Value Creation Though Integration

A Holistic Approach to the Design of Assembly Operations for Defense Aerospace Products

31 January 2002

Presented By: Mandy Vaughn
2LT, USAF

Research Sponsored By the Lean Aerospace Initiative
Global Positioning “System”
GPS “Lost” Architecture
Ultra-Quality is defined as the limiting case of quality driven to the extreme.

Examples are space craft, nuclear power plants, commercial aircraft, automobiles...

Demands that a system, regardless of size or complexity, should not fail to perform.
Ultra-Quality

- Manufacturing systems are ultra-quality systems just like the airplanes and space craft they produce...

- Today’s challenge is to achieve and maintain ultra-quality levels as systems become more complex.
Overview

- Research background and objectives
- Manufacturing System Design Framework
- Research Design
- Introduction of the case studies
- Results
- Conclusions
Conducted by the Manufacturing Systems Team of LAI

Original motivation - create a quantitative set of guidelines for the manufacture of air and space craft

This ended up being harder than we thought…
Goals guiding the research effort:

- Study and improve available tools in use
- Understand the processes used in industry to design manufacturing systems
- Propose a model for industry to use
- Test this model in industry
- Establish key characteristics of this design process
- Create analytical models to predict manufacturing system performance
Stakeholders

Corporate Level

Business Unit

Product Strategy

Suppliers

Requirements/Considerations/Constraints

Manufacturing System Design/Selection

Implement (pilot)

Evaluate/Validate

Rate Production

[Interpret]

[Seek approval]

DFMA, IPT

3-DCE

Concurrent Engineering

• VSM
• Kaizen
• Trial & Error
• Kaikaku

• Miltenburg,
• 3P,
• 2D plots,
• MSDD
• AMSDD

Manufacturing System Design

Modifications

Fine Tune

Finalized Product Design

Make/Buy

Risk-sharing Partnerships

- Analytical Tools,
- Simulation Tools

Customer Needs

Technical Feasibility

Feasible performance guarantees
Assembly operations

- Span multiple sectors of the aerospace industry
- Prime contractors are off-loading fabrication
- Most visible portion of the value stream
- Greatly simplifies the problem

Site selection criteria
Framework Evaluation Tool

- Aimed at the Business Unit level for each case
- Scored from 0 (worst) -- 100 (best) called “Framework Congruence”
- Goals of the tool were to determine:
  - Phase Presence
  - Phase Timing
  - Breadth in Phase

Performance Metric

- Actual/Planned Performance
30+ site visits since June 2000

Over 240 interviews ranging from vice presidents to shop floor workers

Real time “fly on the wall” or retrospective observations
Case Studies - Air

- Major Aerostructures (6):
  - 737NG, F-18 E/F EFF, F-16, F-22 (wing/aft, mid), X-35

- Electronics (2):
  - Wedgetail, TDR-94
Case Studies - Space

- Launch Vehicles (2):
  - EELV: Atlas V, Delta IV

- Space (4):
  - A2100, AEHF, Iridium, HVSP
Framework Validation Results

Framework Congruence versus Performance

R² = 0.71

Group 1

Group 2
<table>
<thead>
<tr>
<th>Framework Congruence</th>
<th>Phase Presence</th>
<th>Timing</th>
<th>Breadth</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>25.90</td>
<td>30.71</td>
<td>39.38</td>
</tr>
<tr>
<td>94</td>
<td>25.90</td>
<td>30.00</td>
<td>38.05</td>
</tr>
<tr>
<td>91.9</td>
<td>22.48</td>
<td>29.00</td>
<td>40.38</td>
</tr>
<tr>
<td>81.7</td>
<td>18.57</td>
<td>26.62</td>
<td>36.62</td>
</tr>
<tr>
<td>78.3</td>
<td>23.24</td>
<td>24.19</td>
<td>30.86</td>
</tr>
<tr>
<td>77.67</td>
<td>20.90</td>
<td>25.90</td>
<td>30.86</td>
</tr>
<tr>
<td>57</td>
<td>17.24</td>
<td>19.76</td>
<td>20.14</td>
</tr>
<tr>
<td>53.5</td>
<td>13.33</td>
<td>15.90</td>
<td>24.29</td>
</tr>
<tr>
<td>50.3</td>
<td>12.33</td>
<td>17.90</td>
<td>20.14</td>
</tr>
<tr>
<td>45.3</td>
<td>15.00</td>
<td>18.76</td>
<td>12.29</td>
</tr>
<tr>
<td>26.73</td>
<td>7.33</td>
<td>11.76</td>
<td>7.67</td>
</tr>
</tbody>
</table>

How important are the different aspects?

- Which of Phase Presence, Timing or Breadth impacted the ability of the system to meet its planned performance?
Determinants of Performance

Breadth Score versus Performance

Group 1

Group 2
Framework Validation Results

**Framework Congruence versus Performance**

- Group 1
- Group 2

\[ R^2 = 0.71 \]
Strategy Presence Results

Existence of Strategy versus Framework Congruence

- Group 1

Existence of Manufacturing Strategy

- No Strategy Present
- Strategy Present

Framework Congruence
Conclusions

Framework Validation

- Framework congruence and system performance

Key Characteristics

- Breadth
- Strategy
- Status
Summary

- Research background and objectives
- Propose a framework
- Test the framework
  - Research design and case studies
- Results
  - Framework validation and key characteristics
- Questions? Comments?