

# ***AIR FORCE NUCLEAR WEAPONS CENTER***

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## **Digital Engineering Transformation of a Legacy Weapon System (MMIII)**



**Lt John McCrea  
AFNWC/NIAAA**

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# Summary

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- **Strategy: DOD → ICBM → MMIII**
- **Goals & Challenges**
- **System Modeling Implementation**
- **Digital Ecosystem**
- **Examples**
- **Workforce Transformation**

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# ICBM Systems Directorate Digital Engineering Strategy

- 4 strategic goals (abbreviated)
  - Safe, secure, and effective through modern digital engineering **processes, tools, and methods**
  - **Synchronize** Minuteman digital engineering with GBSD
  - Create a digital engineering **workforce**...enabling them to smoothly transition as GBSD matures and Minuteman is decommissioned
  - Implement a digital engineering **infrastructure** at the classified and unclassified levels



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# *Acquisition in Context: GBSD DE*

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- **System Architecture**
- **Enterprise Architecture**
- **Product Lifecycle Management**
- **Multi-Physics Modeling**
- **Trade Space Analysis**
- **Requirements Verification**
- **Unified Certification**
- **Model Integration & Synergy**
- **Active Workforce Training**

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# ***MMIII Engineering Lines of Effort***

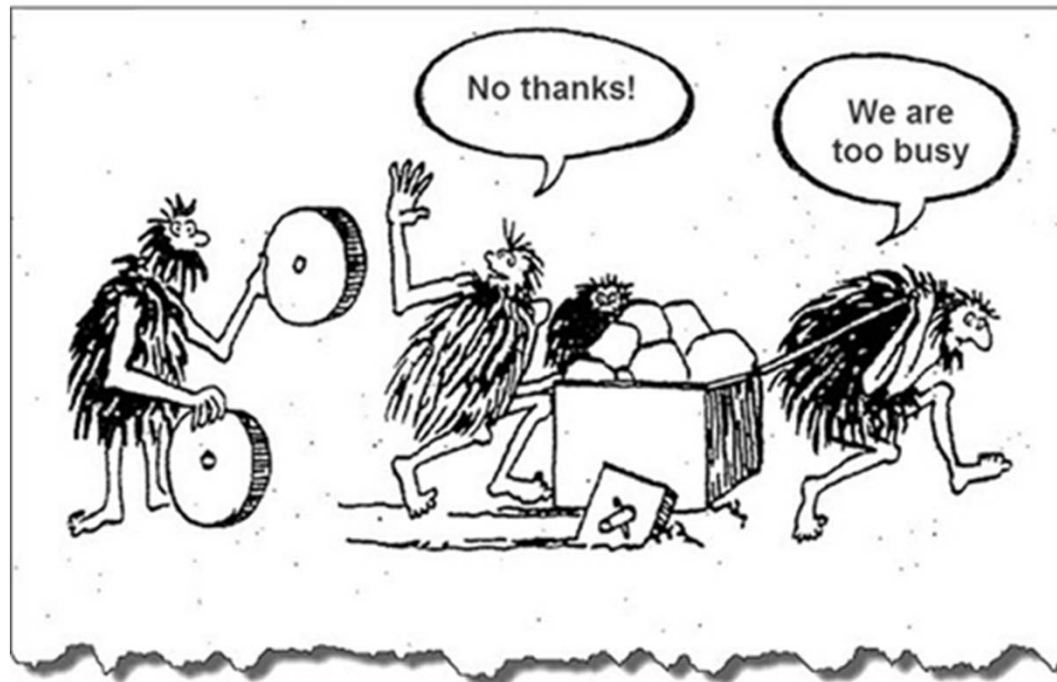
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- **LOE – Meet MMIII Weapon System KPPs through Deactivation**
- **Objectives and Key Results (OKRs)**
  - **Facilitate KPP satisfaction through MMIII end of life with improved cross-IPT integration using MBSE**
    1. **Extraction of MMIII functional baseline out of legacy tool into Cameo using SysML**
    2. **Identify and prioritize high-risk sustainment and acquisition tasks for bottom-up system architecture analysis**
    3. **Initiation of low fidelity top-down system architecture model for MMIII**



# Why?

- There is a more efficient and effective way to manage the ICBM baseline and perform engineering analyses
- Modern tools are at our fingertips



