Application of CAST to Producibility Loss in Aerospace Manufacturing

John Barstow
MIT Leaders for Global Operations
& System Safety Lab

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01 Background

- *Industry Context*
- *Motivation*
- *Project Overview*

02 CAST Process

- *Step 1: Assemble basic information*
- *Step 2: Model safety control structure*
- *Step 3: Analyze each component in loss*
- *Step 4: Identify control structure flaws*
- *Step 5: Create improvement program*

03 Results

- *Key takeaways*

Industry Context: Defense Aerospace

- **State-of-the-art materials and techniques**

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- **Aircraft lifecycles measured in decades**

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- **Low production volume**

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- **Challenging aftermarket support requirement (spare parts)**
  - Long-term revenue stream
  - Reputational risk to OEM

Images: wikipedia.org

Motivation:
Work Movement and Producibility

- **Industry factors drive need for work movement capability**

  but…

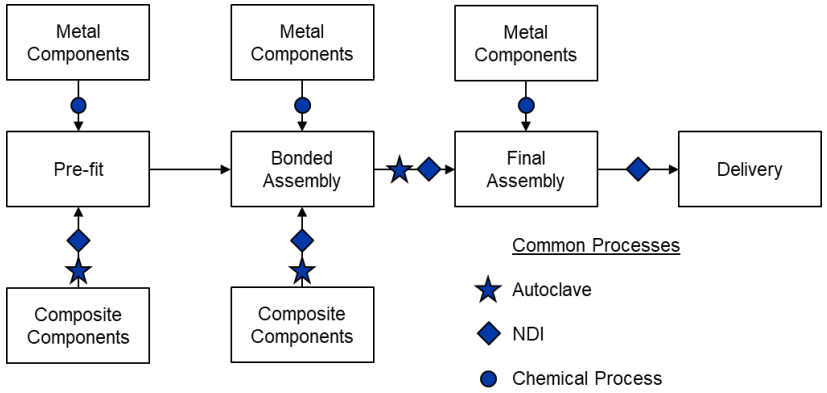
- **Implications of moving complex assemblies after a period of outsourcing are not well understood**
- **Existing procedures are of limited application:**
  - Developed primarily for outsourcing and internal movement
  - Emphasis on technical documentation and equipment

- **Many work movement efforts have been unexpectedly costly and slow**

Can system-theoretic analysis tools improve decision making during work movements?

Project Overview

- **Research project hosted by a large aerospace manufacturer**
- **Production system for spare composite flight control surfaces for out-of-production aircraft, troubled by defects and delays**
- **Timeline**
  - 1970's: Original design
  - 2000's: End of aircraft production, spare part production outsourced
  - 2020's: Supplier ceases operation, OEM decides to re-establish flight control surface spares production at internal facility



What can CAST reveal about the production problems encountered in this situation?

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CAST Process
Step 1: Assemble basic information

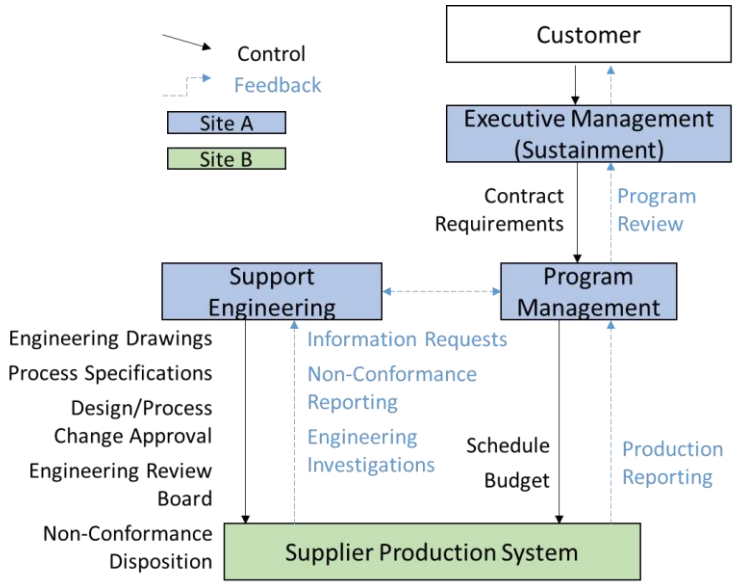
- **Project took place over 6 months of on-site work at a manufacturing facility**

- **Data sources included:**
- 20+ hours of interviews with engineers, mechanics, managers, and executives
- Hundreds of documents including engineering data, production plans, and correspondence
- Approximately 115 days of direct observation

This much study may not be necessary if you're already familiar with the product, process, and organization!

