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Enterprise Value: The New Lean Horizon

Product Realization in the Defense Aerospace Industry

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2LT, USAF

Research Sponsored By Lean Aerospace Initiative

Background

- 21st century aerospace challenge
- Industry maturity perspectives
- Implications on the aerospace industry

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Higher, Faster, Farther - The 21st Century Enterprise Challenge

Aerospace has four core missions:

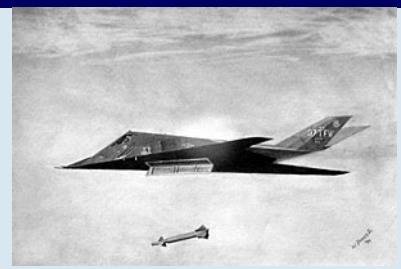
- Enabling the global movement of people and goods
- Enabling the global acquisition and dissemination of information and data
- Advancing national security interests
- Providing a source of inspiration by pushing the boundaries of exploration and innovation

These missions will never be routine and require the best technology and the best organizations

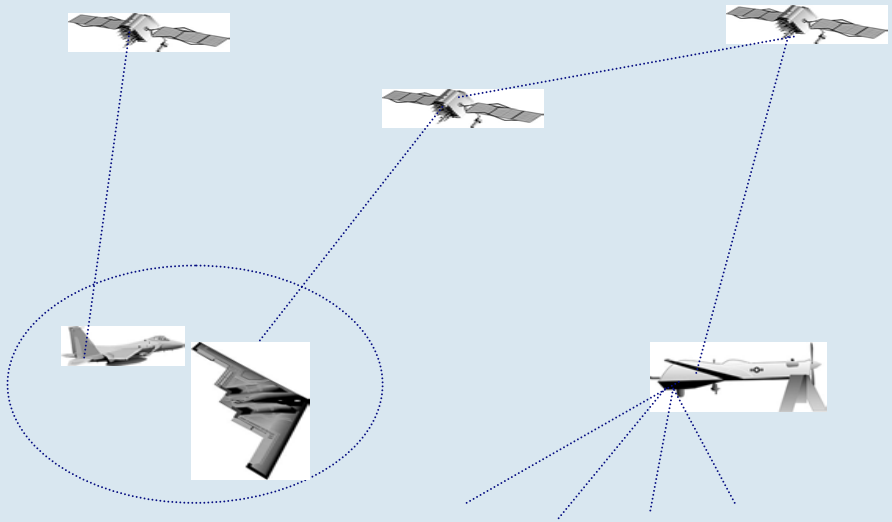
> **"The core challenge for industry in the 21st century involves identifying and delivering *value* to every stakeholder. Meeting that challenge requires *lean* capability at the *enterprise* level."**

The Needs of Aerospace Customers are Changing

From a focus on single vehicles to platforms…



To networks of platforms and…



More flexible challenges in their employment

Innovation in the industry is thus shifting from single vehicles to networks of capability

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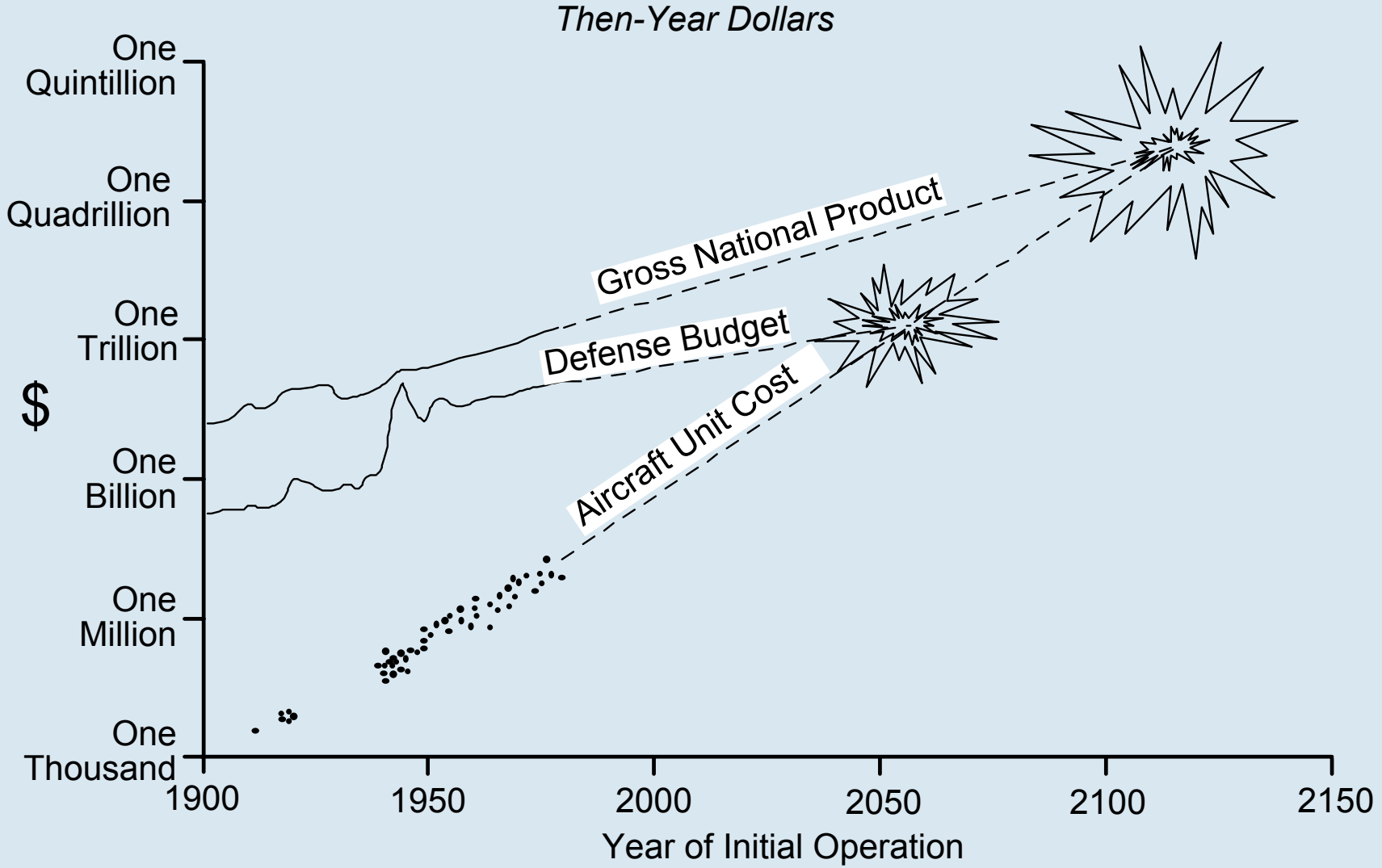
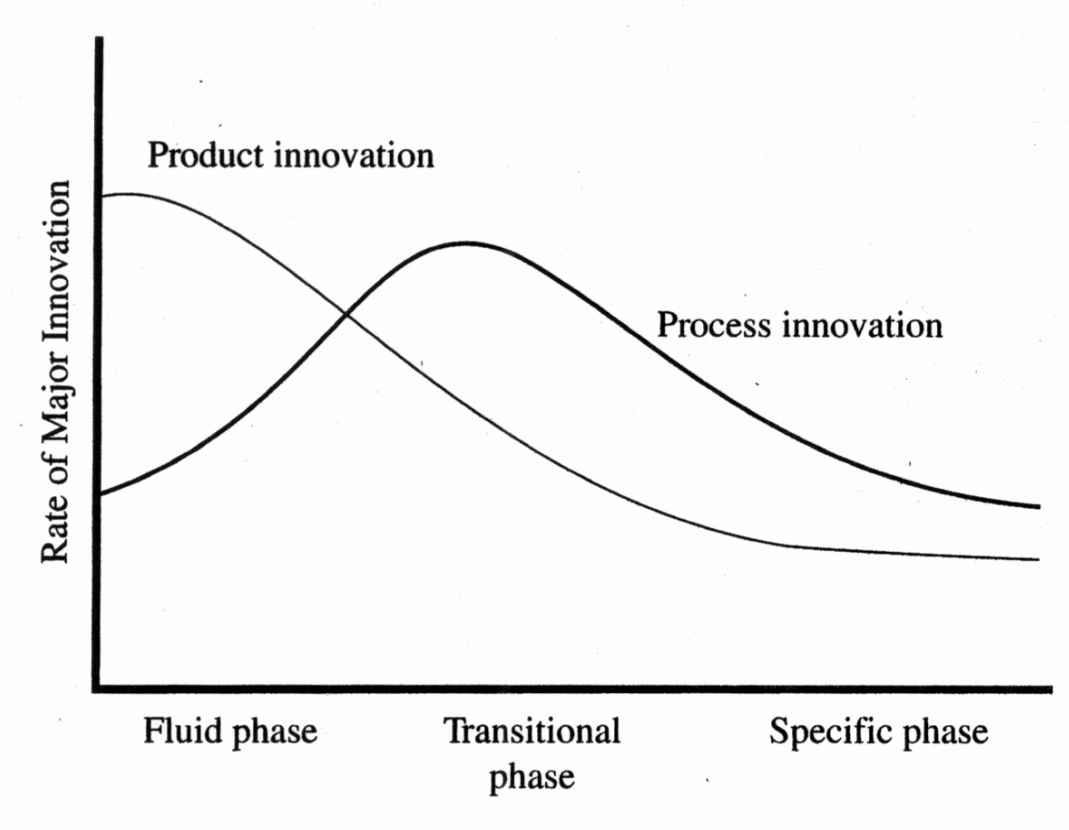
Cost of Tactical Aircraft
Source: Augustine's Laws



