}^2 & \sigma_{xG}\sigma_{xB} \\ \sigma_{xR}\sigma_{xB} & \sigma_{xG}\sigma_{xB} & \sigma_{xB}^2 \end{bmatrix}$$



Rheology  
Adhesion  
Surfactants

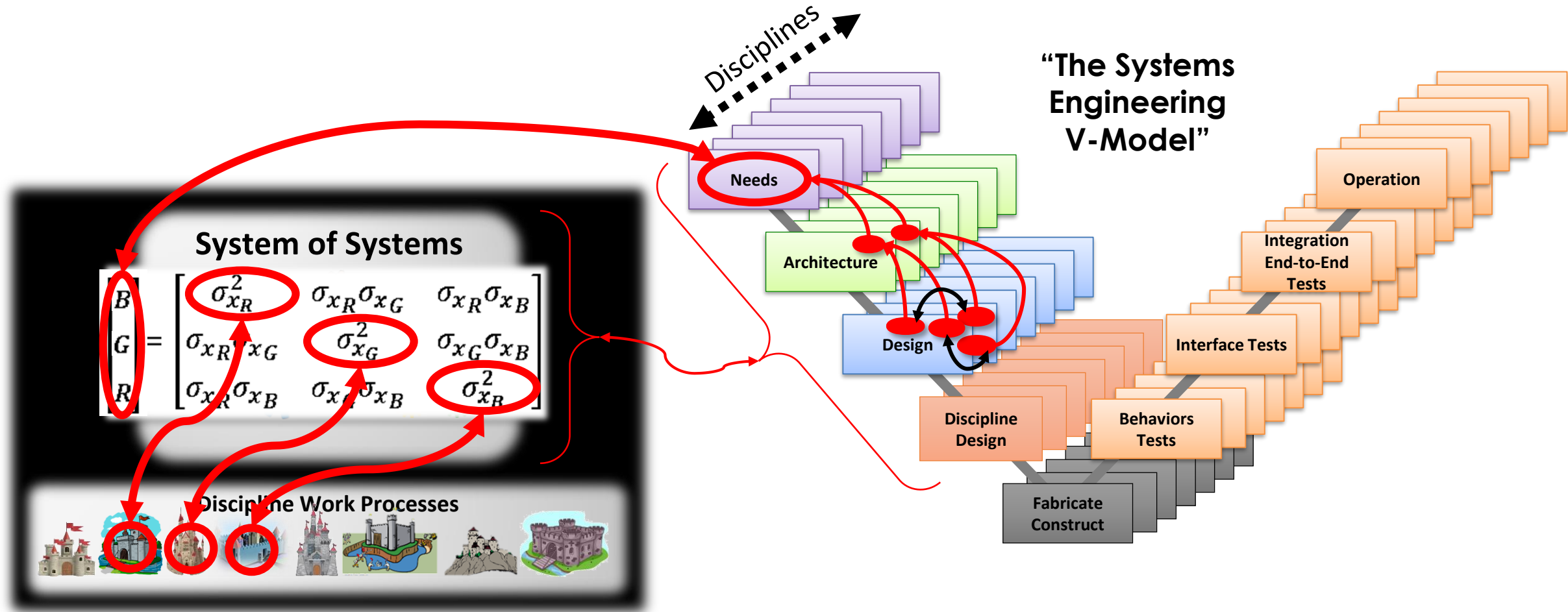
Solubility  
Coatings  
Web Handling

Printing  
etc.



