AVT-369 Research Symposium on
"Digital Twin Technology Development and
Application for Tri-Service Platforms and Systems"

Digital Twins in the Context of Digital Transformation

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Spirit AeroSystems, Inc. / U.S.A.
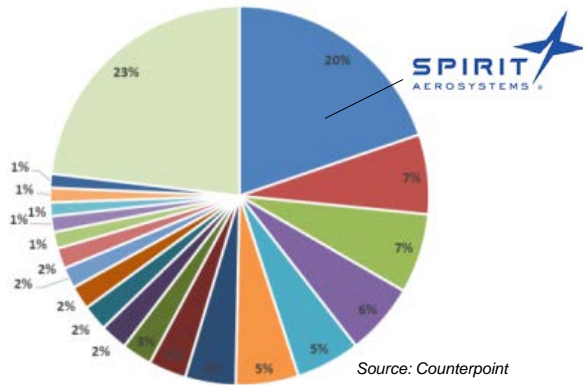
October 12, 2023

Spirit AeroSystems

- **Background & Introduction**
- **Spirit's Digital Twin Progression**
- **Floor Beam Assembly**
  - ➢ Automated Beam Line
  - ➢ Floor Beam Assembly 2.0
  - ➢ Floor Beam Assembly "2.5"
  - ➢ Digital Twinning Lessons & Improvements
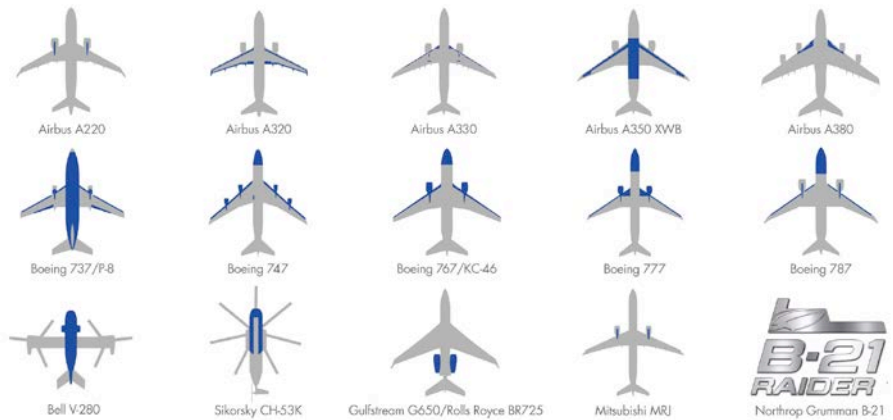- **Spirit ONE™**
- **Questions**

Spirit AeroSystems

Global Aerostructures Leader

Source: Counterpoint

18,000 employees & 20M ft² Across 12 Global Sites

Balanced Capabilities

DESIGN **BUILD** **SUSTAIN**

$48B Backlog Across Multiple Customers & Platforms

Airbus A220 · Airbus A320 · Airbus A330 · Airbus A350 XWB · Airbus A380

Boeing 737/P-8 · Boeing 747 · Boeing 767/KC-46 · Boeing 777 · Boeing 787

Bell V-280 · Sikorsky CH-53K · Gulfstream G650/Rolls Royce BR725 · Mitsubishi MRJ · Northrop Grumman B-21

COMMERCIAL · DEFENSE & SPACE · AFTERMARKET

Spirit AeroSystems

18,000+ commercial employees across 12 global locations | 20 million square feet

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Introduction

- **Level set on definitions**
  - AIAA / AIA Digital Twin: Definition & Value (2020)
    - **Full:** A set of virtual information constructs that mimics the structure, context and behavior of an individual / unique physical asset, or a group of physical assets, is dynamically updated with data from its physical twin throughout its life cycle and informs decisions that realize value.
    - **Simplified:** Virtual representation of a connected physical asset.
  - Essential characteristic is existence of the physical asset. Lacking that, you simply have a nominal digital representation.