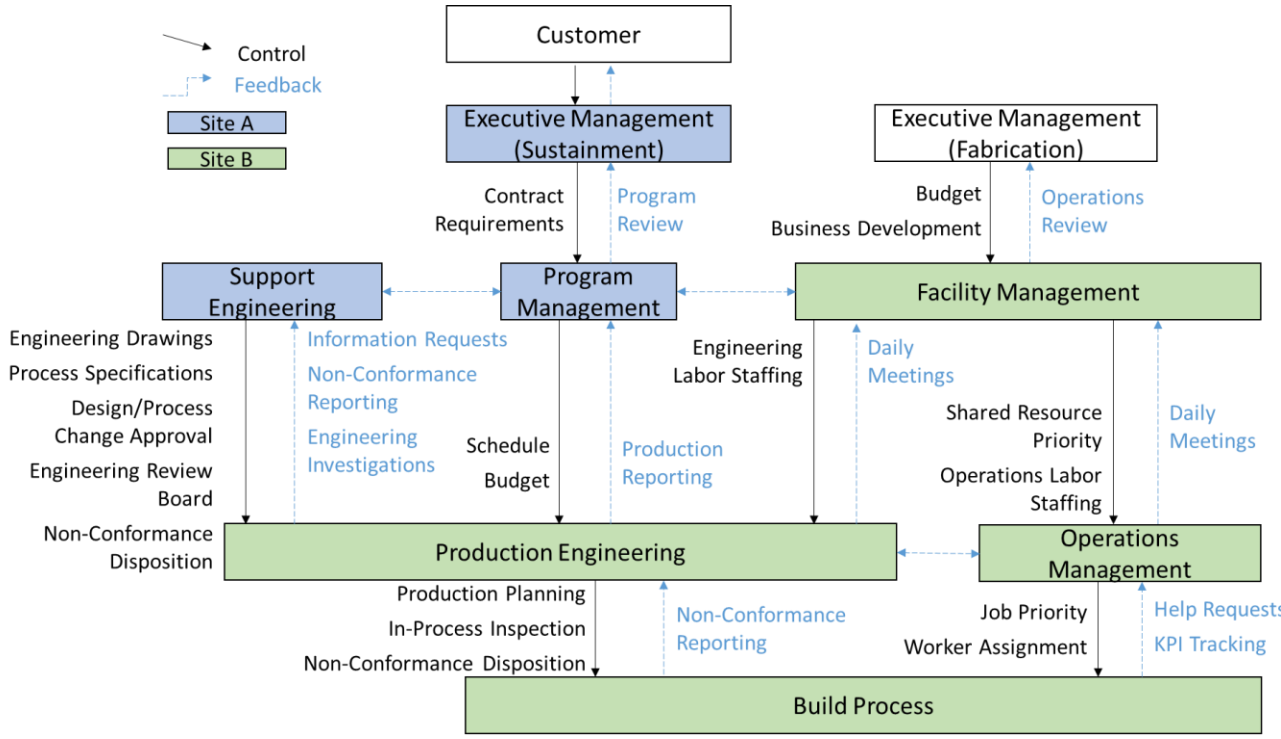
CAST Process
Step 2: Model safety control structure

- **Control structure was designed to manage the supplier process (pre-movement)**
- **Simple and effective, but with limited visibility into the supplier production system**



CAST Process
Step 2: Model safety control structure

- The same management structure was adapted to control internal production after movement
- Control structure results in distributed authority over aspects of build process
- Communication and coordination are complicated by the location of some management functions away from build process