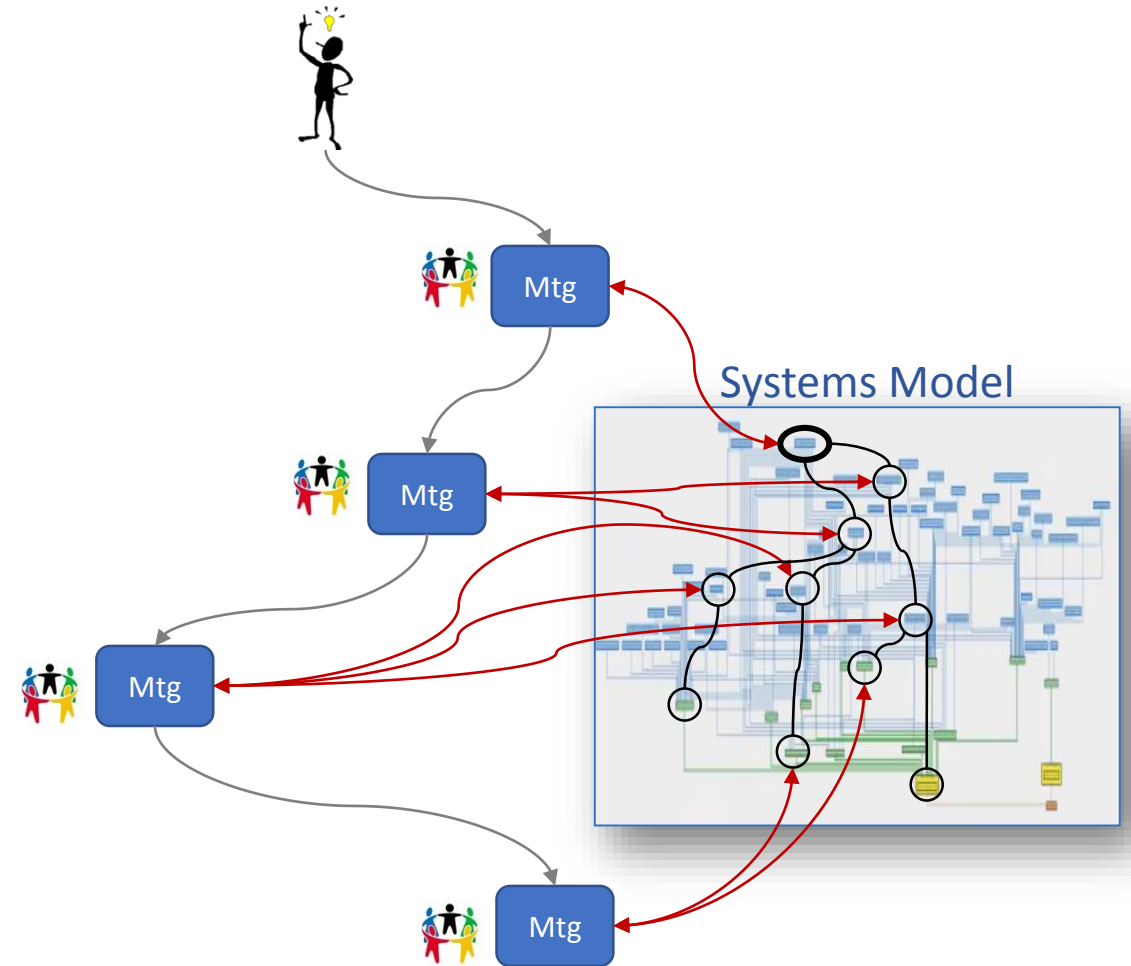