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# ***MBSE Goals***

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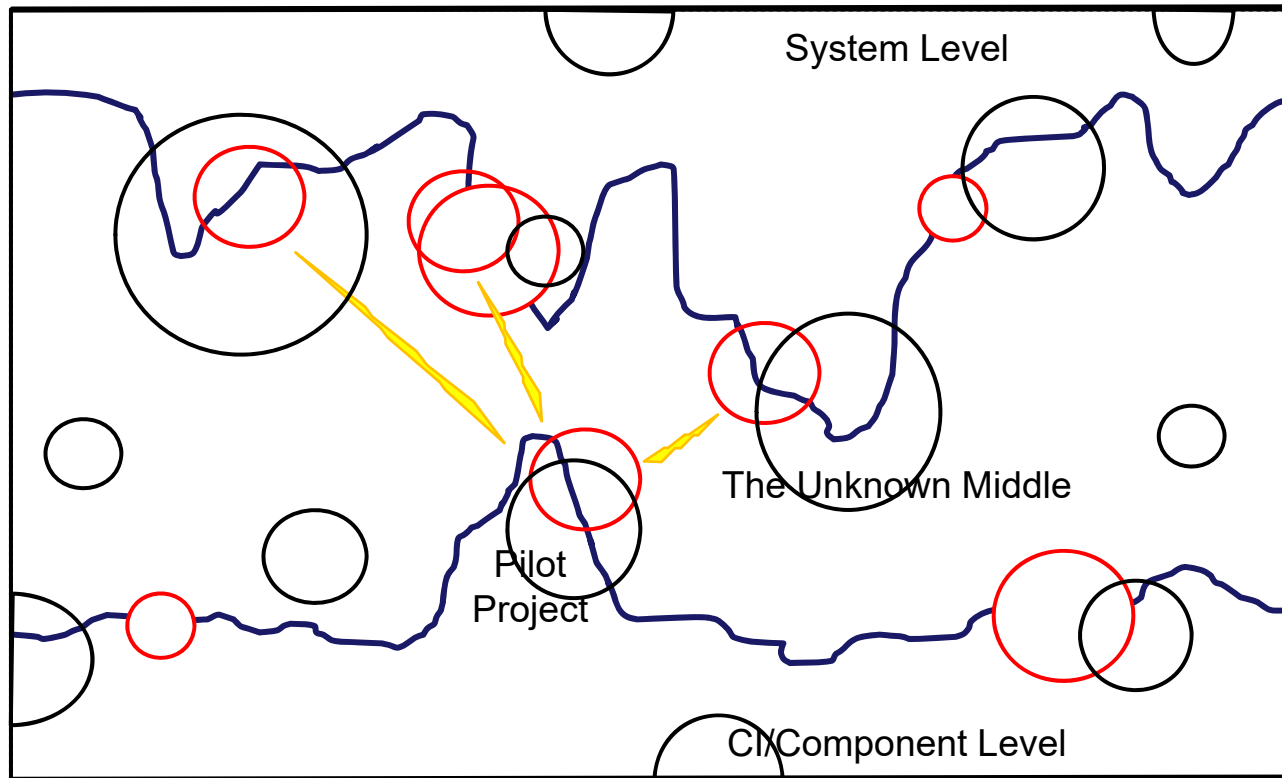
- **Develop:**
  - **ICBMSD MBSE Framework**
  - **Standardized MBSE Methodology**
  - **MMIII MBSE Roadmap**
- **Compatibility Across New and Legacy Systems**
- **Digital Thread – Authoritative Source of Truth**
- **Digital Twin – Complete, Integrated, Executable Models**
- **Own the Technical Baseline (OTTB)**
- **Workforce Transformation**

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# MMIII System Modeling



Functional Disciplines + Ilities across weapon system

- Enterprise Requirements
- **What is not going to be perfect and it doesn't have to be**
- System Requirements
- **subsystems are wrong, some are "Lost," interfaces useful**
- System Level Design
- **Details fleshed out in one pile the project might be to let technical owners forget interfaces and impacts**
- Interface Design (Currently in Drawings)
- Subsystem Level Design (Currently in Drawings)
- Component Level Design (Currently in Drawings & Documents)