>> A major theme throughout Spirit's experience <<

Our Digital Twin Progression

- **Digital Twin in context of P³…**
    - → Products
        - → Processes
            - → Production System

- **Early focus on digital part modeling (CAD)…**
  …with subsequent focus on factory data ("connect & collect")

ACTION		EFFECT
Connect Systems	=▶	Data Collection
Analyze Data	=▶	Information
Synthesize Information	=▶	Knowledge
Act on Knowledge	=▶	Closed-loop Control

Our Digital Twin Progression

- **Production System Digital Twin: Smart Factory Fabric**
  - ➤ Floorsight
  - ➤ OptiCrew
  - ➤ Constraint Command Center

Resulting in…

- ~20% hours/unit reduction
- ~10% throughput improvement
- ~25% variation reduction
- ~20% inventory reduction & ~40% accuracy improvement
- ~10% machine utilization improvement

Our Digital Twin Progression

- **Digitally modeling transformation for a high-rate application**

- **Pseudo-concurrent digital iteration of...**

  ➢ Product configurations

  ➢ Manufacturing processes

  ➢ Production system concepts
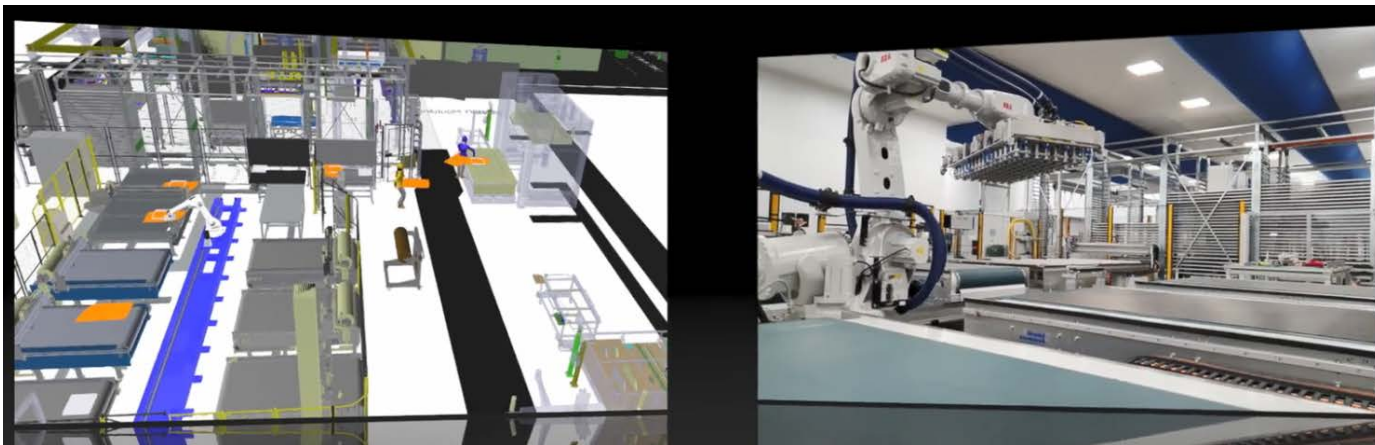
- **Continuous digital twin production operation**

Automated Beam Line

- **Mission:** Transform a fuselage floor beam sub-assembly production area from mostly-manual, batch process to mostly-automated, takt-based hybrid single-piece flow line

- **Application complexities**
  - Variety: minor models, customer options, qty/shipset
  - Engineering definitions (recipes)
 - Consumption by downstream customers

Automated Beam Line

- **Floor Beam Assembly 2.0**
  - ➢ A path-finder to investigate & demo Industry 4.0 capabilities
  - ➢ Ground rule constraints
    - ▪ No engineering design changes to the parts
    - ▪ New production process to be introduced as greenfield line
  - ➢ Focus on three primary forms of modeling
    1. Discrete event
    2. Physical processes
    3. Data processes

