



# What's Hot in SE for 2023?

Dr. Steve Biemer

January 18, 2023



# Shameless Plug for SE Vision 2035

Hybrid: In-Person & On-Line Lecture

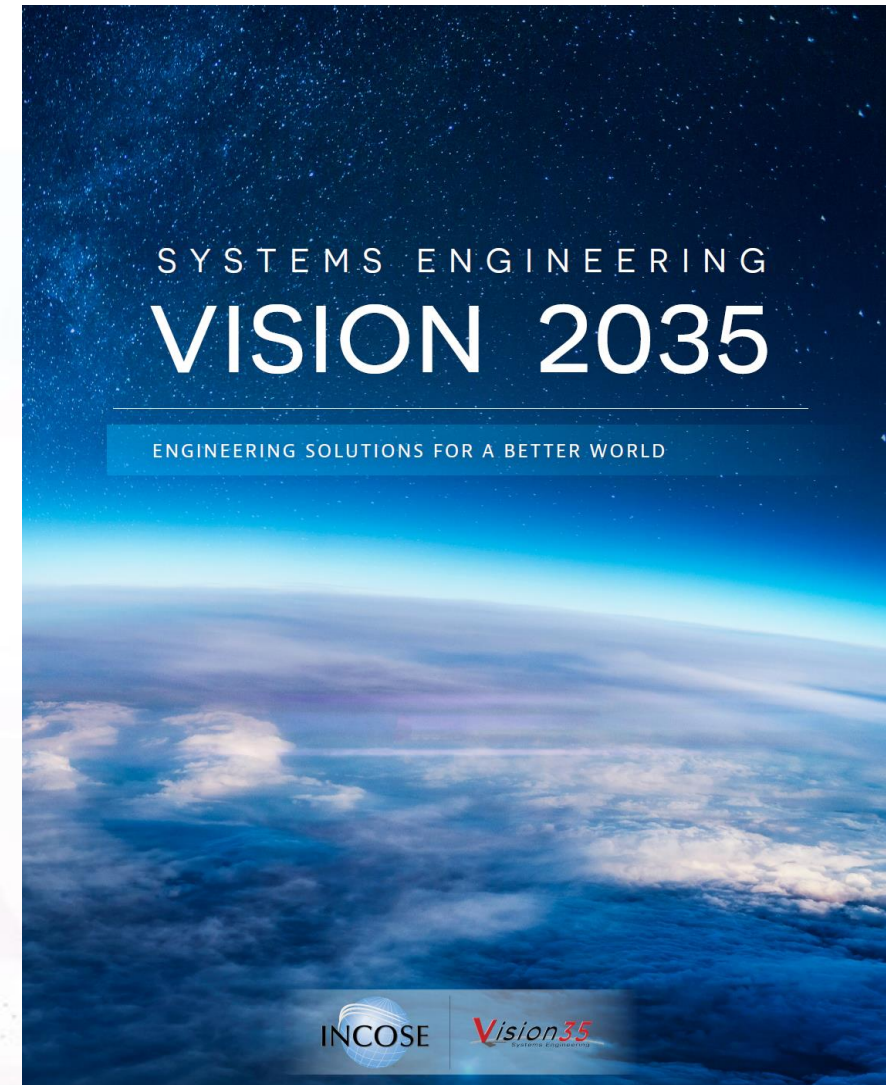

**Engineering a Better Tomorrow: SE Vision 2035 and Beyond**

**Mar 15<sup>th</sup>**

- Networking: 6:00 – 6:45 pm
- Member Meeting: 6:45 pm
- Lecture: 7:00 – 8:00 pm
- Location: JHU/APL - Parsons Auditorium

**FREE** Online Webcast Link will be sent to Registrants.

**David Long**



<https://www.incose.org/docs/default-source/se-vision/incose-se-vision-2035-executive-summary.pdf>



# Shameless Plug for INCOSE WGs

## Transformational Enablers

- Agile Systems & System Engineering
- Artificial Intelligence Systems
- Digital Engineering Information Exchange
- Lean Systems Engineering
- Model Based Concept Design
- NAFEMS-INCOSE Systems Modeling & Simulation WG
- Object-Oriented SE Method
- SE in Early Stage Research & Development
- Small Business Systems Engineering
- Soft Skills
- Systems Science
- Tool Integration and Model Lifecycle Management
- Systems Engineering Tools Database
- MBSE Initiative
- Smart Cities
- Systems Software Interface
- MBSE Patterns

## Application Domains

- Automotive
- Critical Infrastructure
- Healthcare
- Oil and Gas
- Power & Energy Systems
- Telecommunication
- Transportation
- Infrastructure
- Systems of Systems
- Space Systems

## Analytic Enablers

- Complex Systems
- Decision Analysis
- Human Systems Integration
- Natural Systems
- Product Lines
- Resilient Systems
- Social Systems
- System of Systems
- System Safety
- Training
- Systems Security Engineering

## Process Enablers

- Architecture
- Configuration Management
- Measurement
- Risk Management
- Systems Engineering Quality Management
- Systems Engineering and Lawmaking
  - SE Law Integration Yammer
- Requirements
- PM-SE Integration



# What does “Hot” mean?

- **What are Managers and Executives Talking About?**
- **What are Customers investing in?**
- **What are Practitioners doing?**
- **What are Researchers researching?**



# #1. Model-Based Systems Engineering

## Managers & Executives are asking...

- What is it?
- How can I participate?
- Why is it so expensive?
  - Licenses
  - Training & Learning Curve
  - Translating
- What is the Return on Investment?