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# ***MMIII Sustainment***

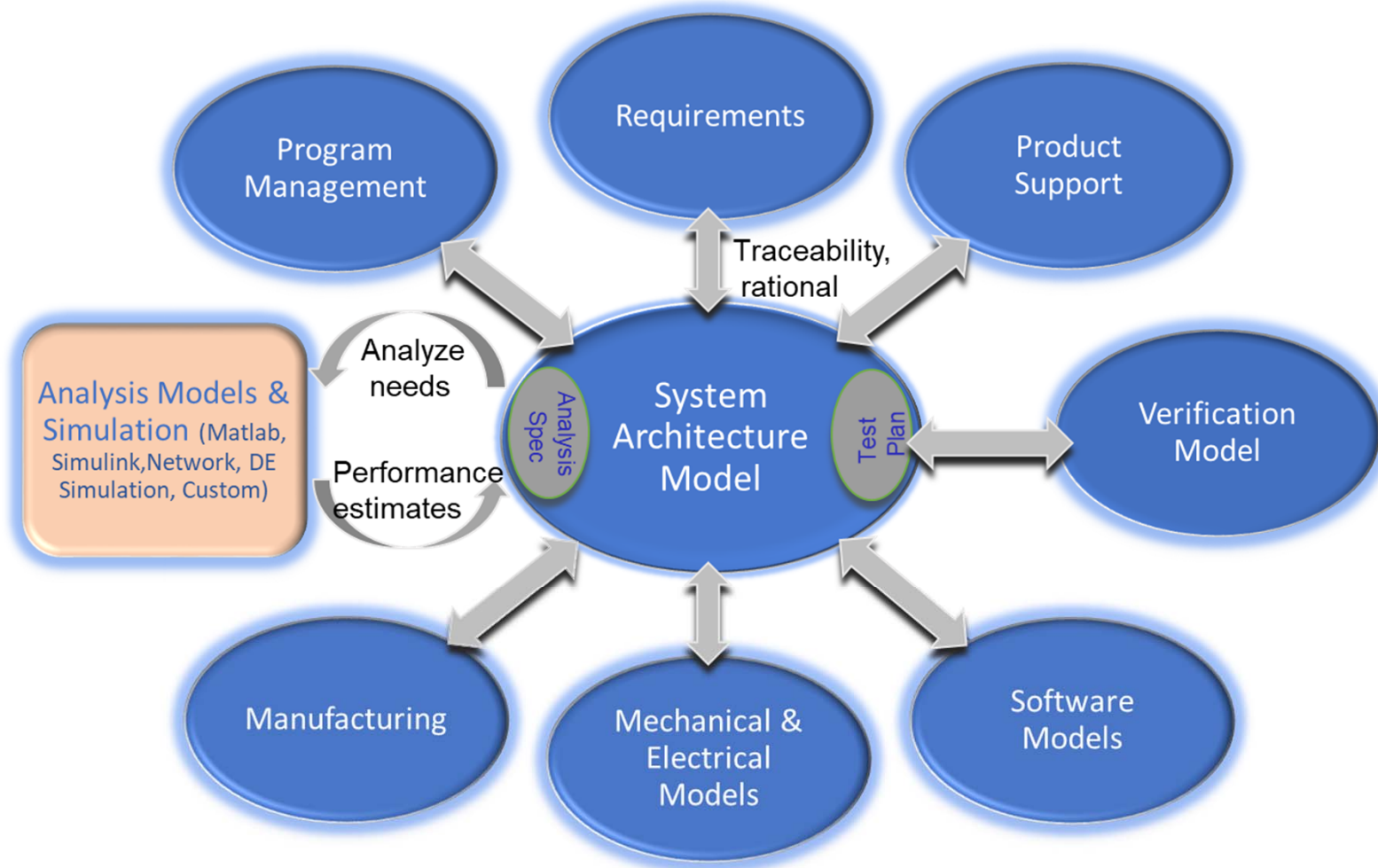
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- **Capability**
    - **PLM and 3D Models**
      - **Integration with Future Acquisitions**
      - **Visualization, Training, High-fidelity Modeling**
      - **Sustainment Workflows (ETARs, Modifications)**
      - **Configuration Management**