Floor Beam Assembly 2.0

- **Discrete Event Modeling**
  - ➢ Takt-based hybrid single-piece flow line concept
  - ➢ Station-by-station, relatively low fidelity
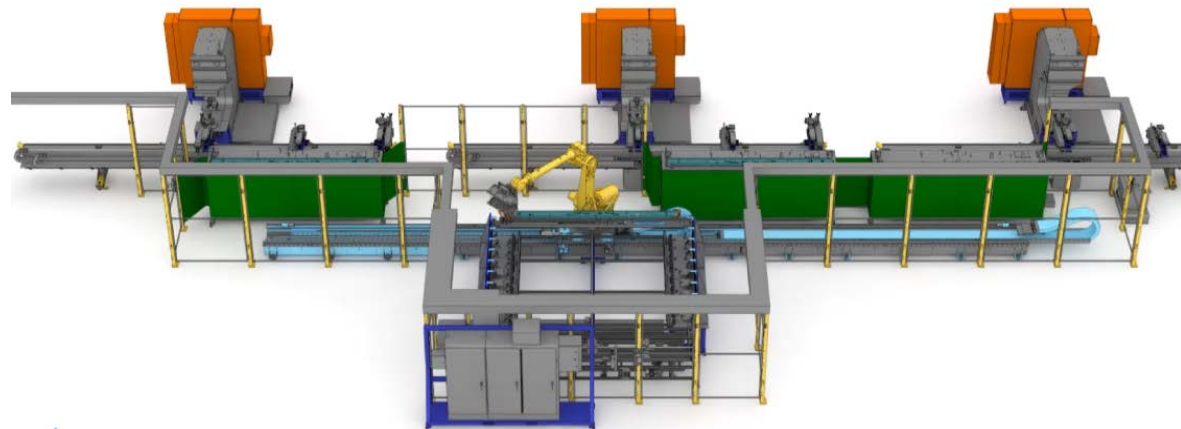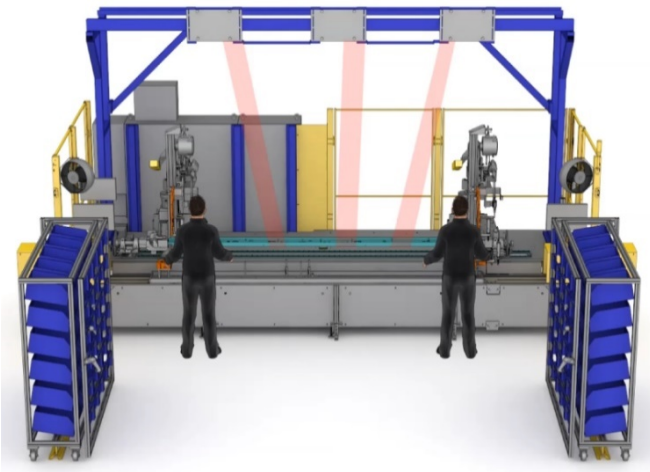 - ➢ Many upfront assumptions not updated over time
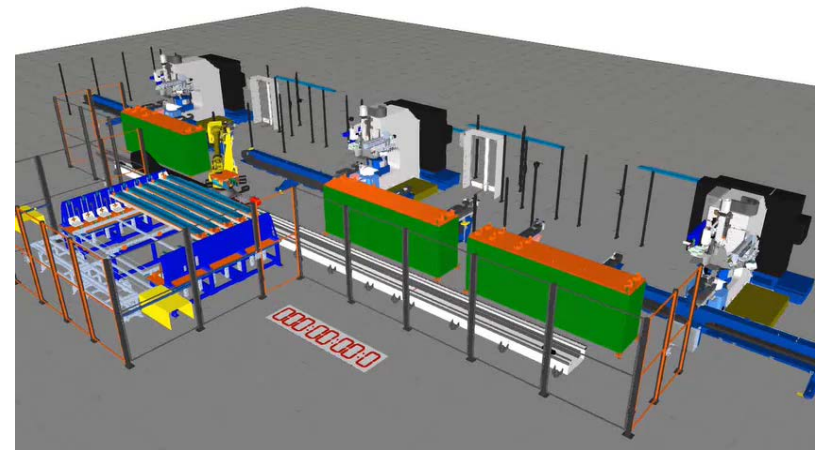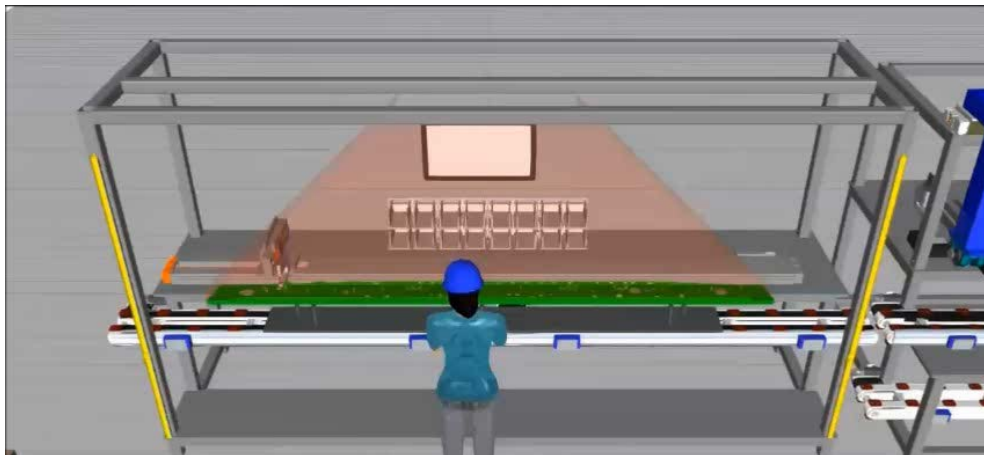
DES: First of multiple digital orphans

