International Council on Systems Engineering
A better world through a systems approach

Bridging Realities: Bringing MBSE Models to Life with Digital Twins

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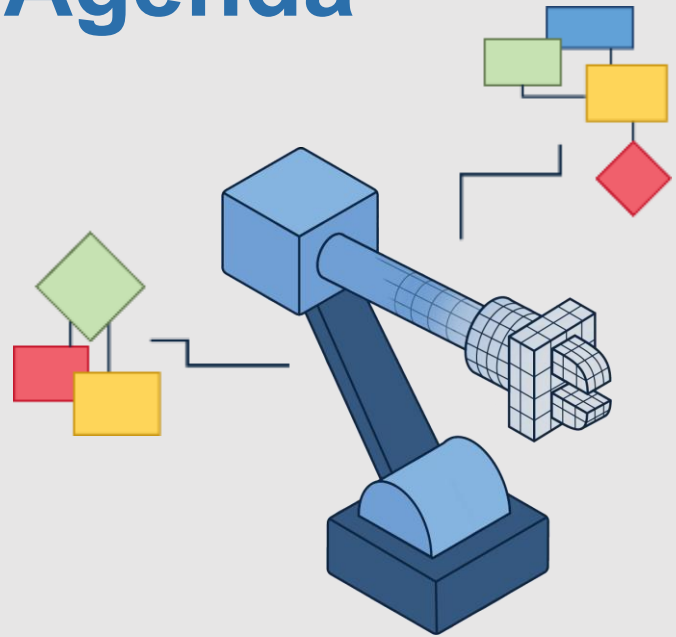
Today's Agenda

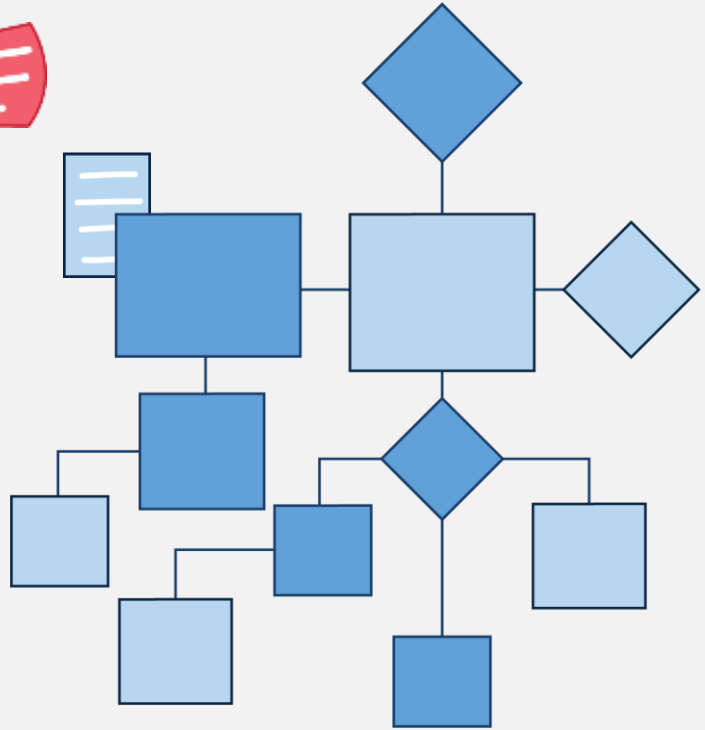


- Complexity: A Modern-Day Problem
- Introducing MBSE & Digital Twins
- Current Research
- Creating the MBSE-Linked Digital Twin
- Our Study
- Findings & Lessons Learned
- Summary

Complexity: A Modern-Day Problem

Systems are more complex than ever before

- Industry recognizes increasing complexity causes communication issues & design errors
- U.S. Department of Defense is implementing its own large-scale digital transformation
- MBSE is proven to help mitigate these issues – but it's not an end-all solution



An MBSE-linked digital twin can help stakeholders understand their system from a more holistic view