      - **Single Repository Source Accessible for all Stakeholders**
        - **Field, SPO, Supply, Depot, Contractors**
  - **Path Forward**
    1. **Start small (RV 3D Models)**
      - **TeamCenter as the PLM**
      - **3D Model Baseline & Validation**
    2. **Sustainment Workflows (ETARs, etc.)**
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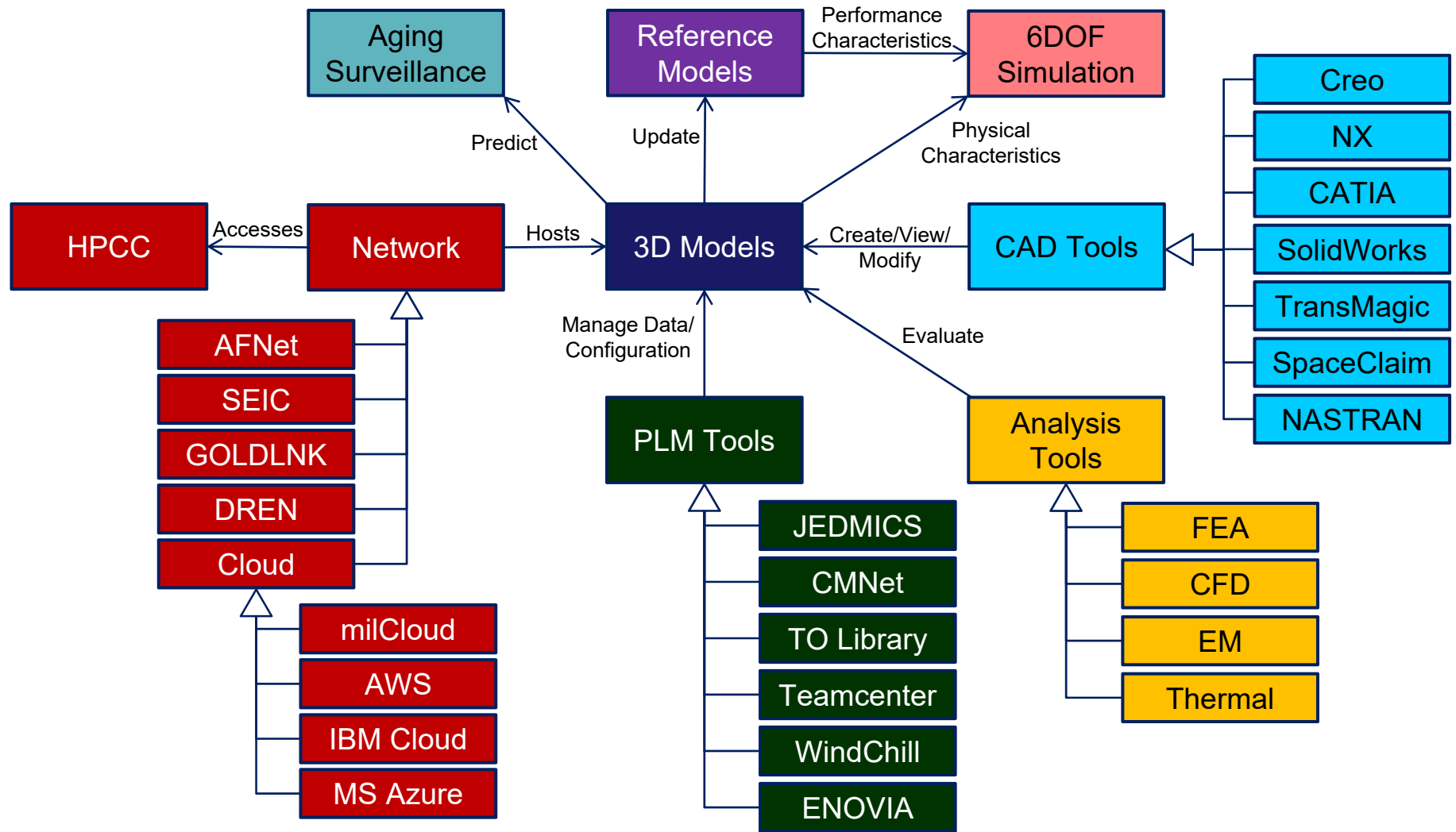
# Digital Ecosystem Example