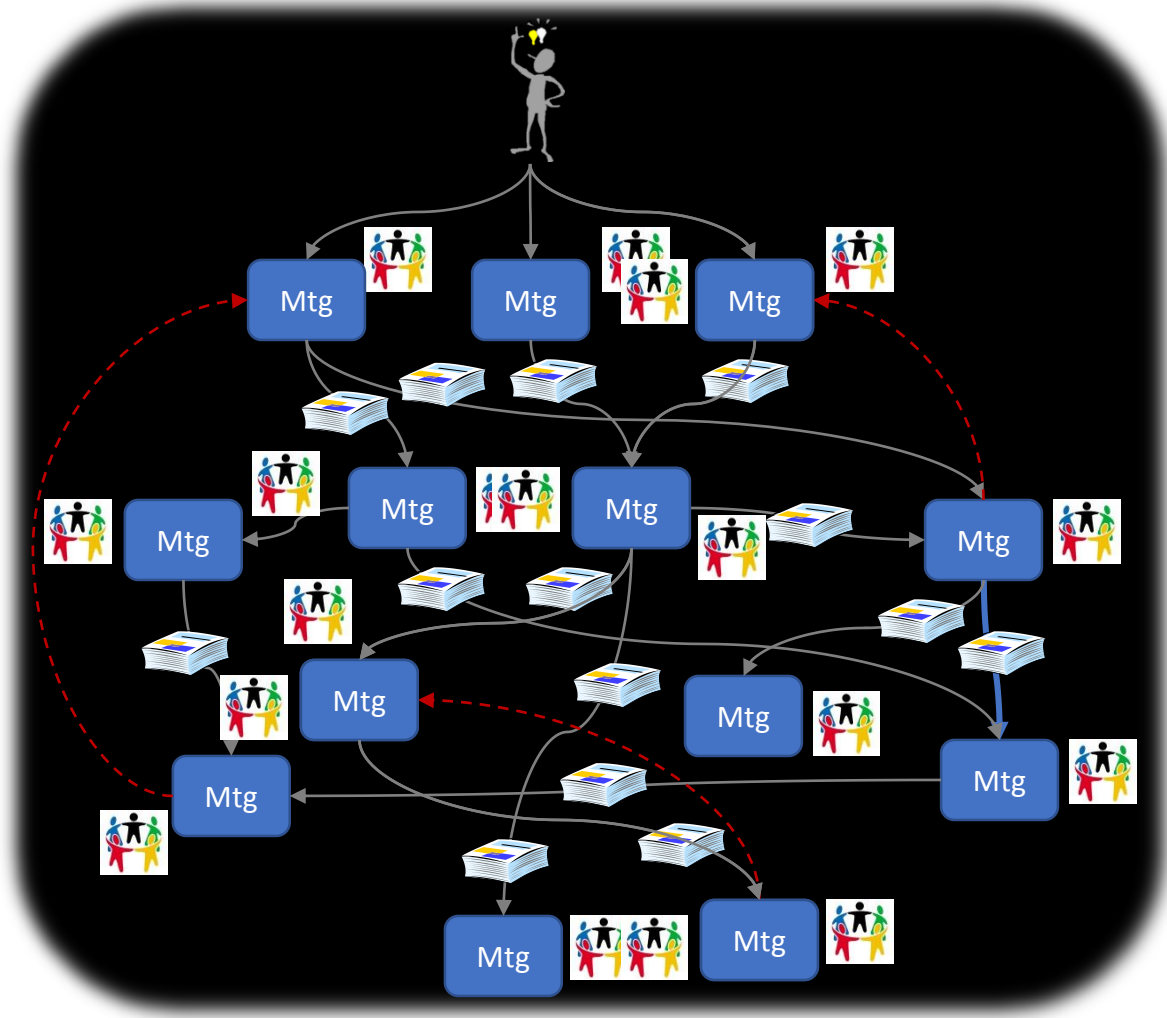