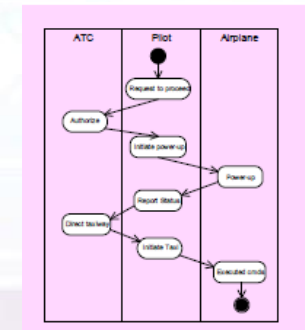


# #1. Model-Based Systems Engineering

## Traditional Systems Engineering



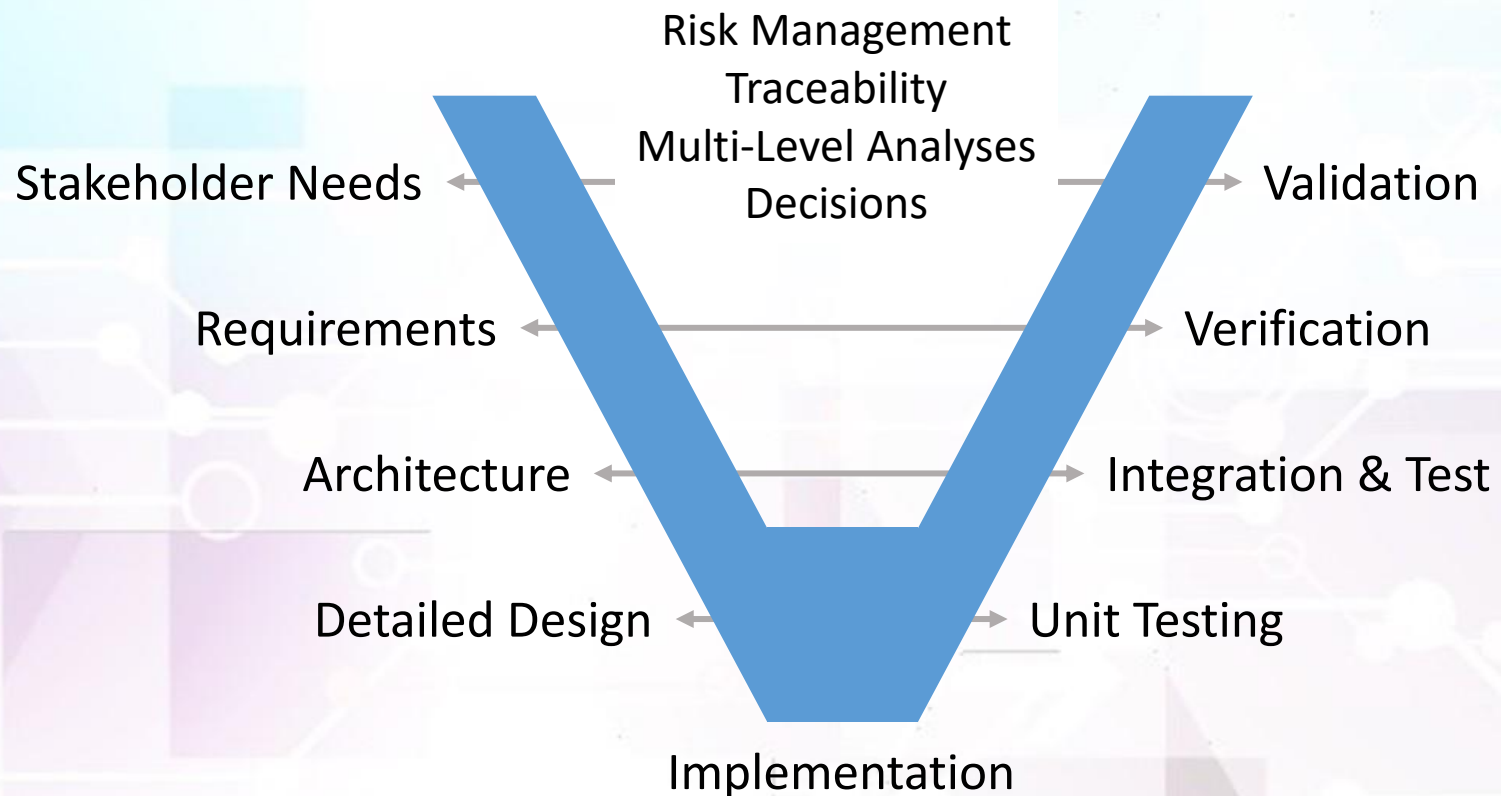
## Model-Based Systems Engineering





# #1. Model-Based Systems Engineering

## Traditional Systems Engineering





# #1. Model-Based Systems Engineering

## Traditional Systems Engineering

## Systems Engineering With a Model



Stakeholder Needs

Risk Management  
Traceability  
Multi-Level Analyses  
Decisions

Validation

Requirements

Verification

Architecture

Integration & Test

Detailed Design

Unit Testing

Implementation

Cameo EA  
Rational & Rhapsody  
Enterprise Architect  
Innoslate  
GENSYS & CORE  
Teamcenter  
...