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# Digital Ecosystem Example

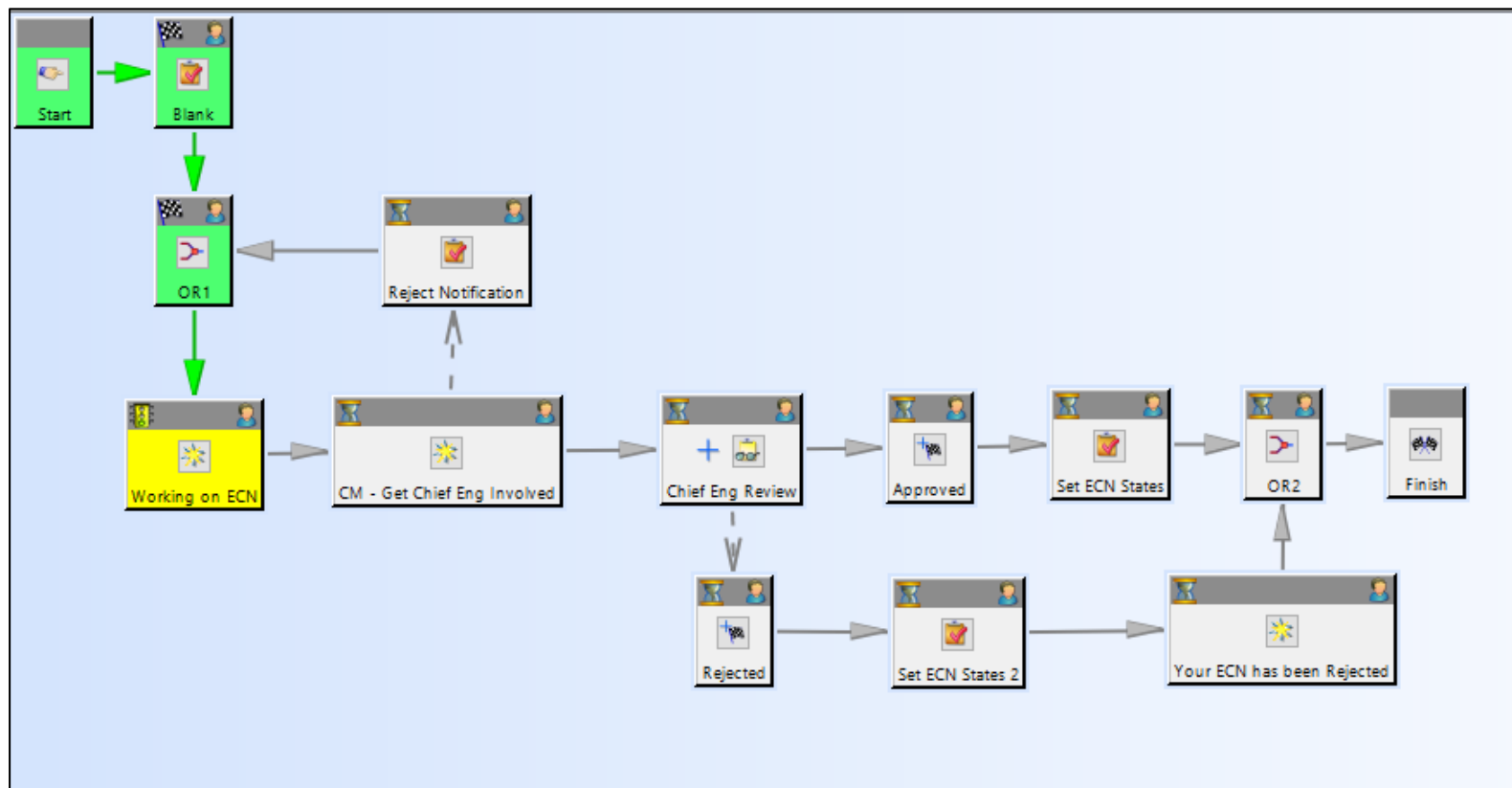


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# Real-Time Configuration Management

- With PLM, we can watch “real-time” changes
  - Any change, any workflow, any time...