# Already doing it... It's just not in models





# Key Benefit of Model Driven Work Processes



# MBSE Transformation Foundational Strategies

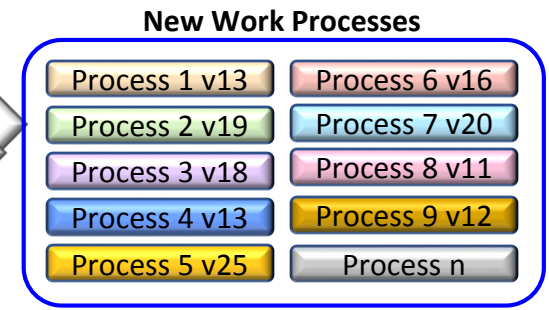
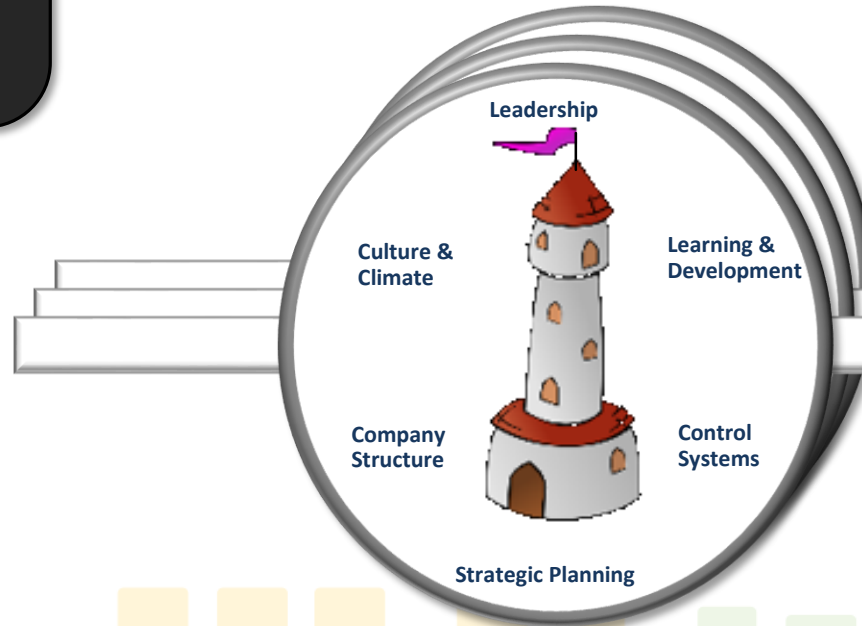
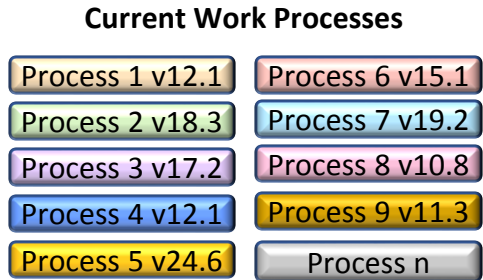
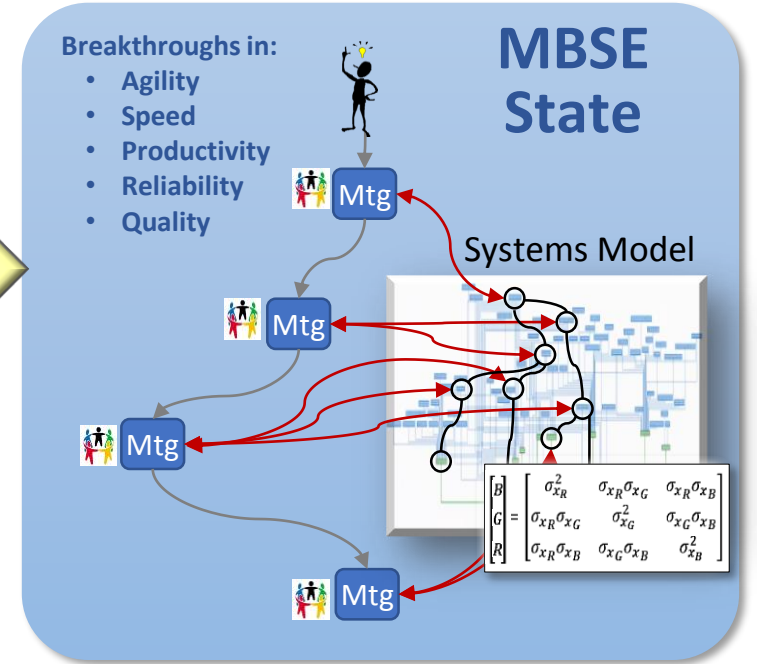
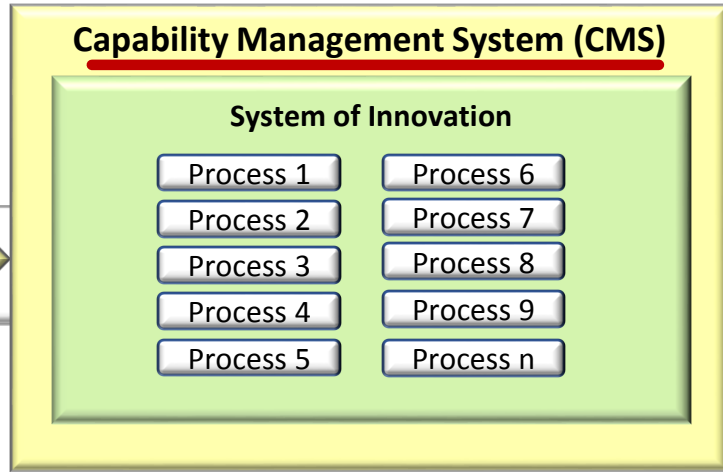
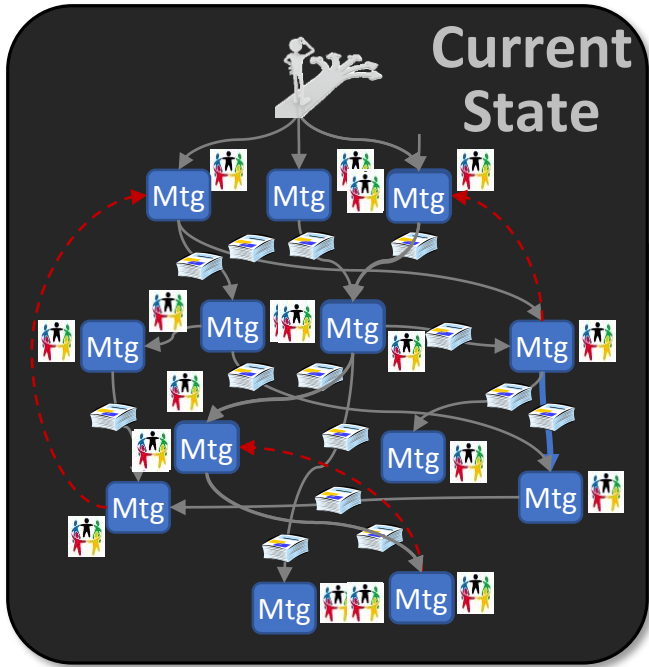