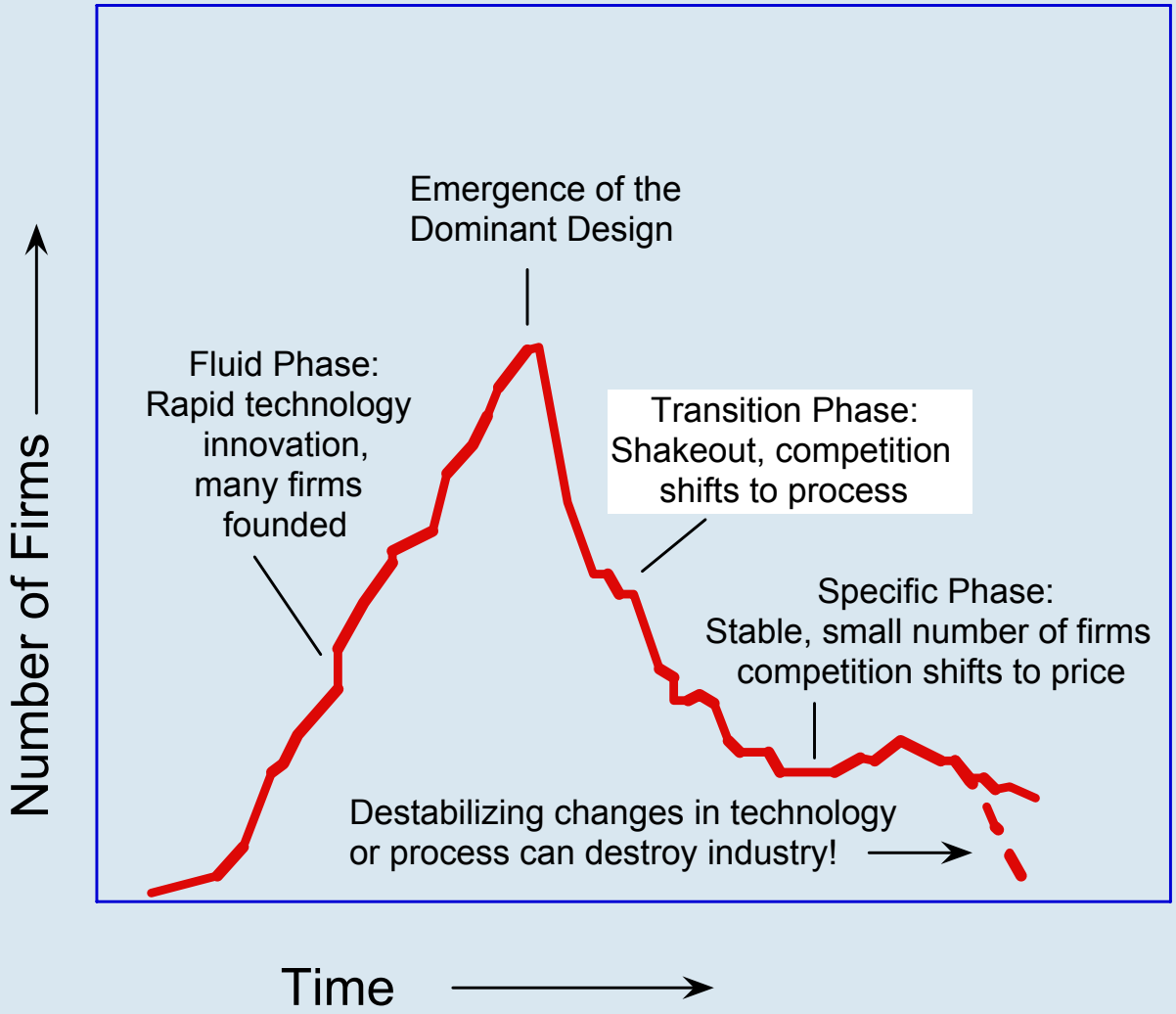
Model of Product and Process Innovation



- **Rate of product innovation highest during formative years**
- **As product matures rate of process innovation overcomes product innovation**
- **Very mature products have low levels of both product & process innovations**

Source: William Abernathy & James Utterback, 1978

Utterback's Dynamics of Innovation Model



Source: Utterback, *Dynamics of Innovation, 1994* as adopted by Hugh McManus , 2001

Dominant Design?