Floor Beam Assembly 2.0

- **Physical Process Modeling**
  - ➢ CAD 3D layouts relatively commonplace; process models less so
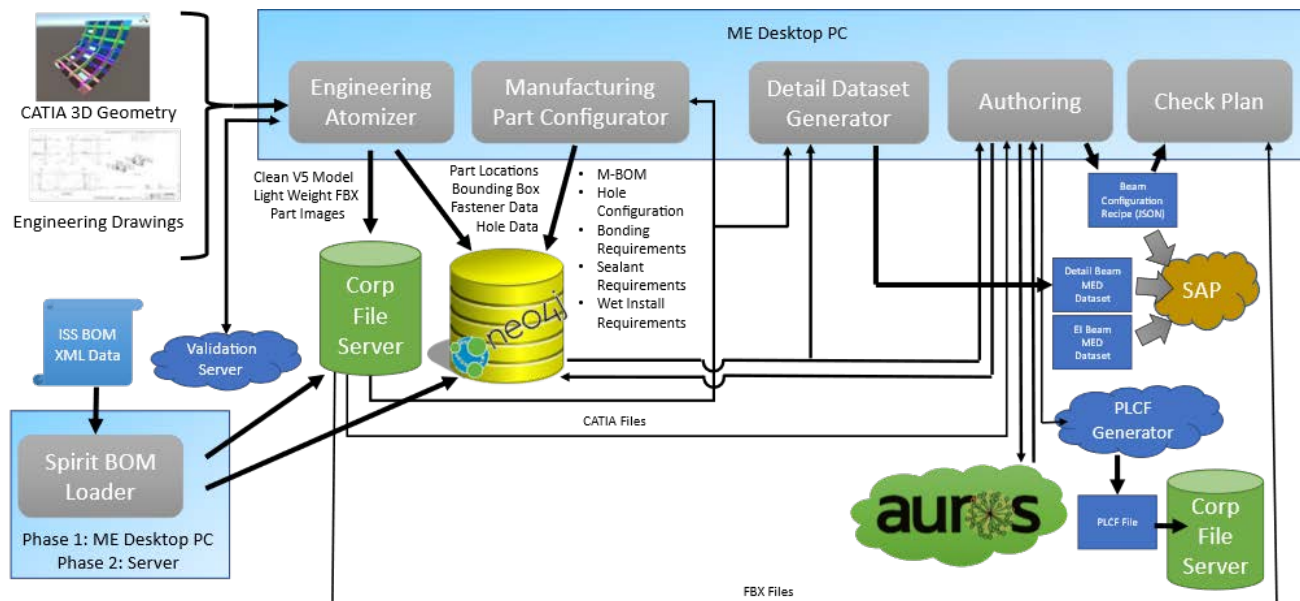 - ➢ Considered: station ergonomics, part handling/conveyance