1. CHALLENGE: The rate of discipline speciation & emergence is exceeding the rate of standardized discipline integration. The result is knowledge losses, under-utilization of new disciplines and untapped system lifecycle productivity gains.
2. SOLUTION: MBSE is uniquely positioned to be the lead strategy for solving the discipline integration problem.
3. EXECUTION: The "MBSE Transformation", as with any transformation, must be driven by a Transformation System that is not typically formalized in most enterprises. Thus, an organizational design change intervention is required.





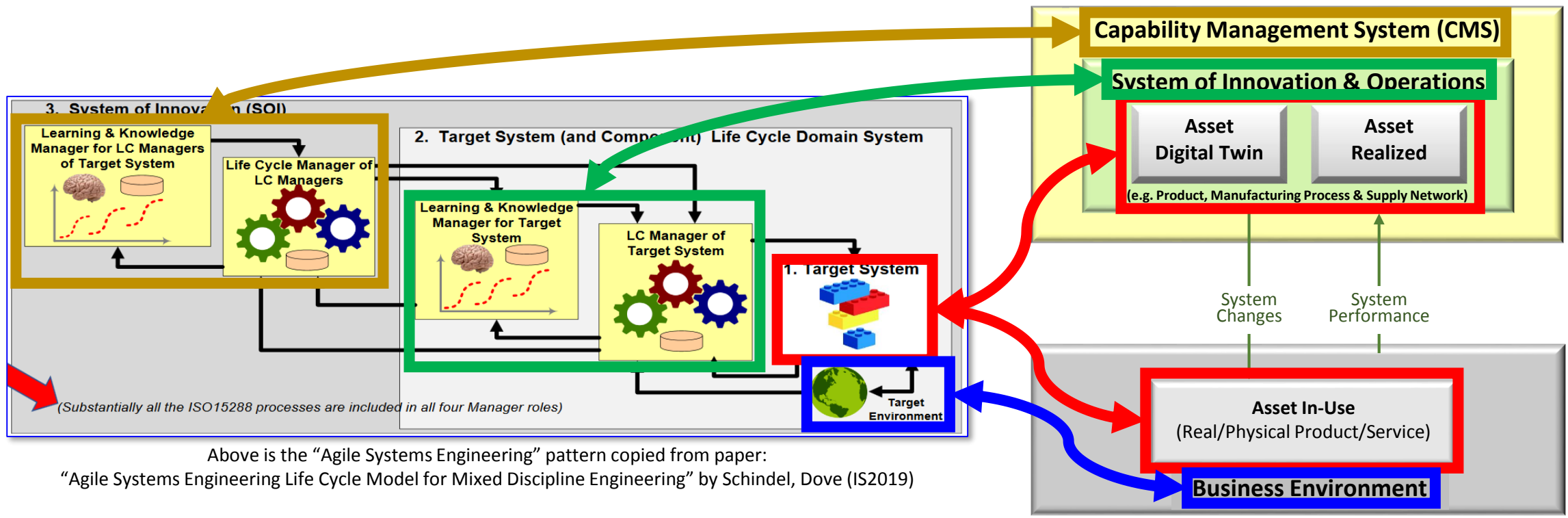
# The Transformation System



**Overall System Performance?**



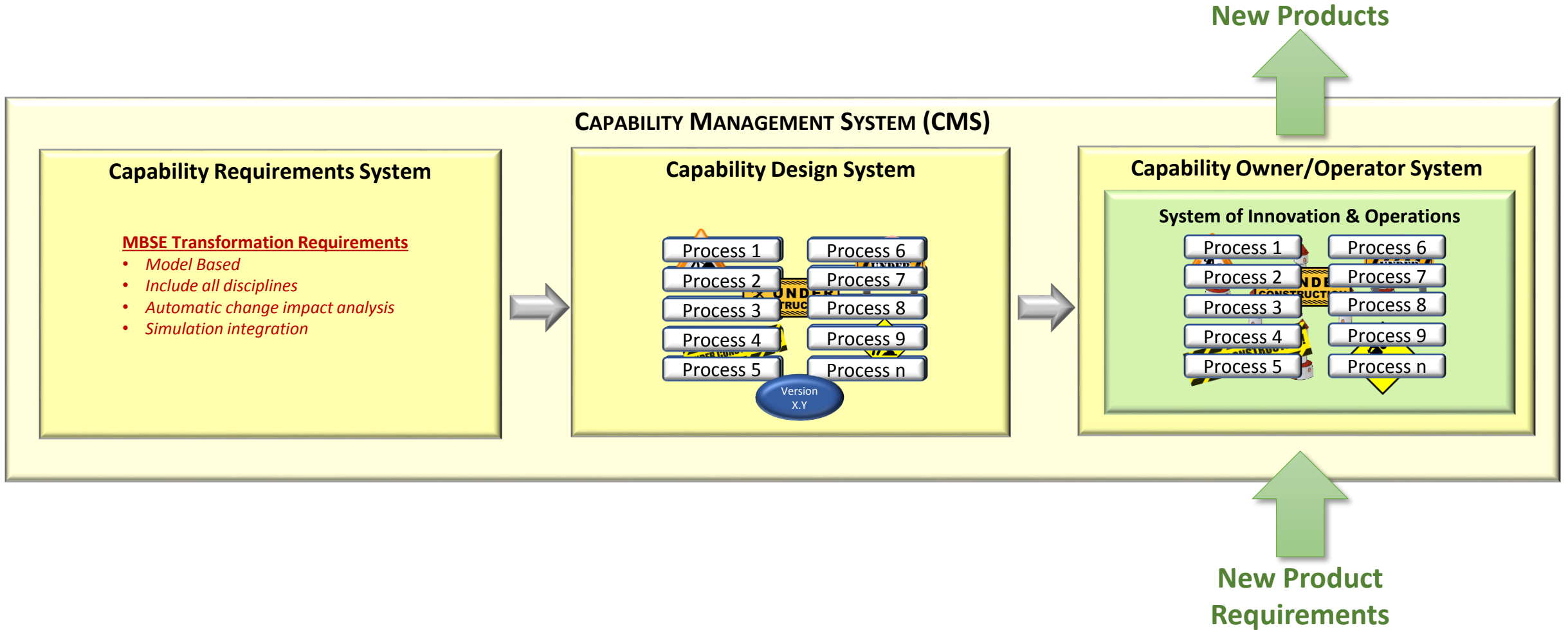
# Relating to Prior Work by Schindel/Dove



