

# Creating the Digital Thread "Golden Spike" to Connect MBSE and MDAO



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Fan Exit Velocity 400	🖌 🧮 fan						
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# The Digital Thread "Golden Spike"

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### **J. Simmons, Ph.D.** Systems Engineering Manager, NGSP Launch Vehicles

### 15 years in Digital/Systems Engineering

- Ph.D. in Space Systems Engineering from the Air Force Institute of Technology
- M&S automation/integration for MDAO
- Implementing Digital Threads between MDAO & MBSE

# Supported all corners of the Aerospace Industry

- Govt: DoD | Air Force | Navy | Army | NASA
- Cont: NGC | Lockheed | Boeing | Raytheon | SAIC
- Labs: JPL | APL | SNL



NORTHRO



### We must establish a trusted Digital Thread



"Absent required human judgment or critical thinking, activities we can turn into computerized checklists may be automated." Dr. Will Roper, *Bending the Spoon* should



### We start with a shared definition of done





### Which schedule would you prefer?

### **Option 1: Serial Execution**

### Systems Modeling



### **Option 2: Parallel Execution**



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# **ModelCenter MBSE in a Nutshell**

### Systems Engineering: Architectural Model



### **ModelCenter MBSE**



### Domain/Discipline Engineering: Executable Analysis Model



**Engineering Analysis** 

### The Constraint Block is where the magic happens



### **Completing and running the analysis**



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# **Structured Approach to Integration (Cliffs Notes)**

- Step 1: Create Representation of Analysis
- Step 2: Identify the Independent Models
- Step 3: Identify the Interfaces
- Step 4: Build the Models
- Step 5: Perform the Integration
- Step 6: Execute Analysis/Process Results



Cory Kinsel, Engineer Systems Architect Northrop Grumman Space Systems









#### Step 2: Identify the Independent Models

- Who are the stakeholders in this integration process?
  - Systems Engineering needs to breakdown system level requirements
  - Propulsion Engineering has design and part selection authority
- Are there existing analytic models (Excel, Matlab, CAD, etc)?
- 3 models (Core Performance, Nozzle Performance, Overall Performance)
- Each has impact on future lower-level requirements
- · Is there any new development that needs to occur?
- May need to create a workflow that automates these calculations

# **Step 3: The Constraint Block defines the Interface**



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#	Name	Documentation	Туре	Units
1	BPR		V Real	
2	Cp		V Real	
3	🔲 Mach		V Real	
	77 11			



## **Step 4 then happens in parallel**





## **Step 5 becomes trivial**



# **That just leaves Step 6**

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# In Summary....







Mark pages according to the proprietary level of information as described in Company Procedure J103 (or remove)