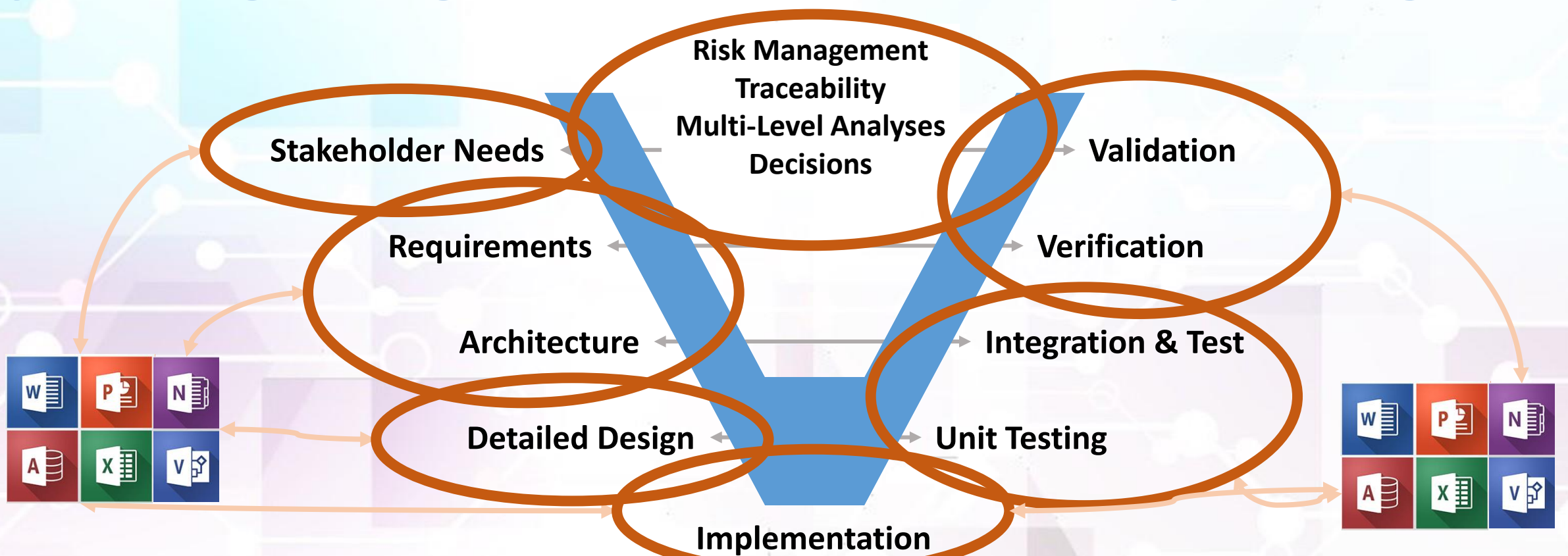


# #1. Model-Based Systems Engineering

Traditional Systems Engineering

Systems Engineering With a Model

Model-Based Systems Engineering

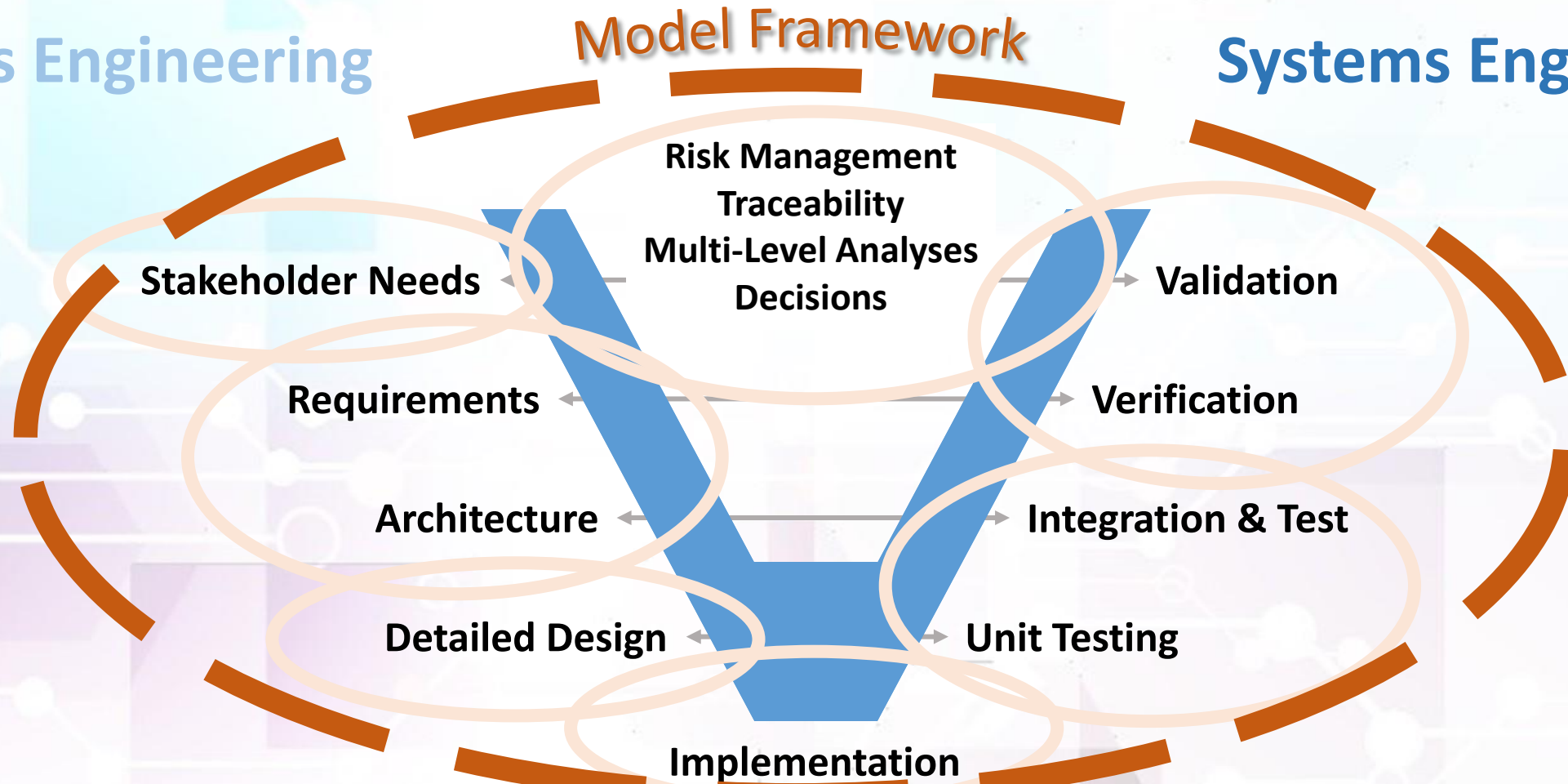




# #1. Model-Based Systems Engineering

Traditional Systems Engineering

Model-Based Systems Engineering



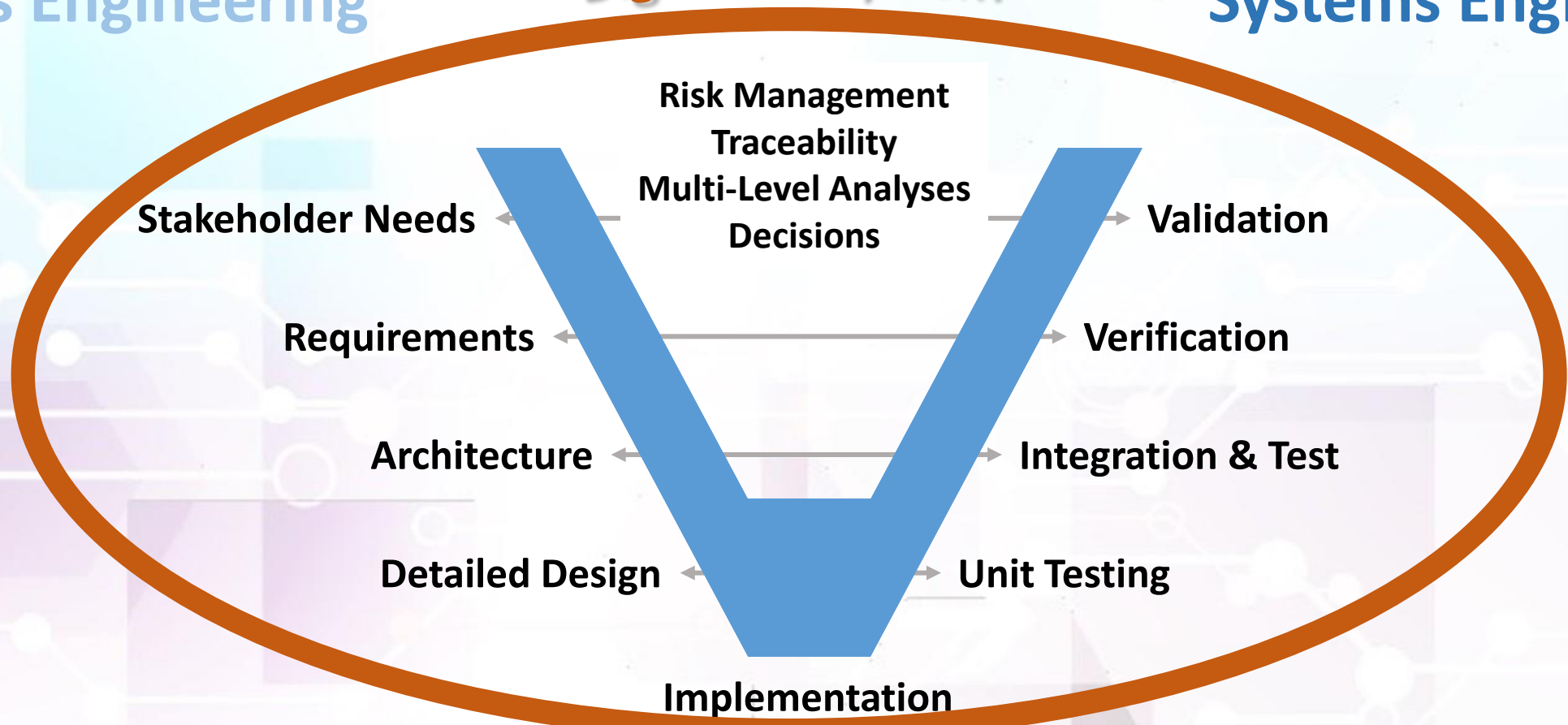


# #1. Model-Based Systems Engineering

Traditional Systems Engineering

Model-Based Systems Engineering

Digital Ecosystem





## #2. Agile Systems Engineering

### Managers & Executives are asking...

- What is it? How is it implemented?
- How can I participate?
- Is it cheaper than traditional / MB systems engineering?

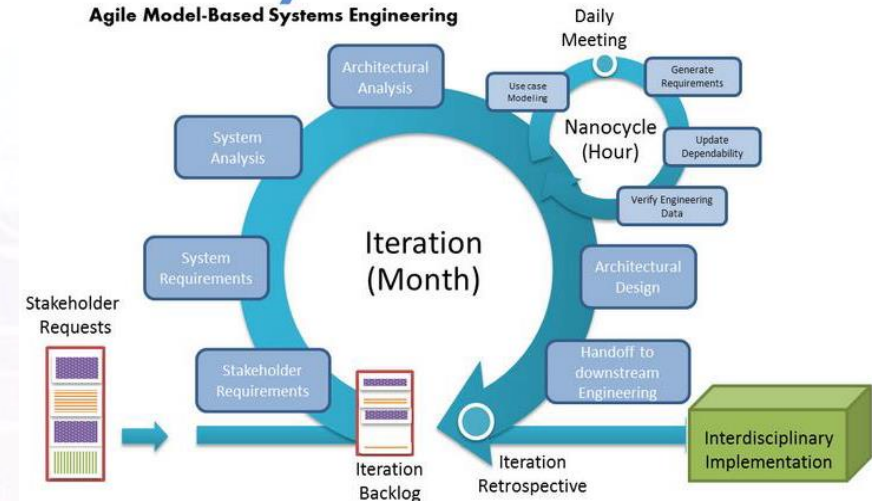