1958

1995

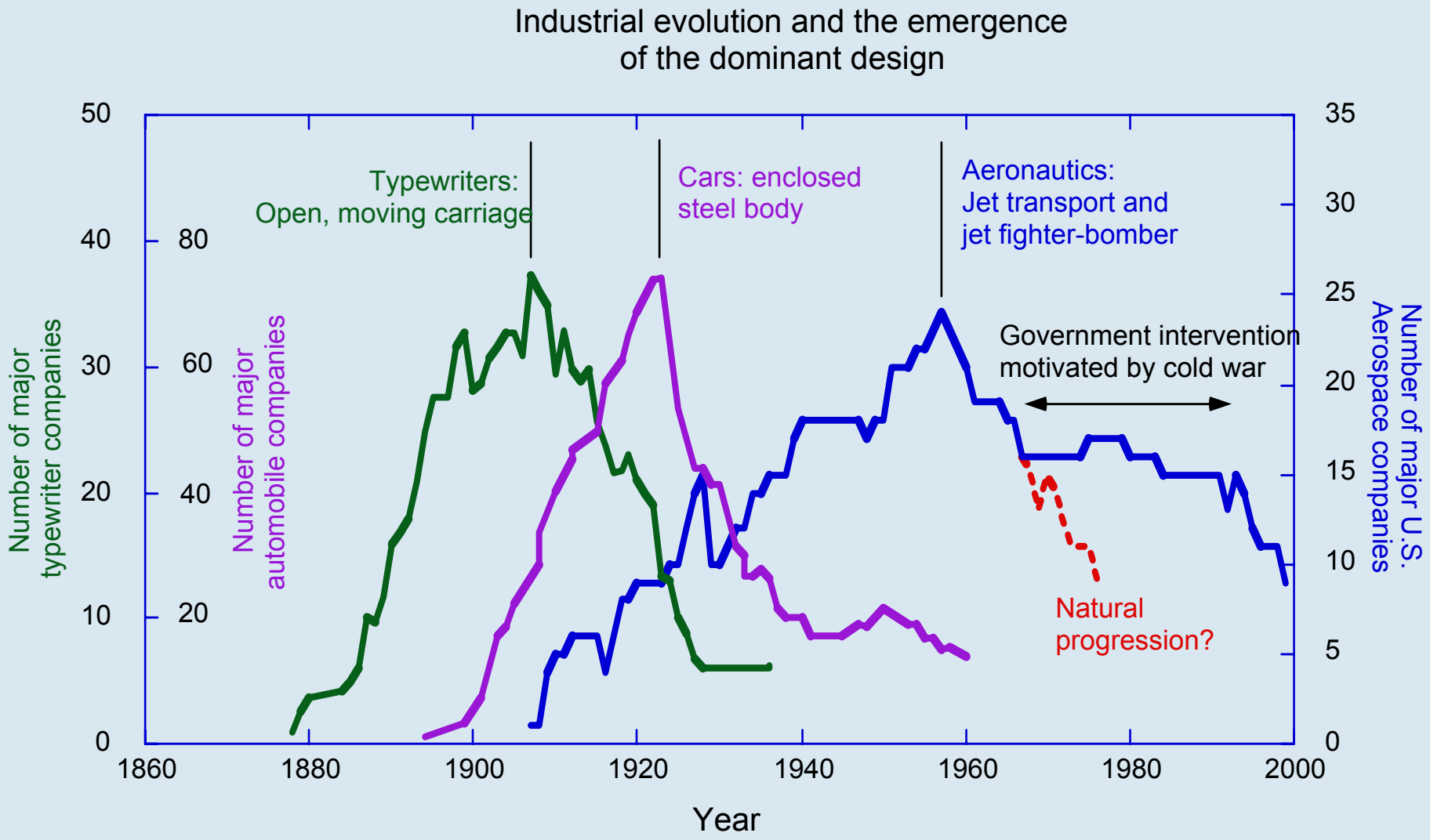
Dominant Design?

1953

1972

2002

Aerospace Industry



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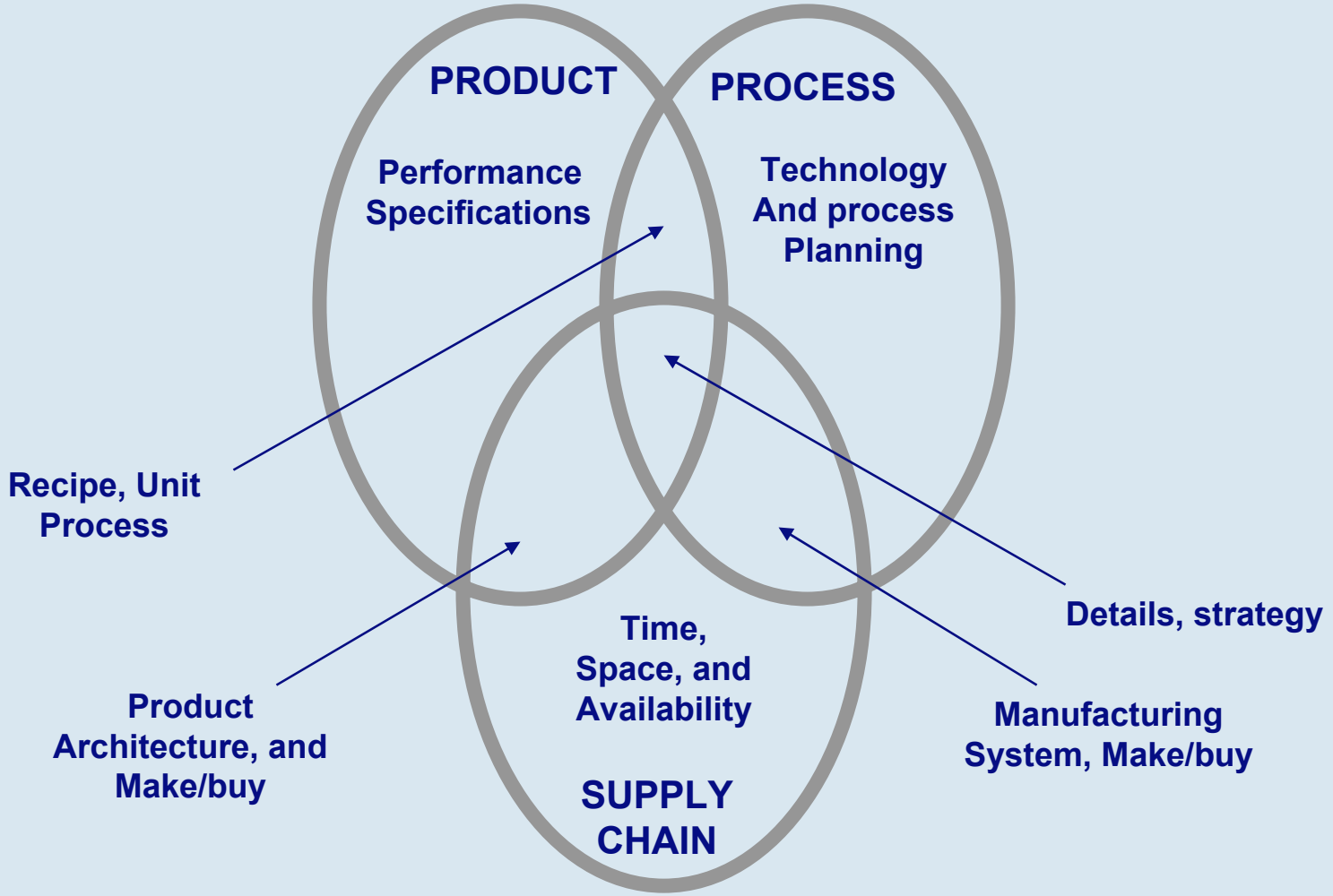
Implications of Post Dominant Design