Floor Beam Assembly 2.0

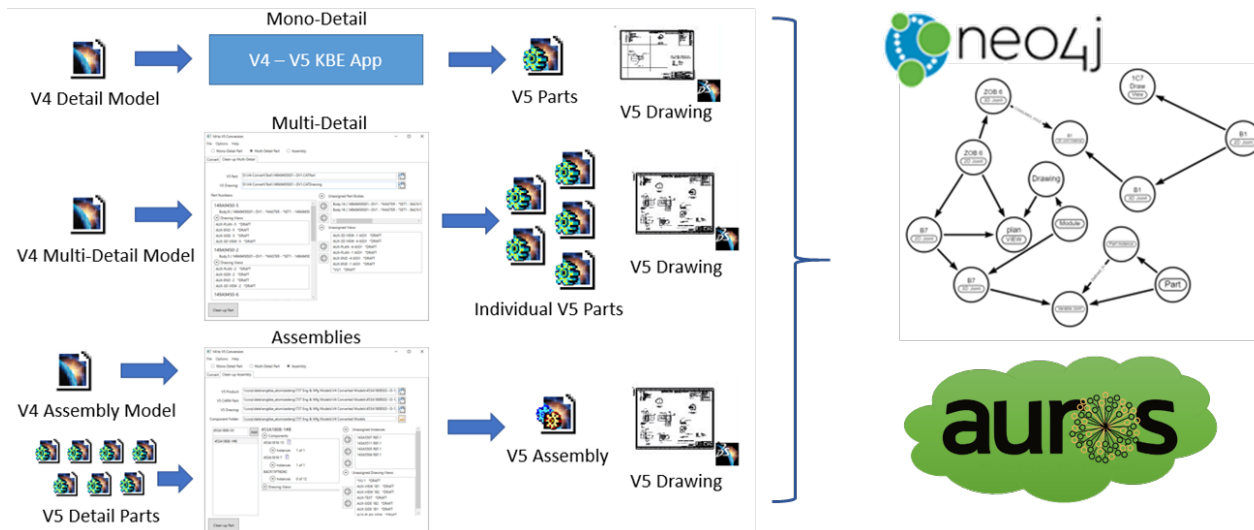- **Data Process Modeling: Facilitation**
  - ➢ Data & data flow became engine that drove the line
  - ➢ Crucial to leverage legacy data sources, derive digital work instructions, dynamic orchestration
  - ➢ Automated Work Instruction (AWI) authoring