Introducing MBSE & Digital Twins

Consolidating details, aiding in analysis, & promoting system understanding

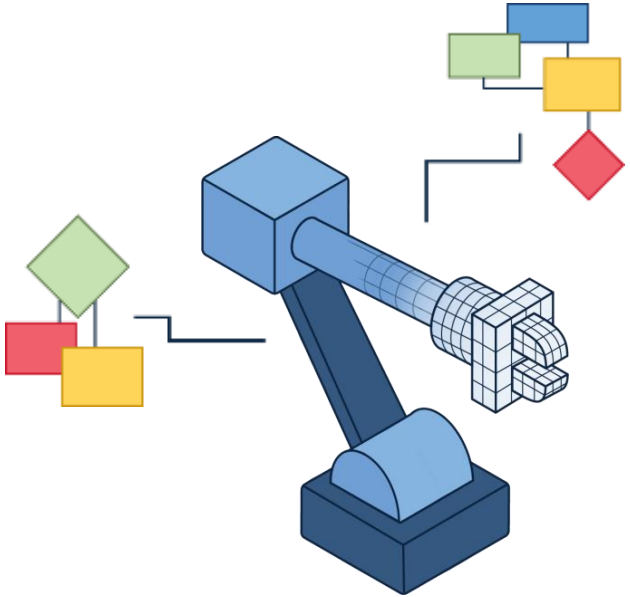
MBSE

STRENGTHS

- See connections between systems & components
- Identify errors earlier

GAPS

- Complicated views
- Number of files can be daunting



DIGITAL TWINS

STRENGTHS

- Interactive Visualization
- Context for system behaviors

GAPS

- Takes time to create
- Performance reliant on hardware

Current Research

Multiple studies have evaluated the integration of MBSE into digital twins

These studies focused on

- Quality evaluations
- System simulation
- Optimizing systems & processes
- Evaluating system design

Our study focuses on integrating MBSE & digital twins to promote communication & understanding

Creating the MBSE-Linked Digital Twin

01 Application Design

Identified representative system, hardware & designed user interface (UI) & interaction

02 MBSE

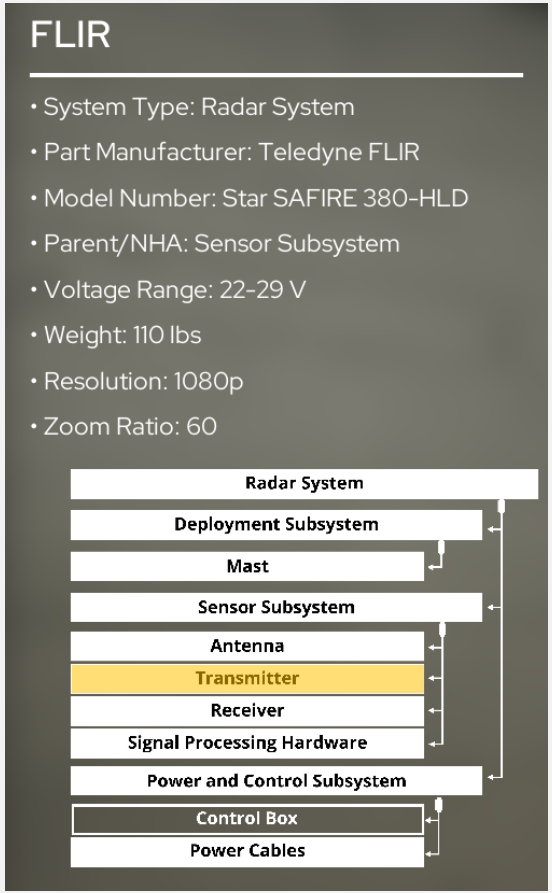
Recreated subsystems & handled assumptions from lack of information

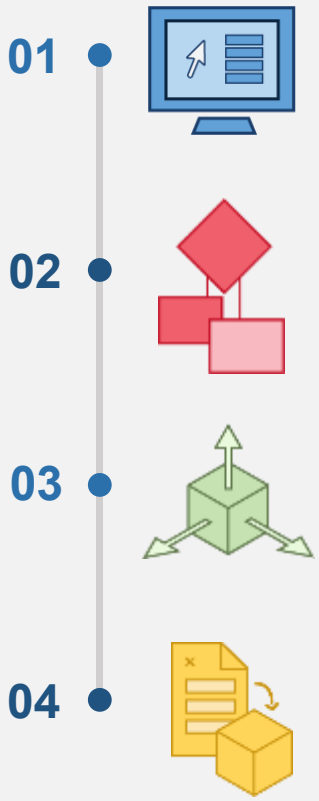
03 Unreal Engine (UE)