- Little product differentiation
- Incremental product innovation
- Acquisition cost becomes focus
- Operating costs more of a concern
- Mergers, acquisitions & exits
- Process innovation dominates
- Organizations become more rigid & hierarchical
- Less risk taking

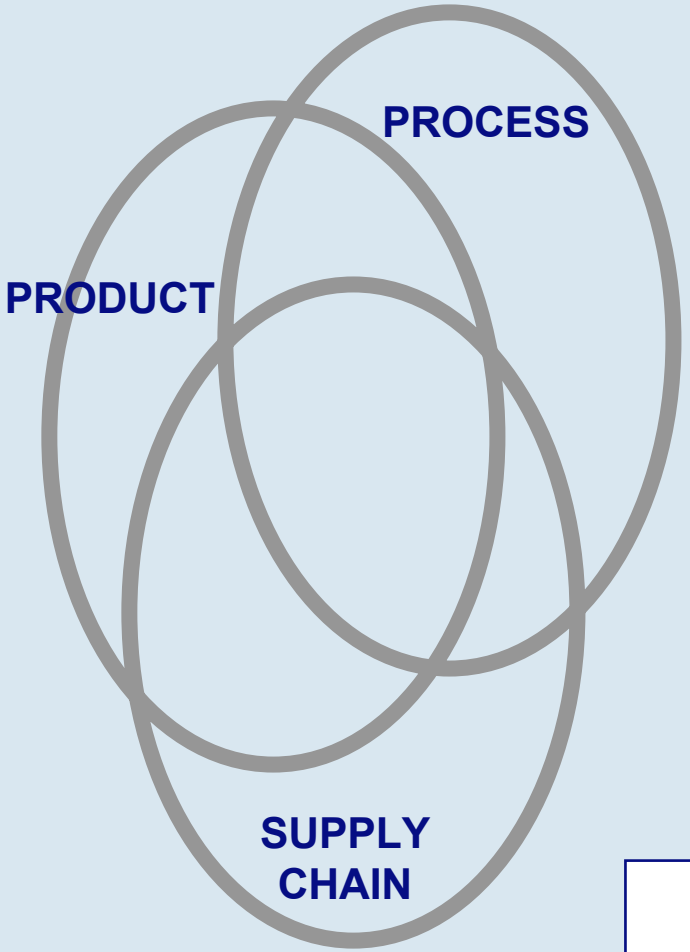
= AEROSPACE INDUSTRY?

Fine's 3-D Concurrent Engineering Model



Source: Charles Fine, *Clockspeed*, Perseus Books, p. 146

Fine's Model and the Aerospace Industry in the Transition Phase



In a post dominant design environment two relationships predominate

- **Product interactions become more interlinked with process and the supply chain**
- **Supply chain integration and process improvements have a predominant impact on cost**

Design must be much more interactive with mfg & suppliers

Source: Shields, LAI Joint Workshop "Integration-Framing", Jan 30, 2002

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Conclusions

- Aerospace industry innovation shifting to systems of systems
- In a maturing single product environment
  - Product and life cycle cost predominate
  - Best addressed by process & supply chain improvements
- Enterprise strategy should change in recognition of this new competitive landscape

Lean beyond the factory floor means shifting the enterprise focus from *product design* to *product realization*

Research Overview

- Research objectives
- Manufacturing System Design Framework
- Research Design
- Introduction of the case studies
- Results - with Bonus material!
- Conclusions

Research Objectives

- **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**

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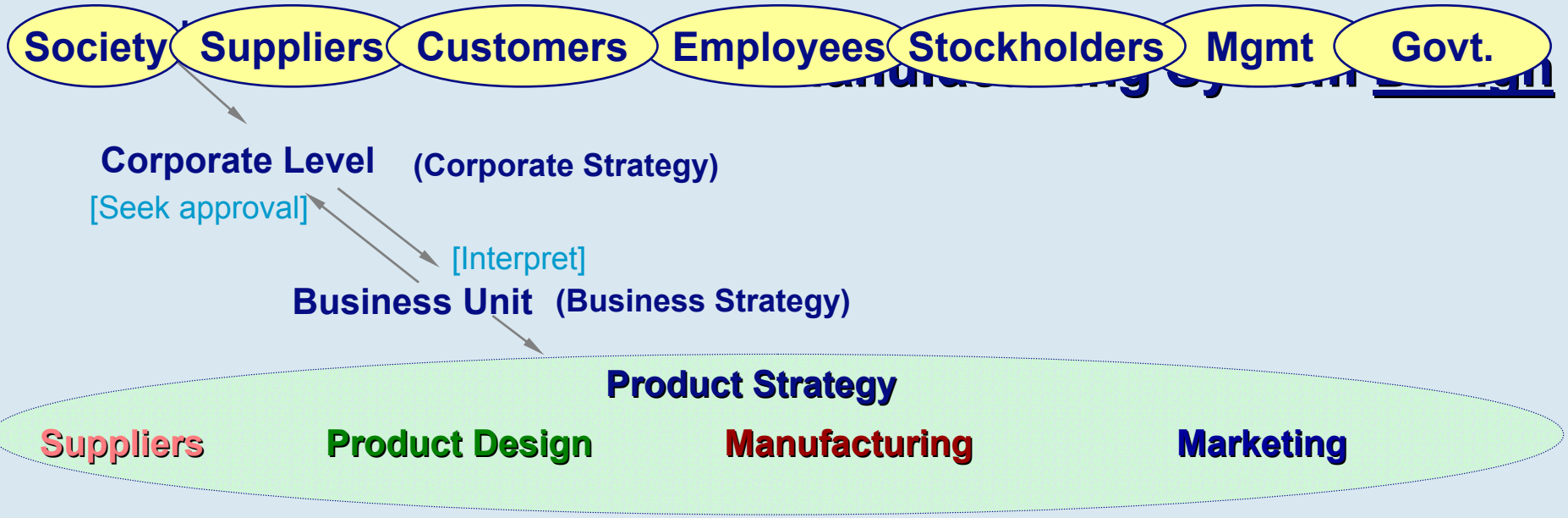
Elements for a Manufacturing System Design Framework