## #2. Agile Systems Engineering

- “Agile” does not mean “process independent”
- When applied correctly, Agile SE can be effective in reducing the system development time
- When not applied correctly, Agile SE is an excuse to perform “Ad-Hoc” or unorganized SE
- Key Requirements for Agile SE: **Transparency, Communication, and a Defined Process**

### Harmony aMBSE

Agile Model-Based Systems Engineering

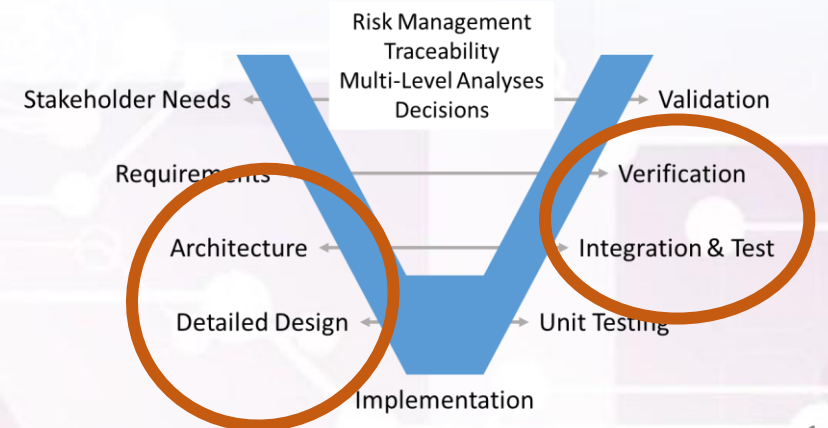




# #3. Artificial Intelligence & Machine Learning in SE

## Managers & Executives are asking...

- What is it?
- How does AI/ML change traditional/MB systems engineering?
- Where is it applied, development or operations?





# #3. Artificial Intelligence & Machine Learning in SE

## What does it change?

- Complex systems to AI-based systems
  - Expert Systems
  - Machine Learning
- Many current architectures and designs are static
  - Functions are now dynamic
  - Interactions among systems & system components are dynamic
  - Ultimately, components evolve
- Example: DODAF is a static framework—it's hard to represent a system that is learning and evolving

William F. Lawless · Ranjeev Mittu ·  
Donald A. Sofge · Thomas Shortell ·  
Thomas A. McDermott *Editors*

## Systems Engineering and Artificial Intelligence



# #3. Artificial Intelligence & Machine Learning in SE

## Enablers

- Internet of Things provides connections
- Cloud Data & Computing
- Interoperability progress is impressive, but has a ways to go