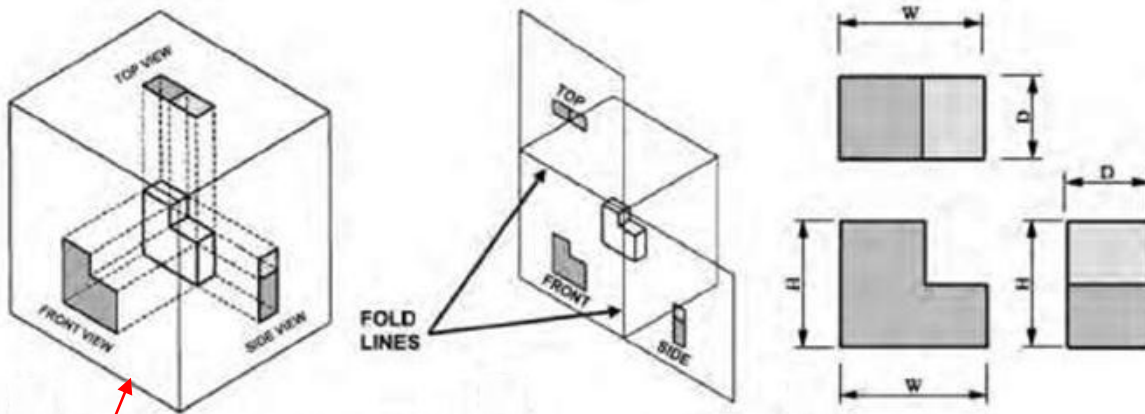


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# 2D to 3D

- Receiving 2D drawings in the modern world is losing the integrity of the design intent.

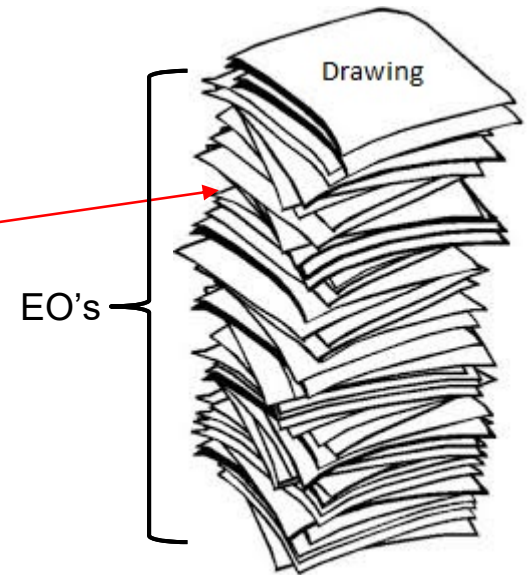


Just lost design intent of the model by presenting the just the 2D images.

The 2D images are just a projection of the 3D model, so the 3D model is really the baseline.

This is the typical practice with hanging paper, the OEM drawing with ~ 2-10 EO hanging off of it is the baseline.

Whereas we could have 1 model.