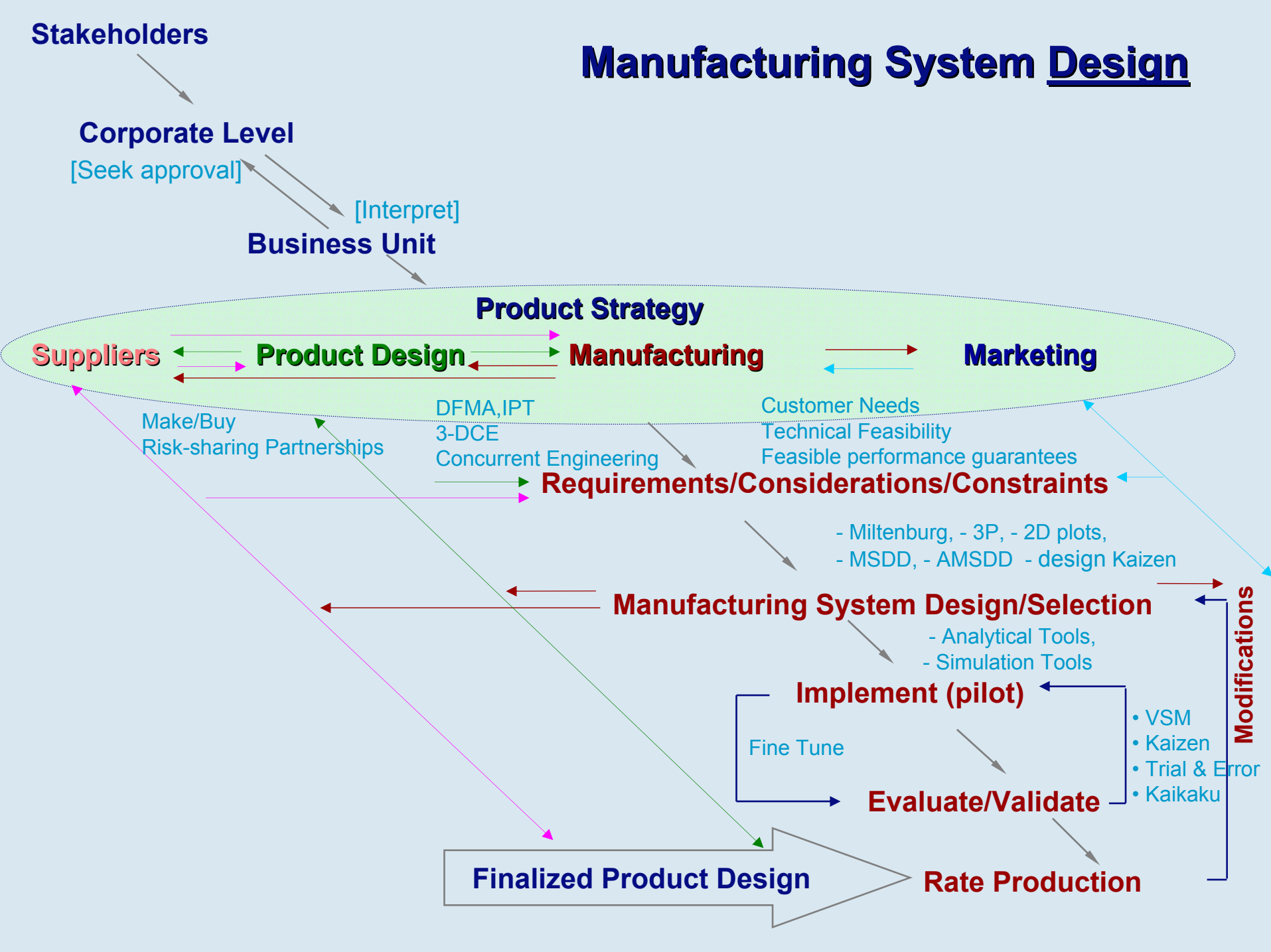
- A holistic view of manufacturing system design environment
- Visual depiction of "design beyond factory floor" ideas
- Manufacturing as part of the product strategy
- ***Manufacturing system design is strategy driven, not product design driven***
- Combines multiple useful tools
- Provides insights into order and interactions
- Not prescriptive
- Can lead to innovative & new manufacturing system designs
- Shows the unending design cycle -- Continuous Improvement

Manufacturing System *Design*

- **Manufacturing system "infrastructure" design**
  - **Manufacturing strategy**
  - **Operating policy**
  - **Partnerships (suppliers)**
  - **Organization structure details**

- **Manufacturing system "structure" design**
  - **Buildings, location, capacity**
  - **Machine selection**
  - **Layout**
  - **WIP**