<https://www.borntoengineer.com/9-engineering-trends-to-watch-in-2023>

<https://www.youtube.com/watch?v=Y-g69aEefGA>

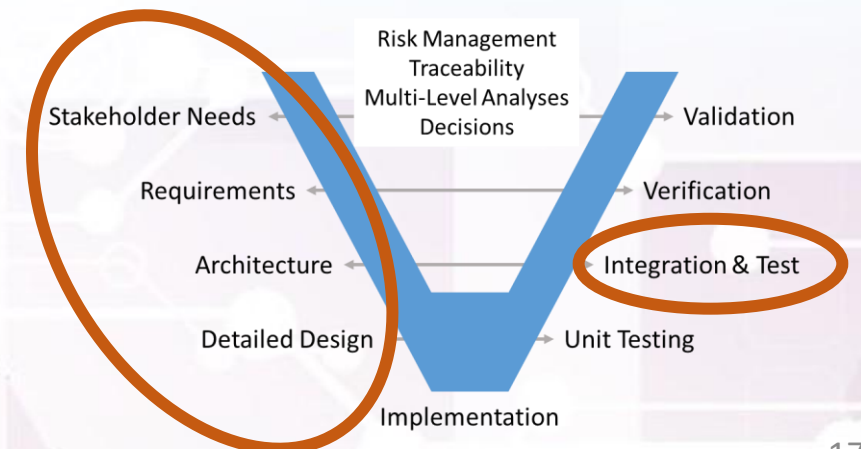




## #4. Augmented Reality in SE

### Managers & Executives are asking...

- What is it?
- What is its capacity? (are we at the Star Trek holodeck yet?)
- Where is it applied, development or operations?
- What is the Return on Investment?



## #4. Augmented Reality in SE

### What is Augmented Reality?





## #4. Augmented Reality in SE

### What does it change?

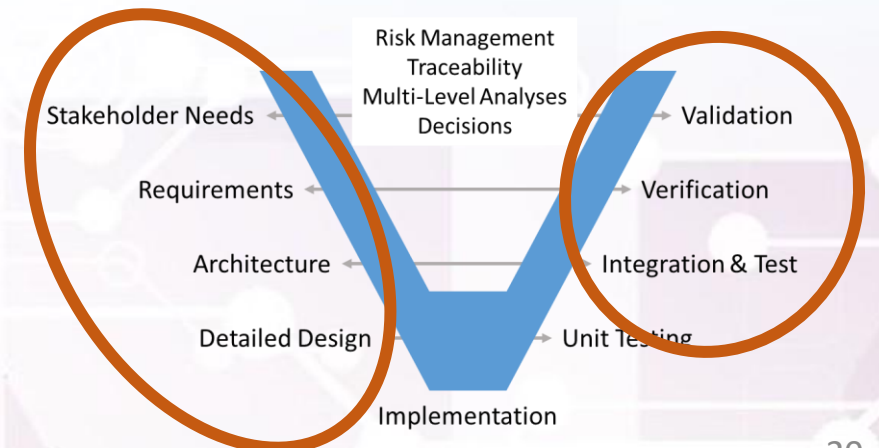
- Blurs the lines between virtual and physical prototypes
  - Physical prototypes are available earlier in the life cycle
  - Important that AR includes performance & human intervention (not just visualization)
- Transition from design to manufacturing
  - Interoperability with manufacturing systems (& robots)
- Integration & Test
  - Integration plans can now be interactive, moving away from documents



# #5. Digital Engineering

## Managers & Executives are asking...

- What is it?
- What's different from MBSE, and other areas?
- Where is it applied, development or operations?
- What is the Return on Investment?