Above is the "Agile Systems Engineering" pattern copied from paper:  
 "Agile Systems Engineering Life Cycle Model for Mixed Discipline Engineering" by Schindel, Dove (IS2019)



# 1st Level Decomposition

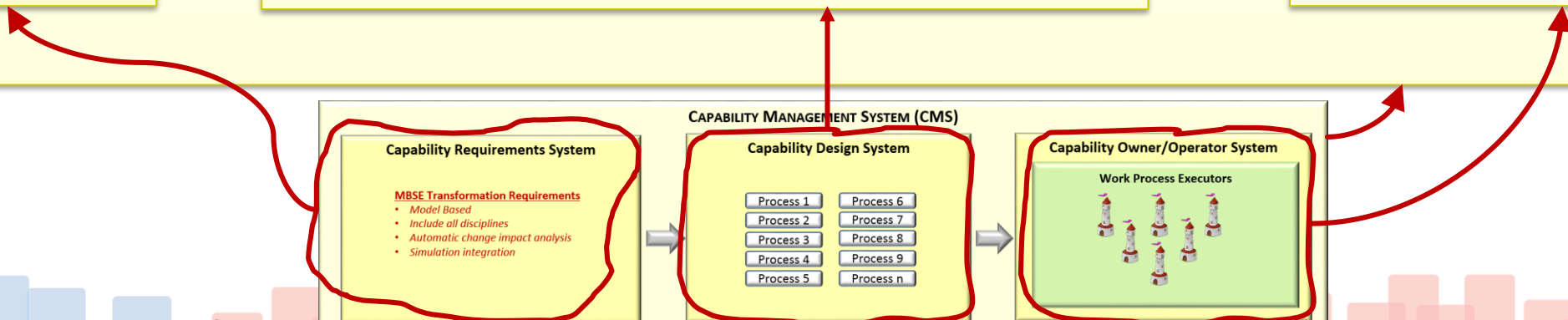


# Capability Management System

## Capability Requirements System

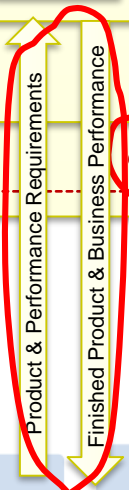
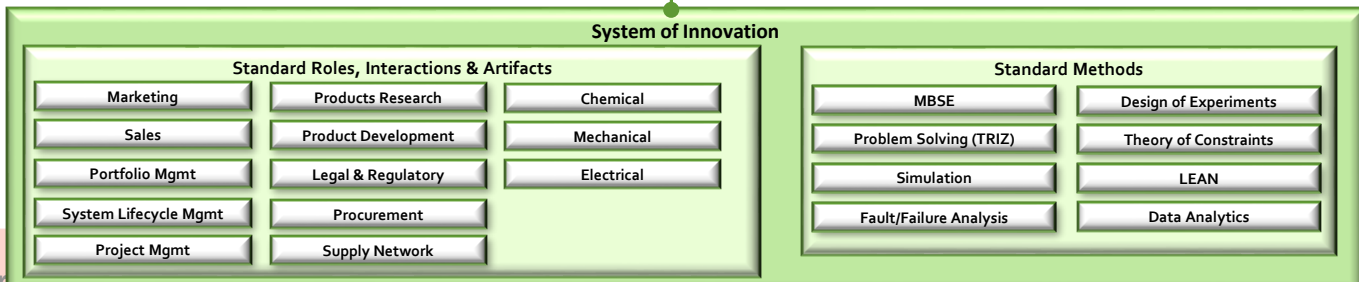
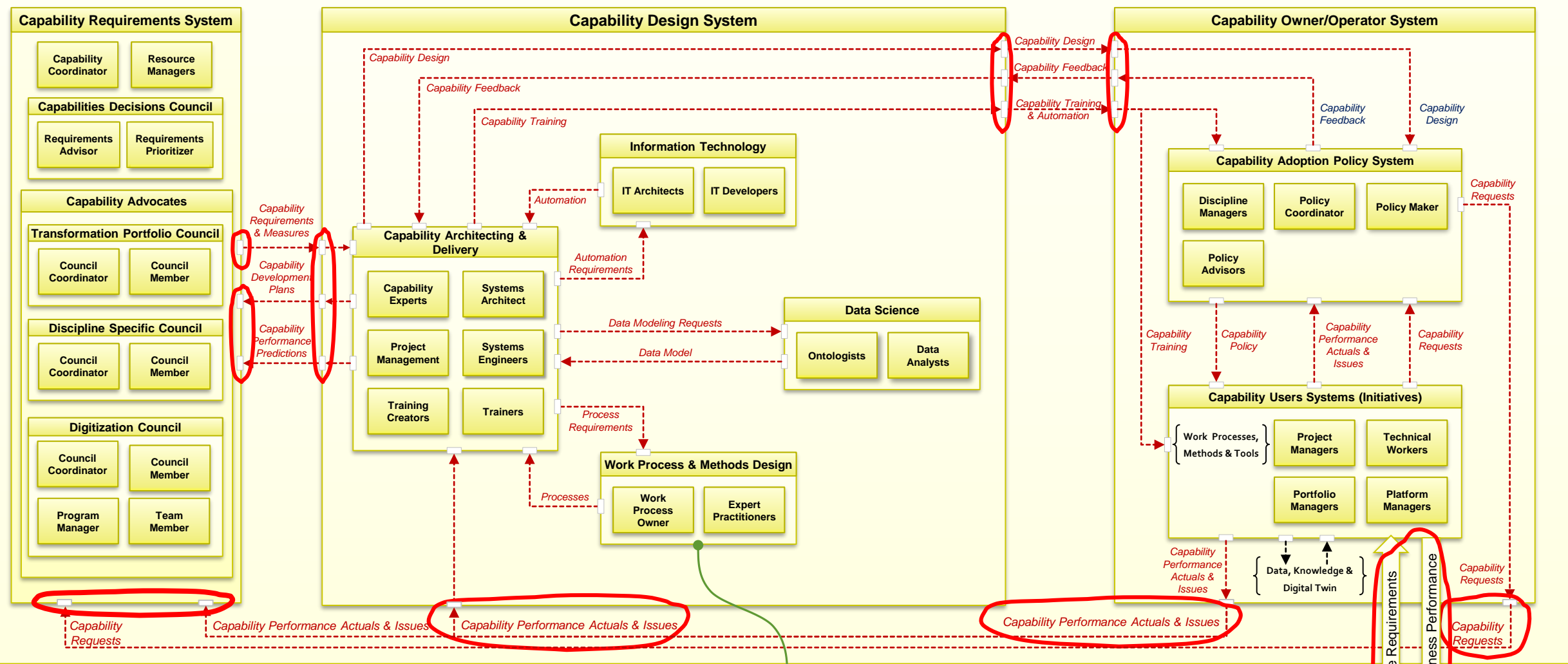