Society
Suppliers
Customers
Employees
Stockholders
Mgmt
Govt.
Corporate Level
(Corporate Strategy)
[Seek approval]
[Interpret]
Business Unit
(Business Strategy)
Product Strategy
Suppliers
Product Design
Manufacturing
Marketing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Manufacturing System Design
Corporate Level
[Seek approval]
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Product Design
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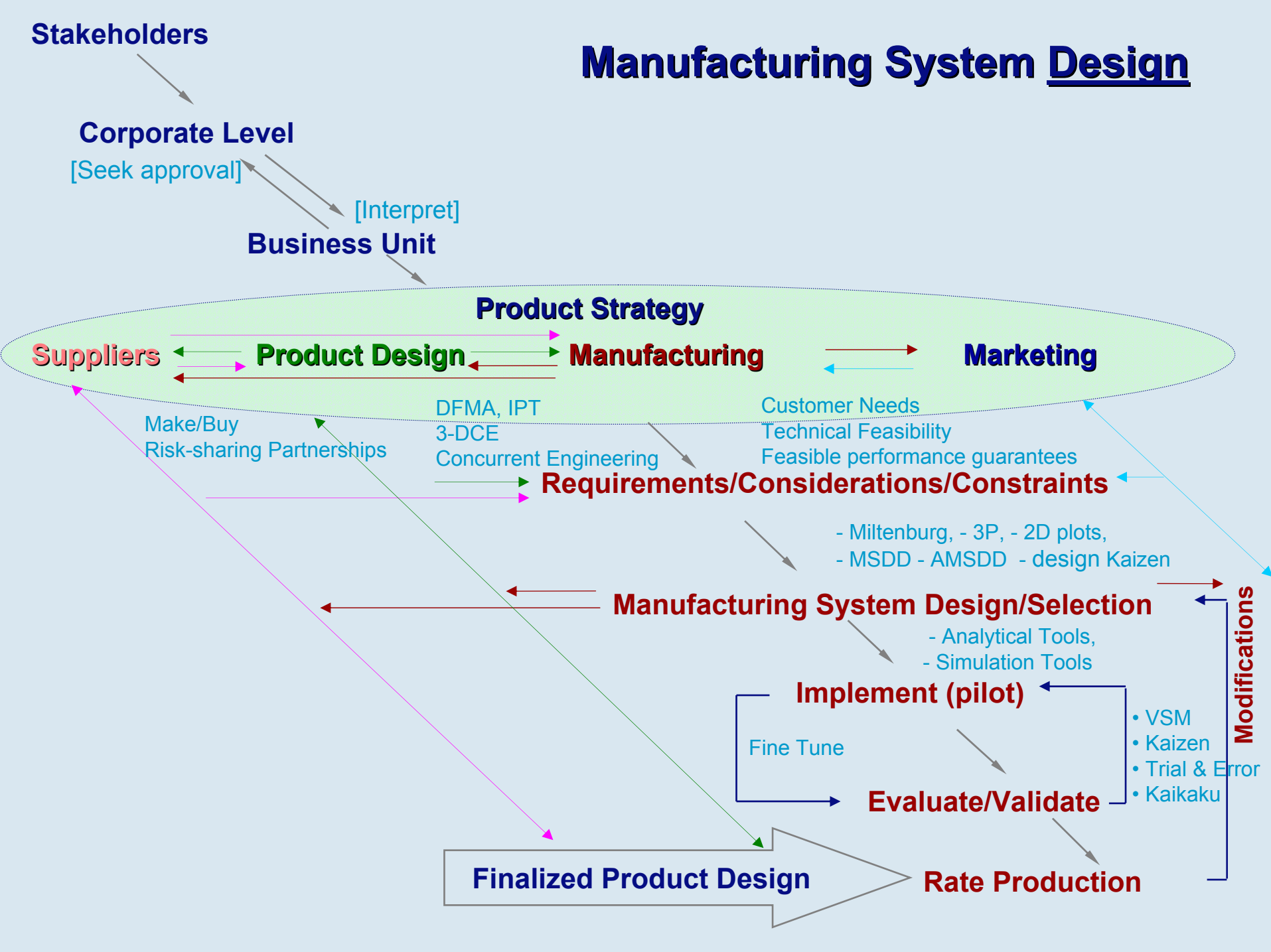
Marketing
Make/Buy
Risk-sharing Partnerships
DFMA,IPT
3-DCE
Concurrent Engineering
Customer Needs
Technical Feasibility
Feasible performance guarantees
Requirements/Considerations/Constraints
- Miltenburg, - 3P, - 2D plots,
- MSDD, - AMSDD - design Kaizen
Manufacturing System Design/Selection
- Analytical Tools,
- Simulation Tools
Implement (pilot)
Fine Tune
Evaluate/Validate
• VSM
• Kaizen
• Trial & Error
• Kaikaku
Modifications
Finalized Product Design
Rate Production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Research Design

- **Assembly operations**
- **Site selection criteria**
- **Framework Evaluation Tool**
- **Performance Metric**