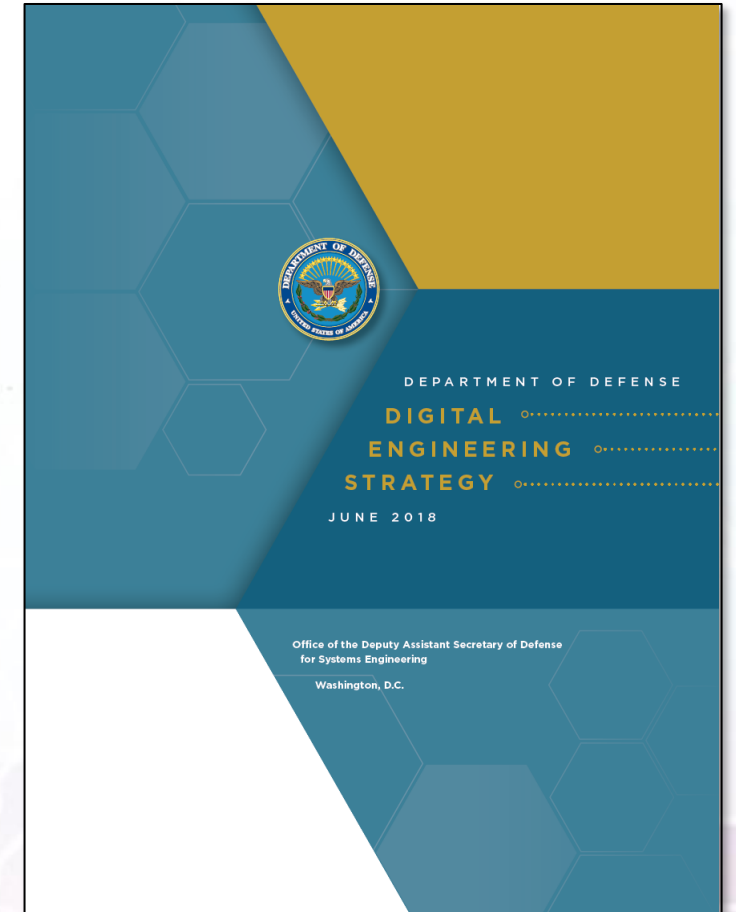




# #5. Digital Engineering

## What is Digital Engineering?

*an integrated digital approach that uses authoritative sources of systems data and models as a continuum across disciplines to support lifecycle activities from concept through disposal. [1]*



[1] <https://sercuarc.org/wp-content/uploads/2020/06/SERC-SR-2020-003-DE-Metrics-Summary-Report-6-2020.pdf>  
<https://man.fas.org/eprint/digeng-2018.pdf>



# #5. Digital Engineering

## What is Digital Engineering?

*an integrated digital approach that uses authoritative sources of systems data and models as a continuum across disciplines to support lifecycle activities from concept through disposal. [1]*

- **Digital Thread:** *the use of digital tools and representations for design, evaluation, and life cycle management. [2]*
- **Digital Twin:** *a software simulation of the operation of a physical system. [3]*
- **Digital Transformation:** *using digital solutions to improve the physical aspects of your business across engineering, manufacturing, and service. [4]*
- *MBSE is a subset of digital engineering. [5]*

[1] <https://sercuarc.org/wp-content/uploads/2020/06/SERC-SR-2020-003-DE-Metrics-Summary-Report-6-2020.pdf>

[2] USAF Global Science and Technology Vision, Task Force. "Global Horizons Final Report". [Homeland Security Digital Library](#).

[3] <https://insights.sei.cmu.edu/blog/what-digital-engineering-and-how-it-related-devsecops/>

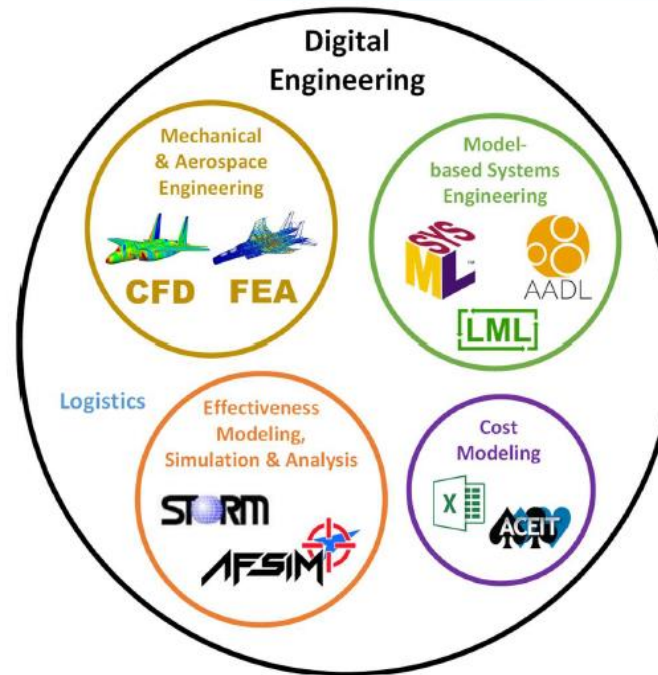
[4] <https://www.ptc.com/en/blogs/corporate/digital-transformation-strategy>

[5] [https://www.sebokwiki.org/wiki/Digital\\_Engineering](https://www.sebokwiki.org/wiki/Digital_Engineering)



# #5. Digital Engineering

## Digital Engineering Ecosystem



**WRT-1051**

**PROGRAM MANAGERS GUIDE TO DIGITAL AND AGILE SYSTEMS ENGINEERING PROCESS TRANSFORMATION**

Principal Investigator:  
Thomas McDermott, Stevens Institute of Technology

Co-Principal Investigator:  
William Benjamin, Georgia Tech Research Institute

August 26, 2022  
Updated: September 14, 2022

Sponsor: Office of the Under Secretary of Defense for Research & Engineering

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The Networked National Resource to further systems research and its impact on issues of national and global significance

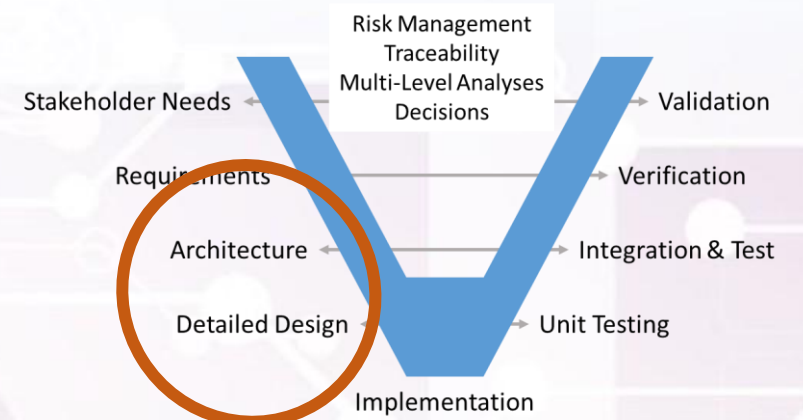
TASK ORDER NO. 0464 Final Technical Report SERC-2022-TR-009



# #6. Security (especially, Cybersecurity)

## Managers & Executives are asking...

- Can't we just engineer in security?
- What's the risk?
- What is the Return on Investment?