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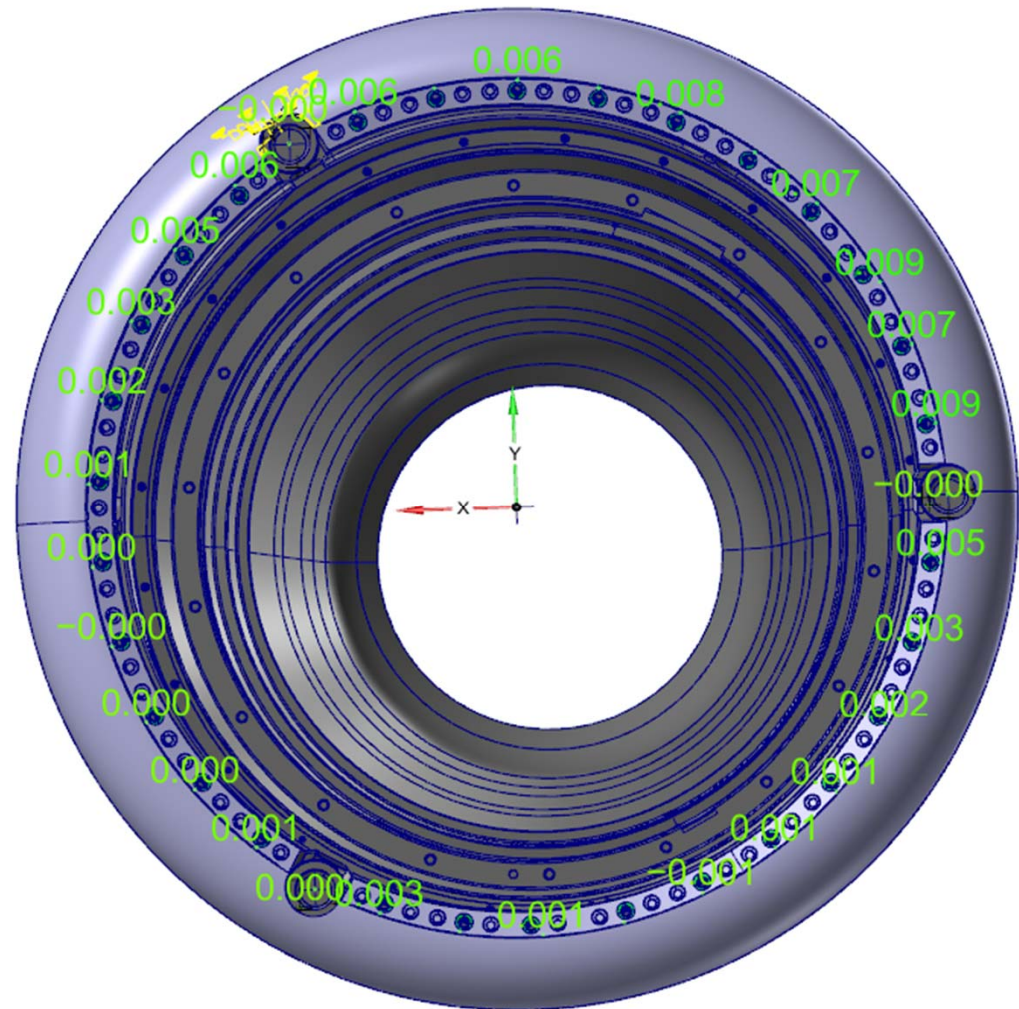


# Motivation for 3D Models

- Part Validation
- Maintenance Tolerancing



Faro Arm



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# System/Requirement Traceability

## Design/ Operational Activities

Requirements/  
Systems

|                   | Coordinate Other Agencies [Oper... | Find Victim [Operational Viewpoint... | Firefight [Operational Viewpoint::... | Investigate Reports Of MissingPe... | Monitor Health [Operational View... | Process Warning Order [Operatio... | Provide continuous radar surveilla... | Provide emergency towing cover i... | Provide Medical Assistance [Oper... | Receive Distress Signal [Operatio... | Recover Victim [Operational View... | Rescue [Operational Viewpoint::... | Search [Operational Viewpoint::O... | Search & Rescue( : Medical Cond... | Send Distress Signal [Operational ... | Send Warning Order [Operational... | Solve incident involving chemicals ... | Solve incidents in all areas of inho... | Transit To SAR Operation [Opera... | Transport Patient [Operational Vi... | Treat Patient [Operational Viewp... |
|-------------------|------------------------------------|---------------------------------------|---------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|---------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|------------------------------------|-------------------------------------|------------------------------------|---------------------------------------|------------------------------------|--|---|------------------------------------|--------------------------------------|-------------------------------------|
| SV-2              |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     | 1                                   |                                      |                                     |                                    |                                     | 2                                  |                                       |                                    |  |   |                                    |                                      |                                     |
| Distress Beacon   |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| ESM System        |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| Frequency Scanner |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| Link 16           |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| Link 16 Terminal  |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| Naval Ship        |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| Receiver          |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| Signal Processor  |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| Track Interface   |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| Transmitter       |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |
| Voice Radio       |                                    |                                       |                                       |                                     |                                     |                                    |                                       |                                     |                                     |                                      |                                     |                                    |                                     |                                    |                                       |                                    |  |   |                                    |                                      |                                     |