Data Collection

- 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

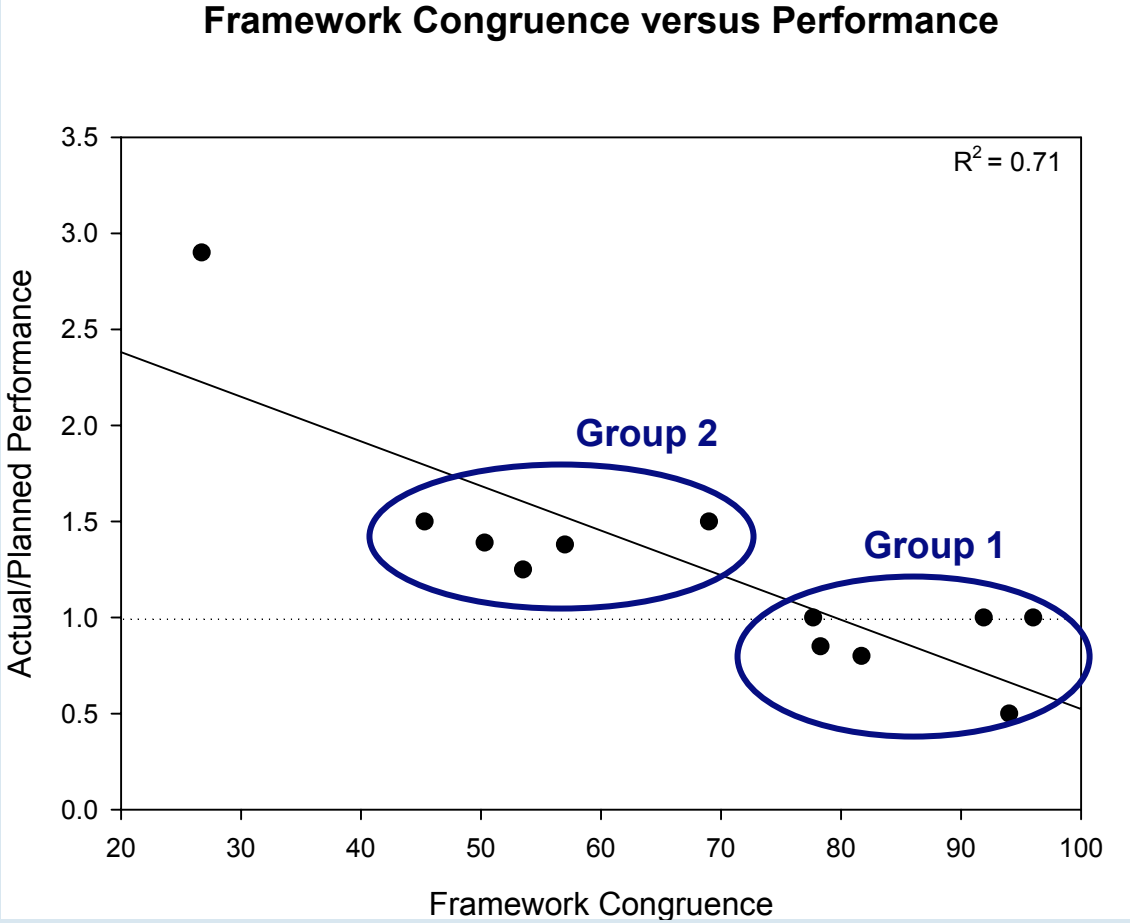
Case Studies - Air

- **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

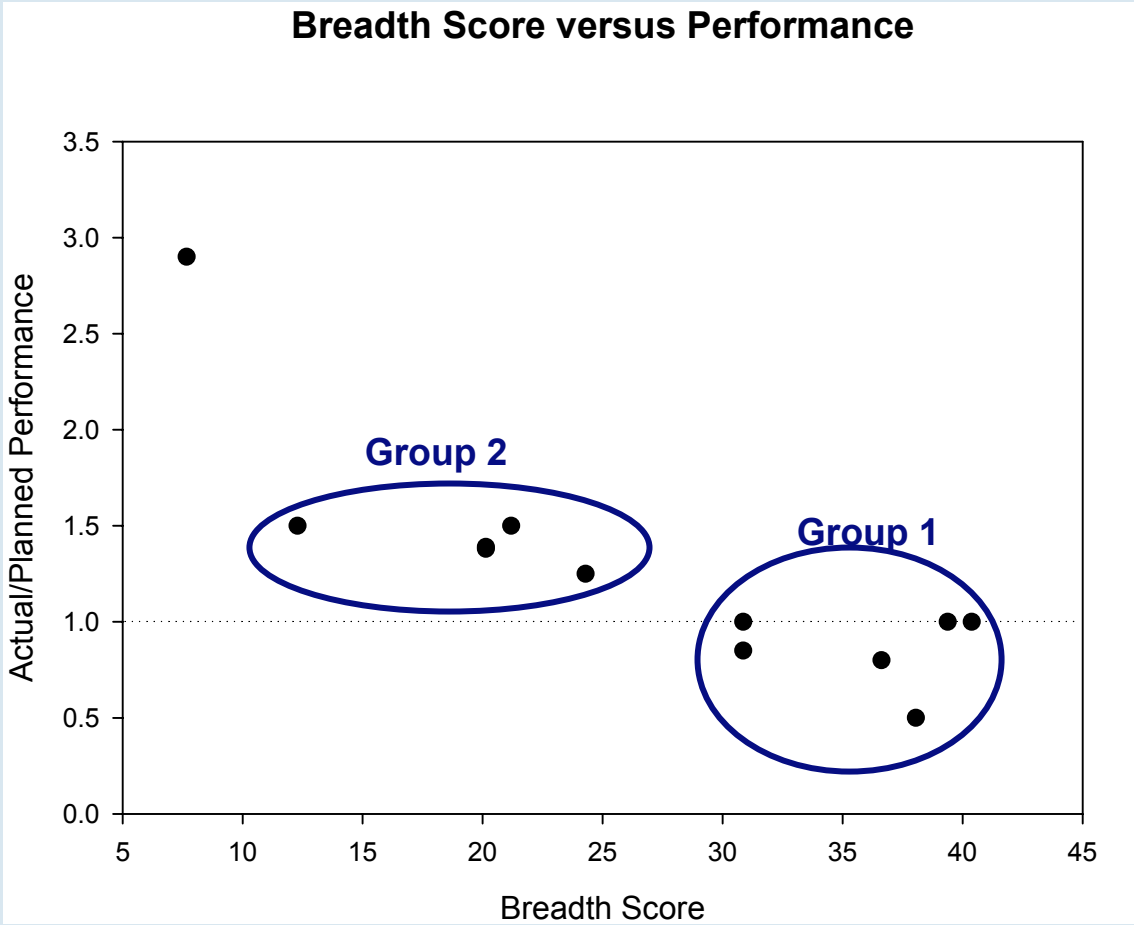


Scoring Breakdown

Framework Congruence	Phase Presence	Timing	Breadth	
96	25.90	30.71	39.38	Group 1
94	25.90	30.00	38.05	
91.9	22.48	29.00	40.38	
81.7	18.57	26.62	36.62	
78.3	23.24	24.19	30.86	
77.67	20.90	25.90	30.86	
69	21.24	26.62	21.19	Group 2
57	17.24	19.76	20.14	
53.5	13.33	15.90	24.29	
50.3	12.33	17.90	20.14	
45.3	15.00	18.76	12.29	
26.73	7.33	11.76	7.67	