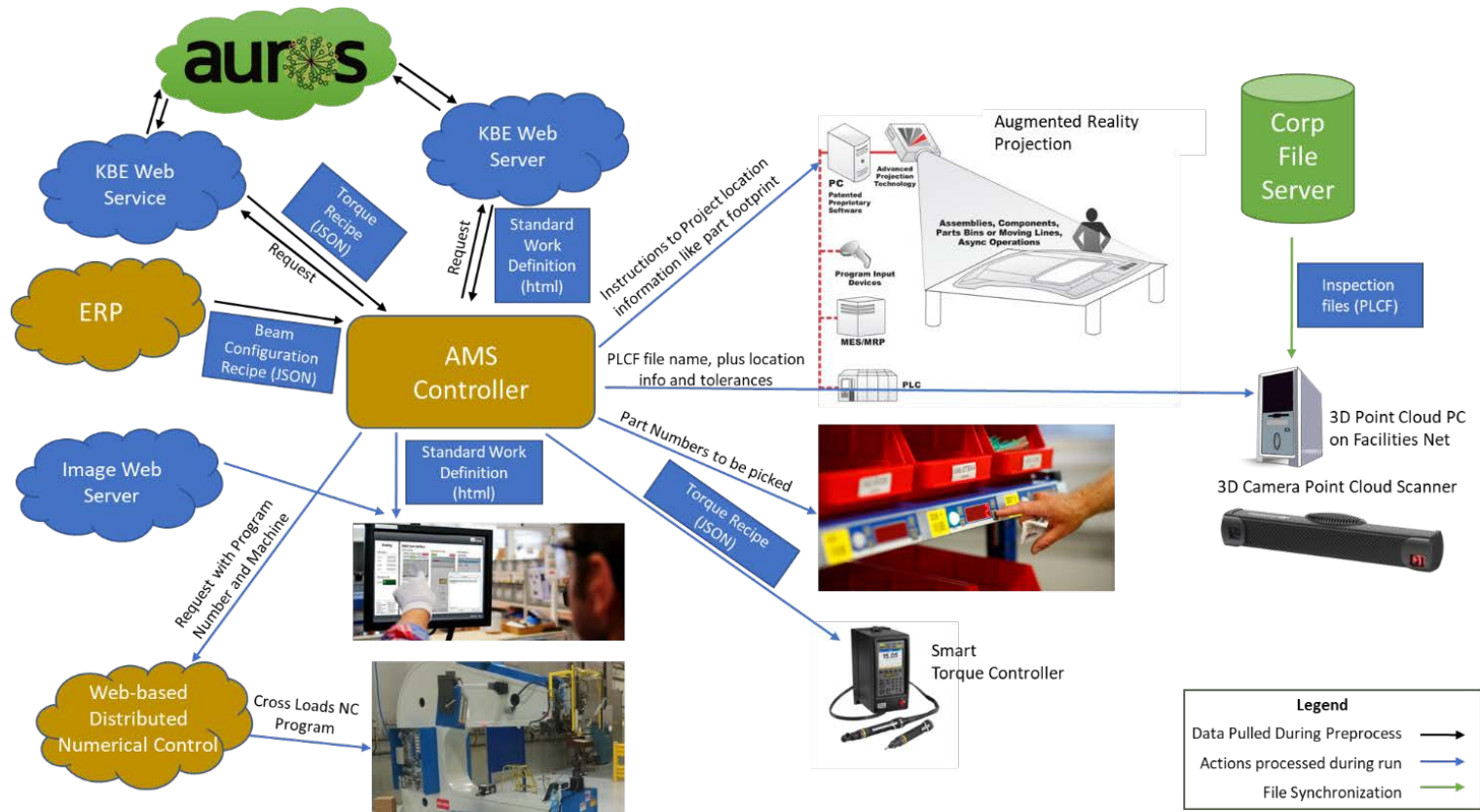# Floor Beam Assembly 2.0

- **Data Process Modeling: Planning**

  ➢ Step 1: Funnel engineering data into intended MBD end-state, storing in a repository

  ➢ Step 2: Data content normalized into Spirit data model, stored in graph database

  ➢ Step 3: Integration with knowledge management system

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Floor Beam Assembly 2.0

- **Data Process Modeling: Execution**
  - ➢ Large-scale SCADA integrates with all physical elements

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Floor Beam Assembly "2.5"

- **Lessons from production ramp-up**

  - Assembly variant complexities

  - Initial DES not discrete enough

  - Pervasive digital orphans

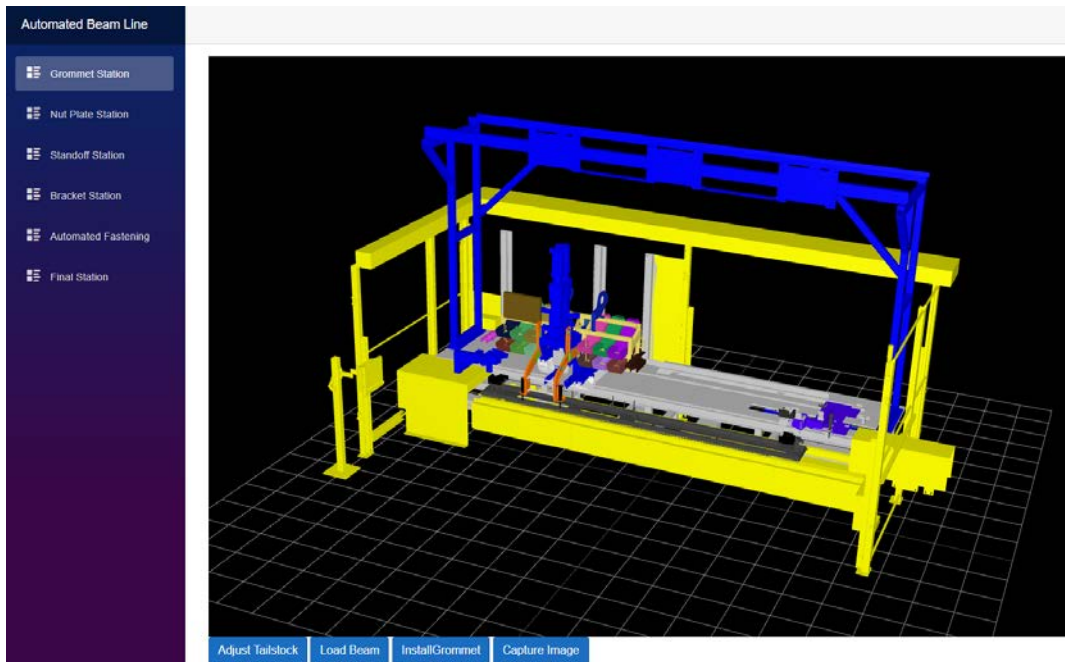 - True virtual commissioning had not been accomplished