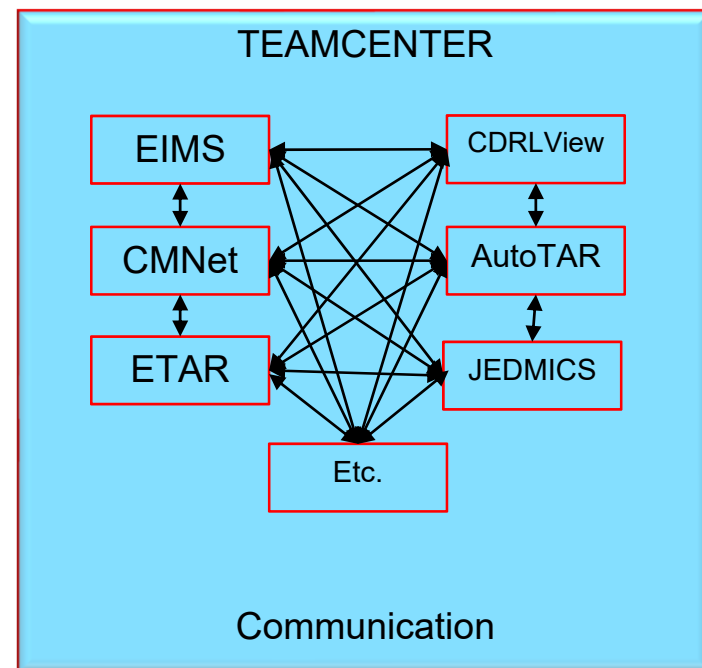
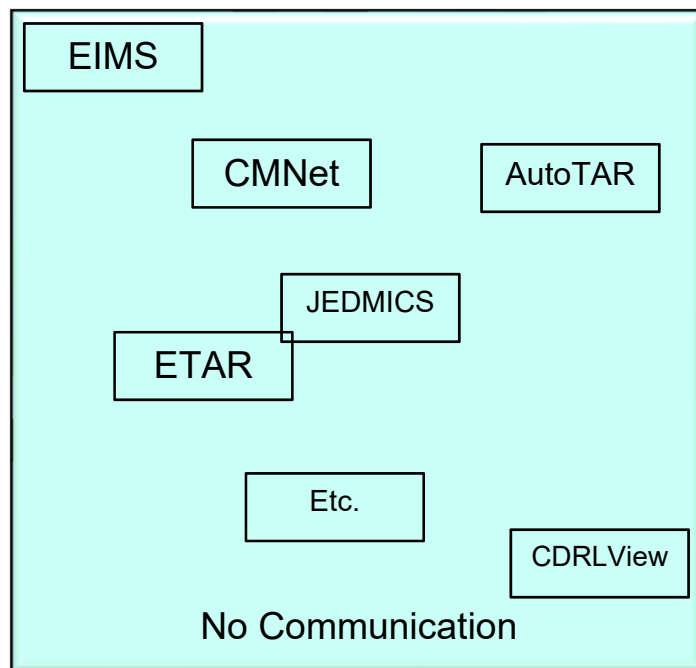
Example: SV-5B Traceability Matrix via Cameo Systems Modeler; c/o nomagic.com

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# Integrate with Other Systems

- By integrating these systems under one roof, with configuration control, there will be better continuity of “why” changes are made
- Too often we see end result of change and we need to rely on “greybeard” knowledge as to why that change was made.



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***What is the biggest hurdle?***

***CULTURE***

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# ***Workforce Transformation***

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- **Culture will likely be one of the biggest blocks to this transition**
  - **Reorg/Realignment already adds much flux to peoples' daily jobs**
  - **People set in their ways (of engineering)**
- **Cultural transitions are not fast – much of it is relearning engineering practices & processes**
- **IT IS WORTH IT**
  - **Skilled legacy workforce to easily grasp GBSD way of doing business**
  - **Employees can be more readily shared across SPOs**
  - **Engineering will be more robust, efficient, and effective**
  - **Snowball Effect**
    - **Undergoing one technological transition may well inspire more**
    - **Breeds innovative thinking**
    - **Better prepare directorate for long term success**

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# ***Government DE Considerations***

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- **MBSE must be executed following sound systems engineering practices**
- **MBSE provides a very precise mode of communication**
  - **Clear requirements**
  - **Clear communication of technical needs**
  - **Avoid incurring new/additional/unforeseen costs**
- **MBSE helps the government own the technical baseline**
- **When used properly, MBSE enables much quicker team-member technical spin-up**

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# ***Bottom Line***

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**Unique Perspective: Legacy system → Trailblazing replacement**

- 1. Ease sustainment burden**
- 2. Smooth system transition**
- 3. Bolster ownership of technical baseline**
  - a) Drawings → models**
  - b) Rediscover knowledge lost across years of churn**
  - c) Cohesive digital ecosystem of tools**
- 4. Skilled workforce for evolving acquisition landscape**

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