## Capability Design System

## Capability Owner/Operator System





# Capability Management System

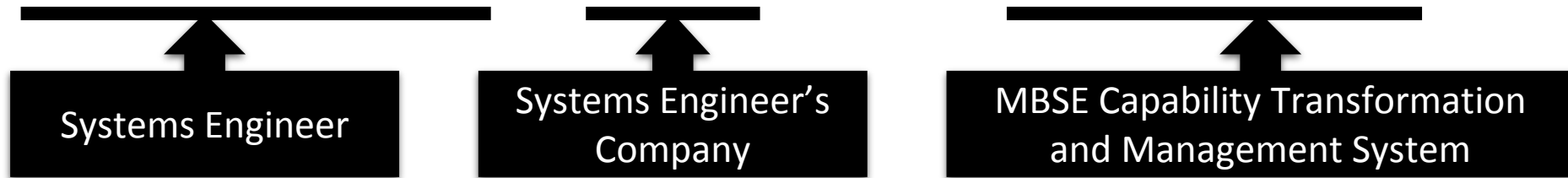




Wrap-up...

# MBSE Transformation

**The Cobbler's Kids Need New Shoes**



# Questions?





**2021**  
Annual **INCOSE**  
International workshop  
Virtual Event  
January 29 - 31, 2021

Premier Systems Engineering Workshop

[www.incose.org/iw2021/](http://www.incose.org/iw2021/)