**Siloed digital models ultimately of limited use**

Floor Beam Assembly "2.5"

- **Improvements planned & in-work**
  - ➤ Updated CAD reflects as-installed equipment, workcell configs
  - ➤ Stakeholder team collaborating on development of enduring, standardized discrete event model

Floor Beam Assembly "2.5"

- **Improvements planned & in-work (con't)**
  - ➢ Implement Spirit standard IIoT platform focused on data collection
    - ▪ Most ABL assets connect to IIoT platform through PLC controller
    - ▪ Robot, machine CNCs connect via intermediate OPC UA server
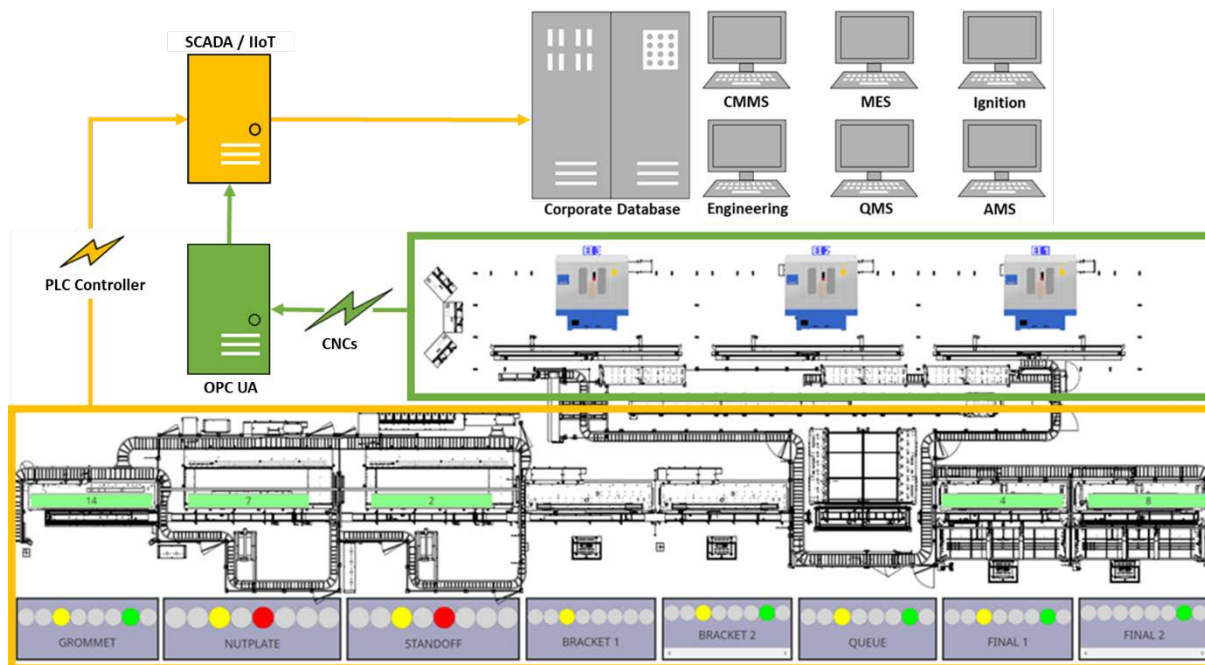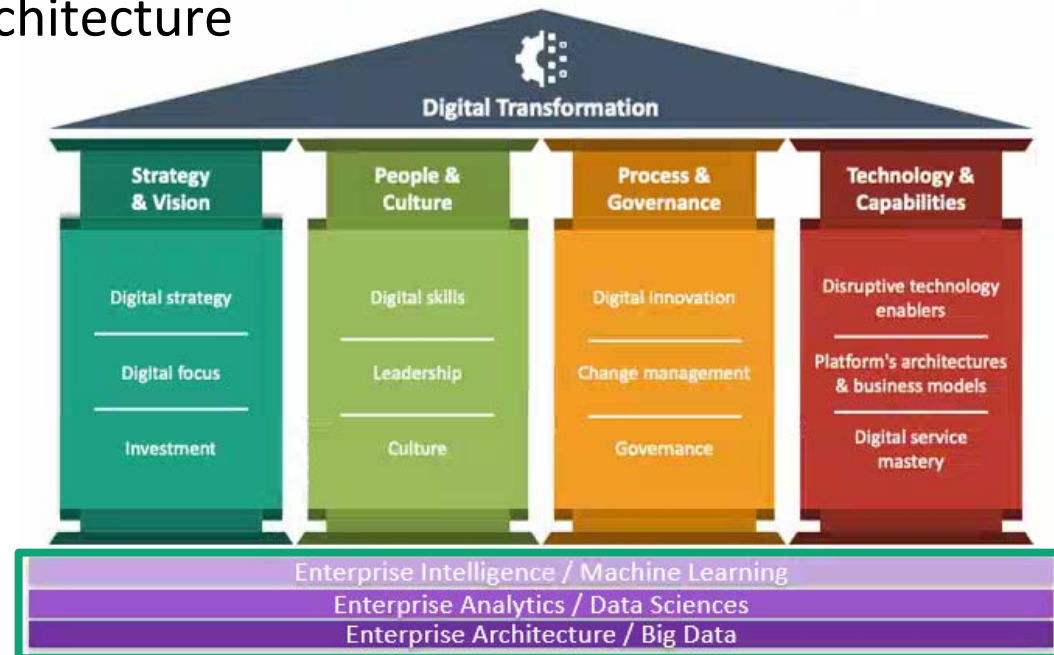
Spirit ONE™