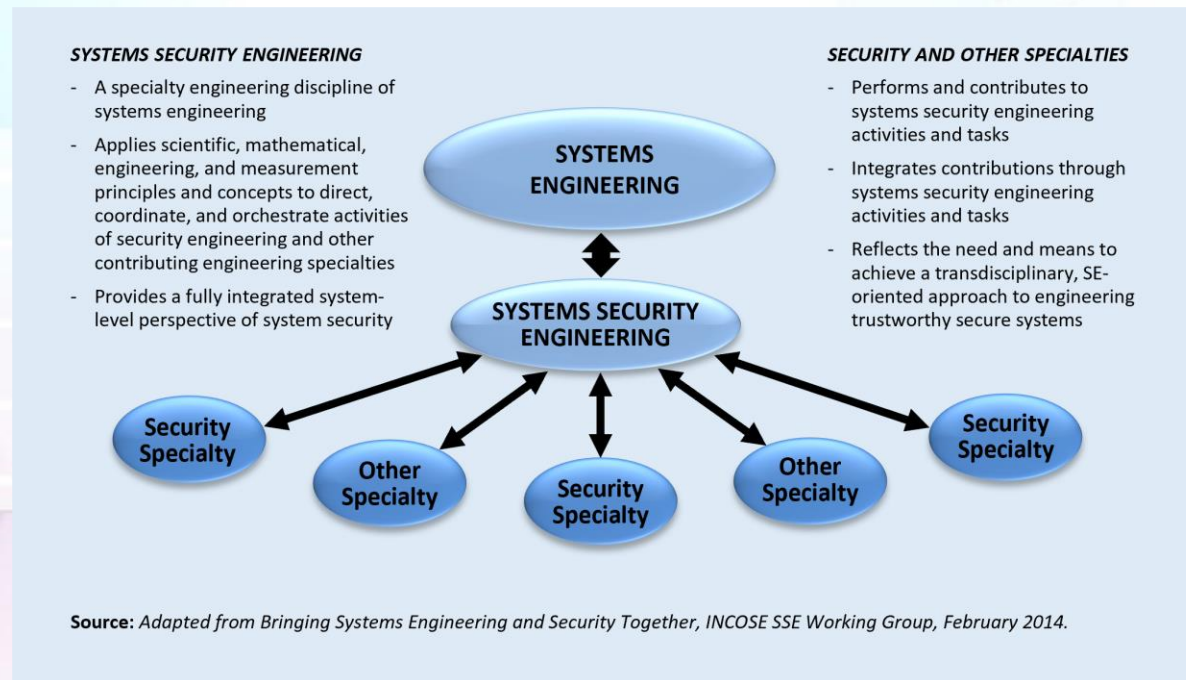







# #6. Security (especially, Cybersecurity)

- Leverage MBSE, AI, and ML






**NIST Special Publication**  
NIST SP 800-160v1r1

**Engineering Trustworthy Secure Systems**

Ron Ross  
Mark Winstead  
Michael McEvilly

This publication is available free of charge from:  
<https://doi.org/10.6028/NIST.SP.800-160v1r1>





# #6. Security (especially, Cybersecurity)

## Related Topics

- System & Infrastructure Resiliency
- System Assurance



# #7. System of Systems Engineering

## Managers & Executives are asking...

- What is it?
- What's different in engineering a SoS from engineering a system?



# #7. System of Systems Engineering

## Challenges

- Almost everything is now referred to as a system-of-systems, so most engineers don't understand SoSE
- Current systems engineering methods, frameworks, and tools do not incorporate dynamic behavior

## Keys Concepts

- Dynamic and emergent behavior (collectively)
- Independent constituent systems
- Dynamic constituent system relationships
- Information Flow & Decision Management



# Domains

**EXPLORATION SYSTEMS**

**POWER AND ENERGY SYSTEMS**

**TRANSPORTATION SYSTEMS**

**INFORMATION SYSTEMS**

**HEALTHCARE SYSTEMS**

**TELECOMMUNICATION SYSTEMS**



# Honorable Mentions

- **Big Data**
  - Volume
  - Velocity
  - Variety
  - Variability (data flow)
  - Veracity (quality)
- **Requirements Analysis**



# Summary

- 1. MBSE**
- 2. Agile Systems Engineering**
- 3. Artificial Intelligence & Machine Learning**
- 4. Augmented Reality**
- 5. Digital Engineering**
- 6. Security**
- 7. System of Systems Engineering**

**HM. Big Data**

**HM. Requirements Analysis**



# Questions