Converted CAD models, built scene, & implemented UI & interaction functionality

04 Data Connection

Exported MBSE diagrams as HTML, parsed into UE, & connected via Blueprint code





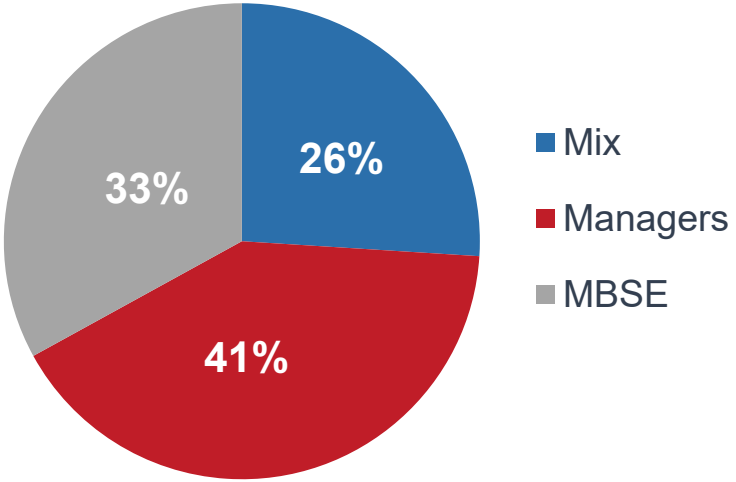
Preparing Our Study

Purpose: evaluate the software's ability to

communicate operational behavior

- Validating requirements in conceptual design
- **15-min demos** with **28 participants** (13 engineers, 11 managers, 4 both)
- **11 survey questions** focused on:
  1. Communicating functionality
  2. Evaluating functionality & relationships
  3. Gauging applicability to current pipelines

Breakdown of Participants by Job Responsibilities



Study Results

	The MBSE-linked DT…	Agree	Neutral	Disagree
Q1	… would help me **convey** the aspects of the system to the customer.	100%	0%	0%
Q2	…would make it easier to **understand** my team's progress.	82%	18%	0%
Q3	…made the system's relationships **easier** to **identify**.	87.5%	12.5%	0%
Q4	…made the behavior of the system **easier** to **comprehend**.	56%	19%	25%
Q5	…would help me **convey** the aspects and behavior to a new engineer.	75%	19%	6%
Q6	…would be more helpful if it was further **incorporated with MBSE data**.	87.5%	12.5%	0%
Q7	…made the system **easier** to **understand** as a whole.	92%	4%	4%
Q8	…was **easy** to use.	92%	4%	4%

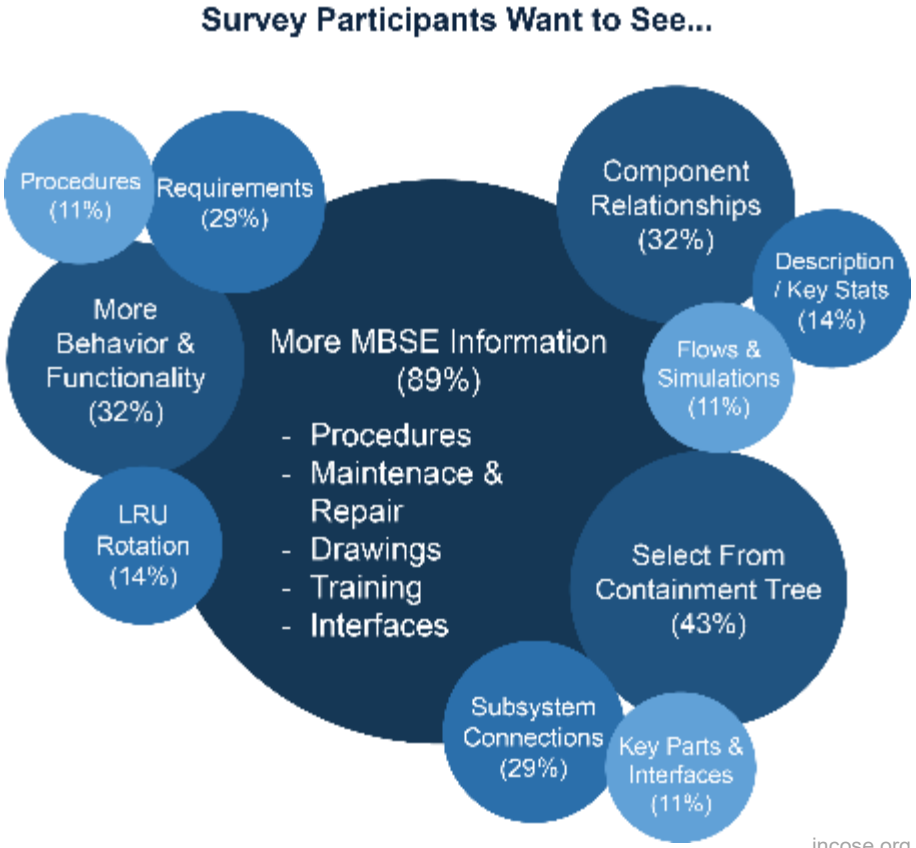
The survey found that the software visualization made exploring the representative system's components & functionality easier