- **Spirit's enterprise digital transformation initiative**
  - ➤ Establish integrated digital way of working
    - ▪ Interaction across business, engineering, manufacturing processes
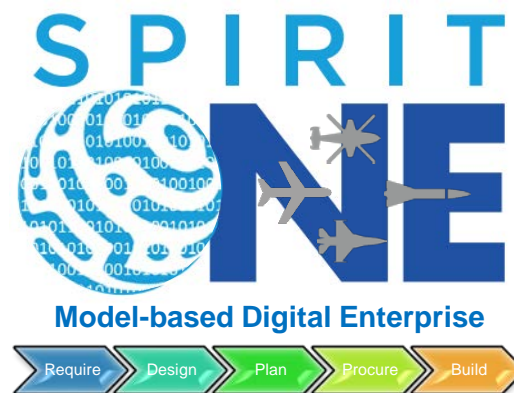   - ▪ Scope: global internal AND multiple external customers, suppliers
  - ➤ Federated Enterprise Architecture
    - ▪ Assure success of digital twinning with total stakeholder integration
    - ▪ Enterprise Analytics turned into Enterprise Intelligence

Spirit ONE™

- **Spirit's enterprise digital transformation initiative**
  - ➤ Factors of Merit PLM trade study; quantify value of OOTB IDE
  - ➤ Resulting strategy specific to Spirit's role:
    - ▪ Tier 1 supplier
    - ▪ Array of major customers
    - ▪ Commercial, defense & space, MRO market segments

Model-based Digital Enterprise

Questions?