CAST Process
Step 3: Analyze each component in loss

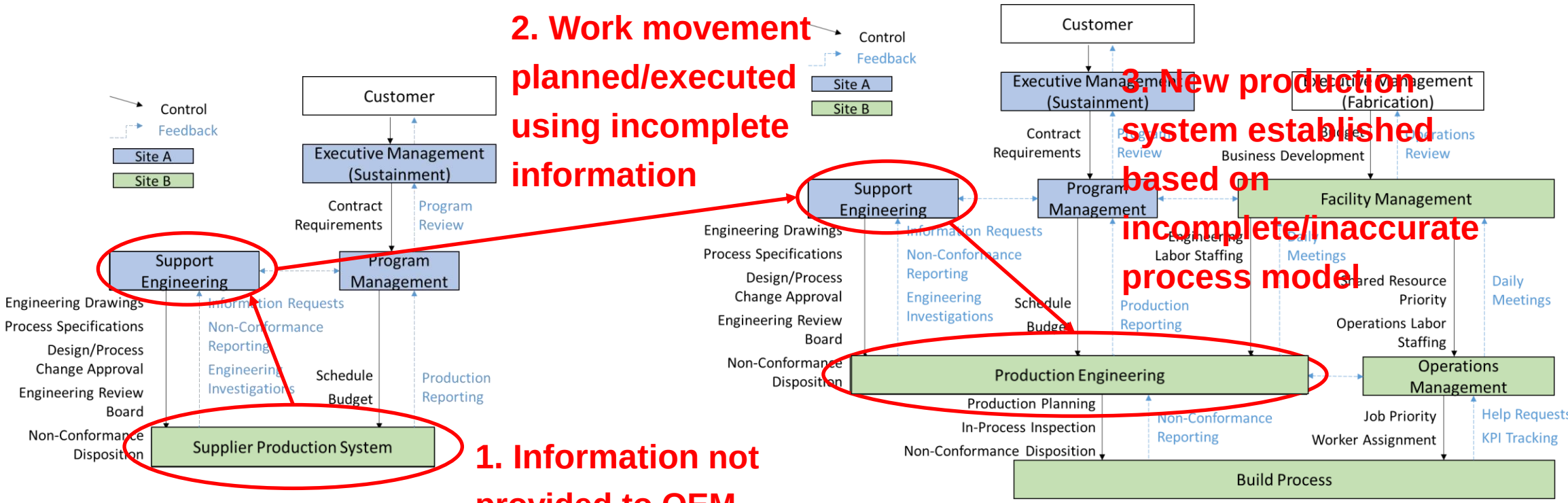
- **From interviews and documents, a detailed timeline of production history (post-movement) was developed**
- **Producibility loss elements were grouped into three categories**
- Manufacturing Plans
- Tooling
- Materials

Example producibility constraints

- “The product and its components and subassemblies must be fabricated and assembled per the manufacturing plan”
- “Any operation or combination of operations in the manufacturing plan that are impossible, dangerous, or unduly difficult must be changed or re-ordered”
- “Changes to the manufacturing plan must be acknowledged by operations and approved by production engineering”

CAST Process
Step 4: Identify control structure flaws

"Changes to the manufacturing plan must be acknowledged by operations and approved by production engineering"



CAST Process
Step 5: Create improvement program

- **Production process was discontinued in early 2023, with no successful deliveries**
- **Recommendations focused on improving decision making in future, similar work movement efforts**
- **Results applicable to complex manufacturing efforts within large, distributed organizations**

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Results
Key Takeaways

Research Conclusions

- **Integrating production efforts across business segments and geographic locations requires deliberate organization design**
- **Fundamental tension exists between configuration control and continuous improvement**

CAST Lessons

- **Importance of subject matter expertise**
- **Applying CAST to organizations is effective but requires specific considerations:**
  - Stakeholder buy-in required for useful results
- ***CAST successfully identified systemic causes of producibility issues that were beyond the reach of traditional "root cause" engineering investigations***

Questions?

jbarstow@mit.edu

THANK YOU