Open Feedback

Participants wanted more features

Requests included

- Requirements
- More behaviors
- Component & subsystem connections
- Ability to select from the containment tree
- Rotating the Lowest Replaceable Units (LRUs)



Evaluating the Results

- Our hypothesis was valid – an **MBSE-linked digital twin helps stakeholders understand their system**
- Experienced engineers can have difficulty navigating complex systems, where data is involved at a **massive** scale

With more integrated information, an MBSE-linked digital twin might be able to reduce assumption & communication errors

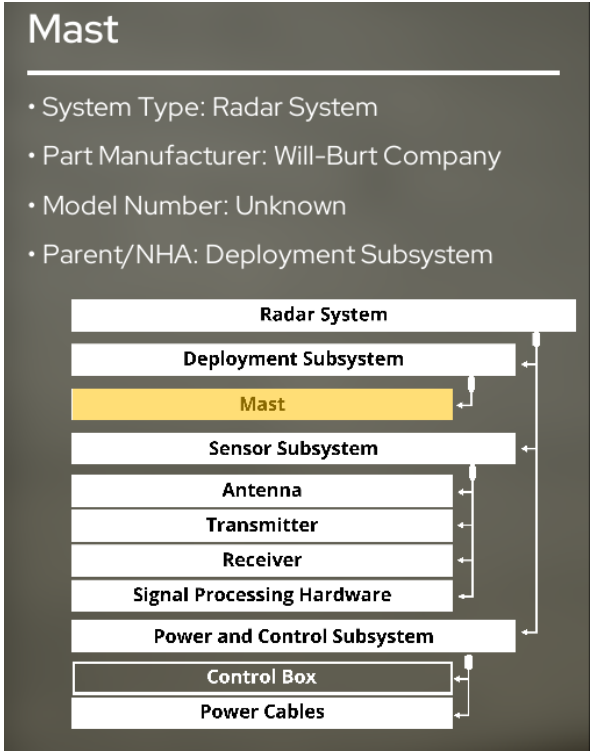
Lessons Learned

#1: Lack of Technical Data

Led to assumptions on the model-based & visual aspects

Minor risk as our subject is a representative system

Mitigation: Identify & use comparative components



#2: More Animations

Due to time, a few animations were selected

Completed animations were isolated behaviors that did not link together

Mitigation: Recreate an entire activity to give system context

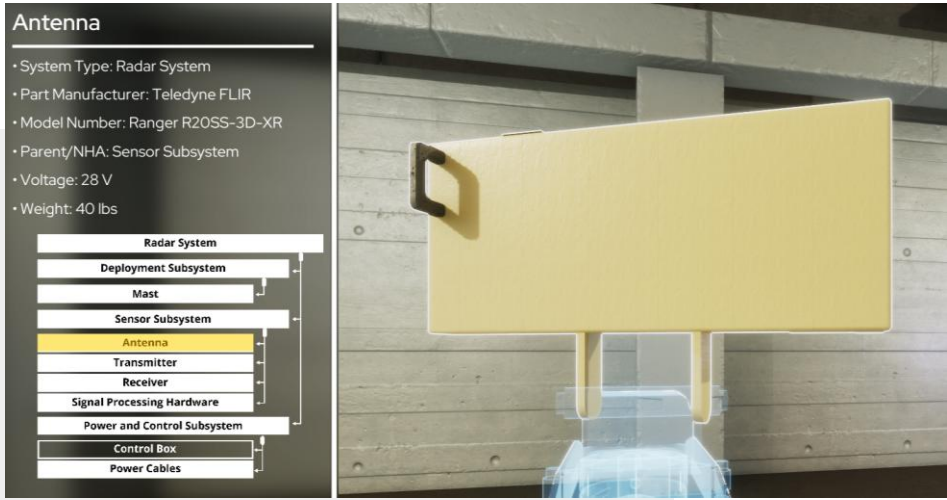
Summary

FUTURE WORK

- Add requirements, more behaviors, aspect connections, & more
- Experiment with Artificial Intelligence or Virtual & Augmented Reality technologies for training

CONCLUSIONS

- Provides a holistic view for rapid comprehension
- Assists in analysis for everyday workflows
- More to be done, but promising to show a use case with both techniques



Questions?

BACKUP SLIDES

35th Annual INCOSE international symposium

hybrid event

Ottawa, Canada
July 26 - 31, 2025

Hello, INCOSE IS 2025!

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Technical Artist

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