- **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



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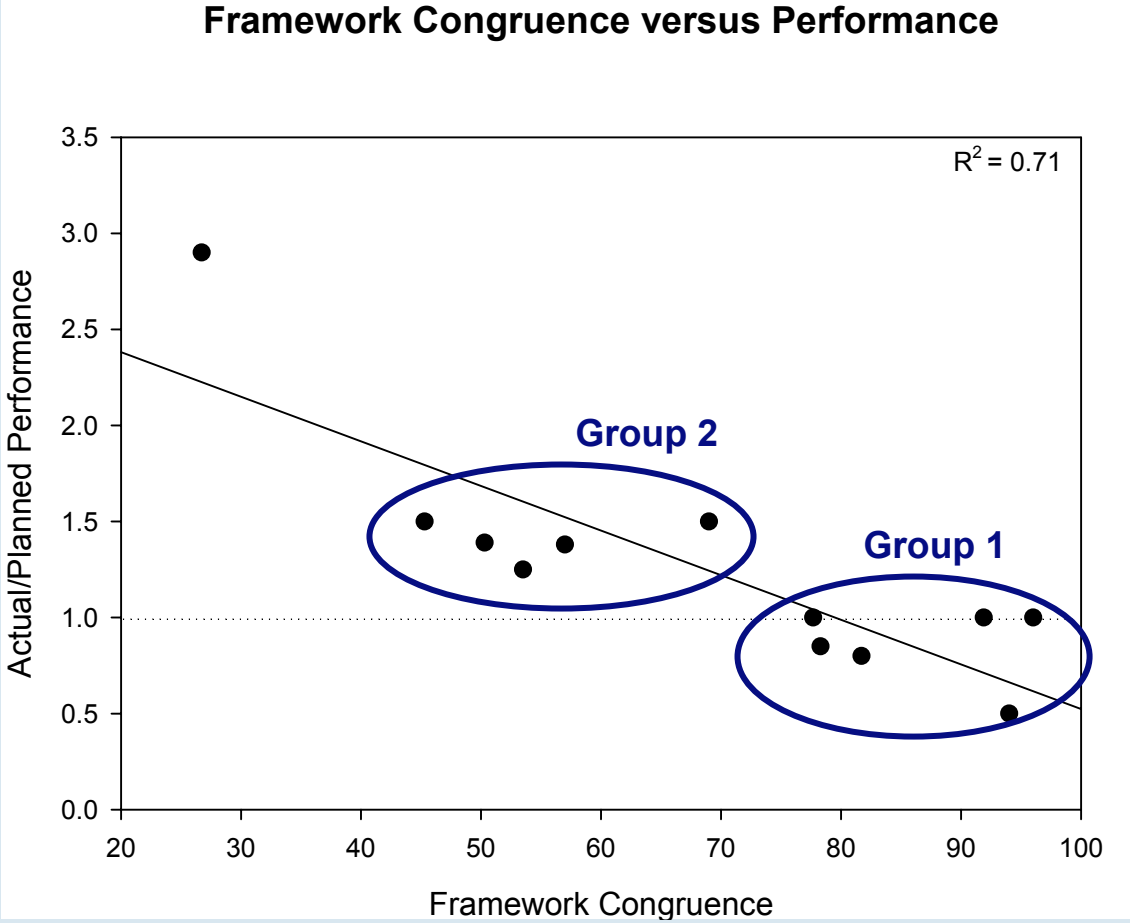
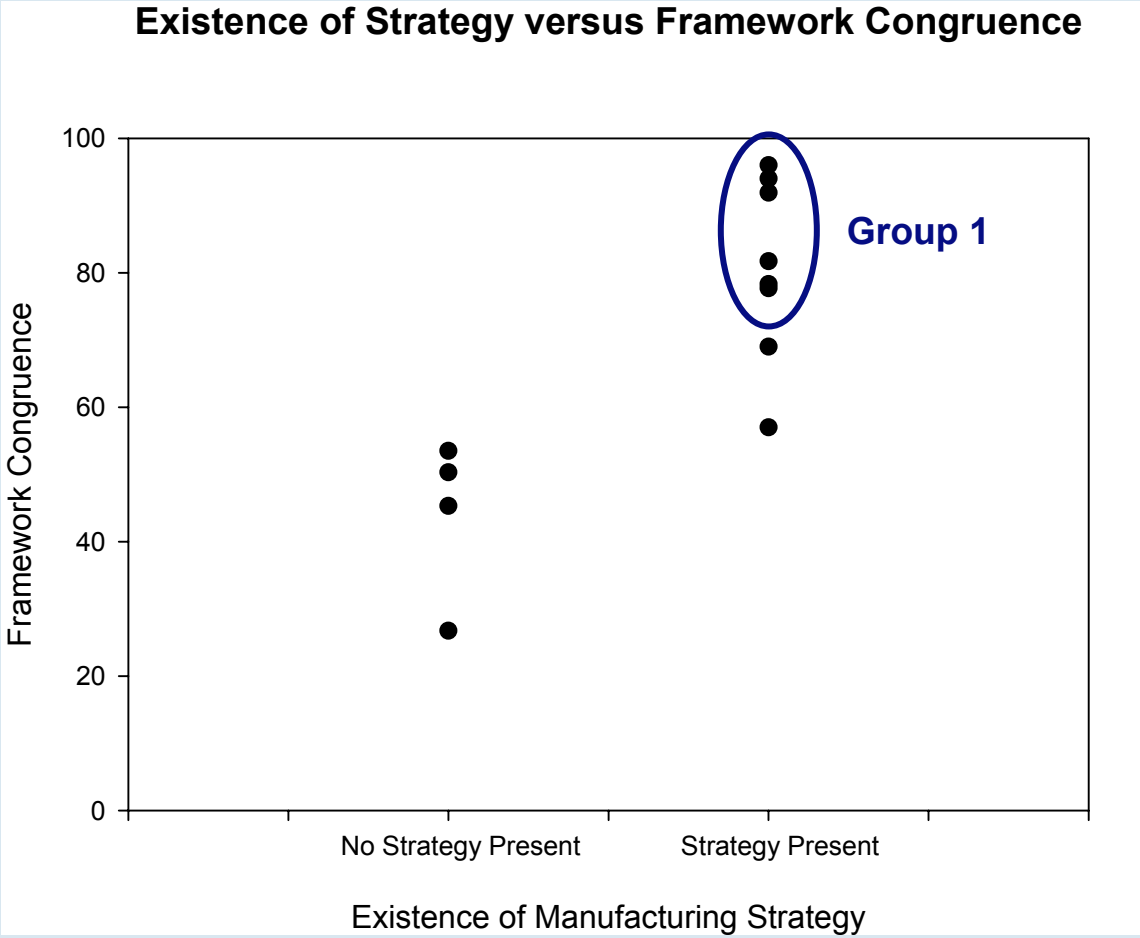
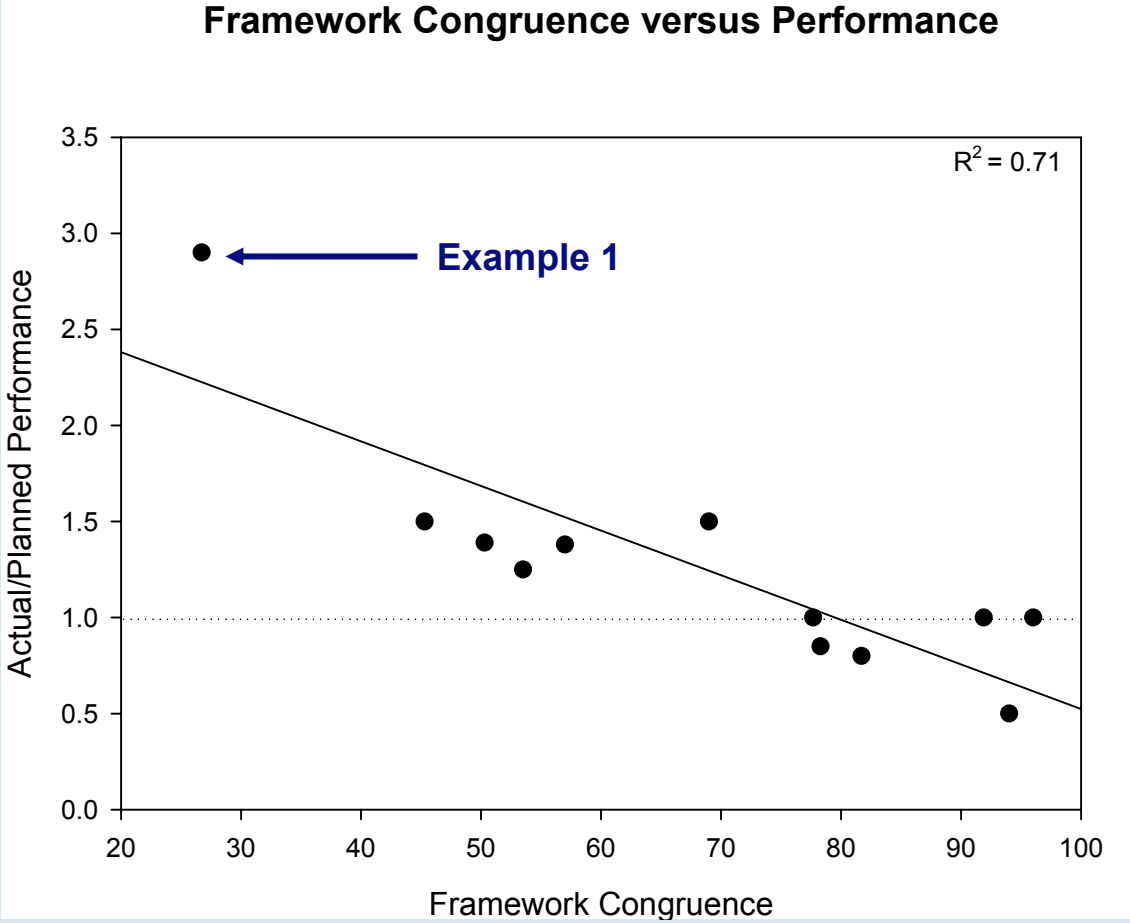


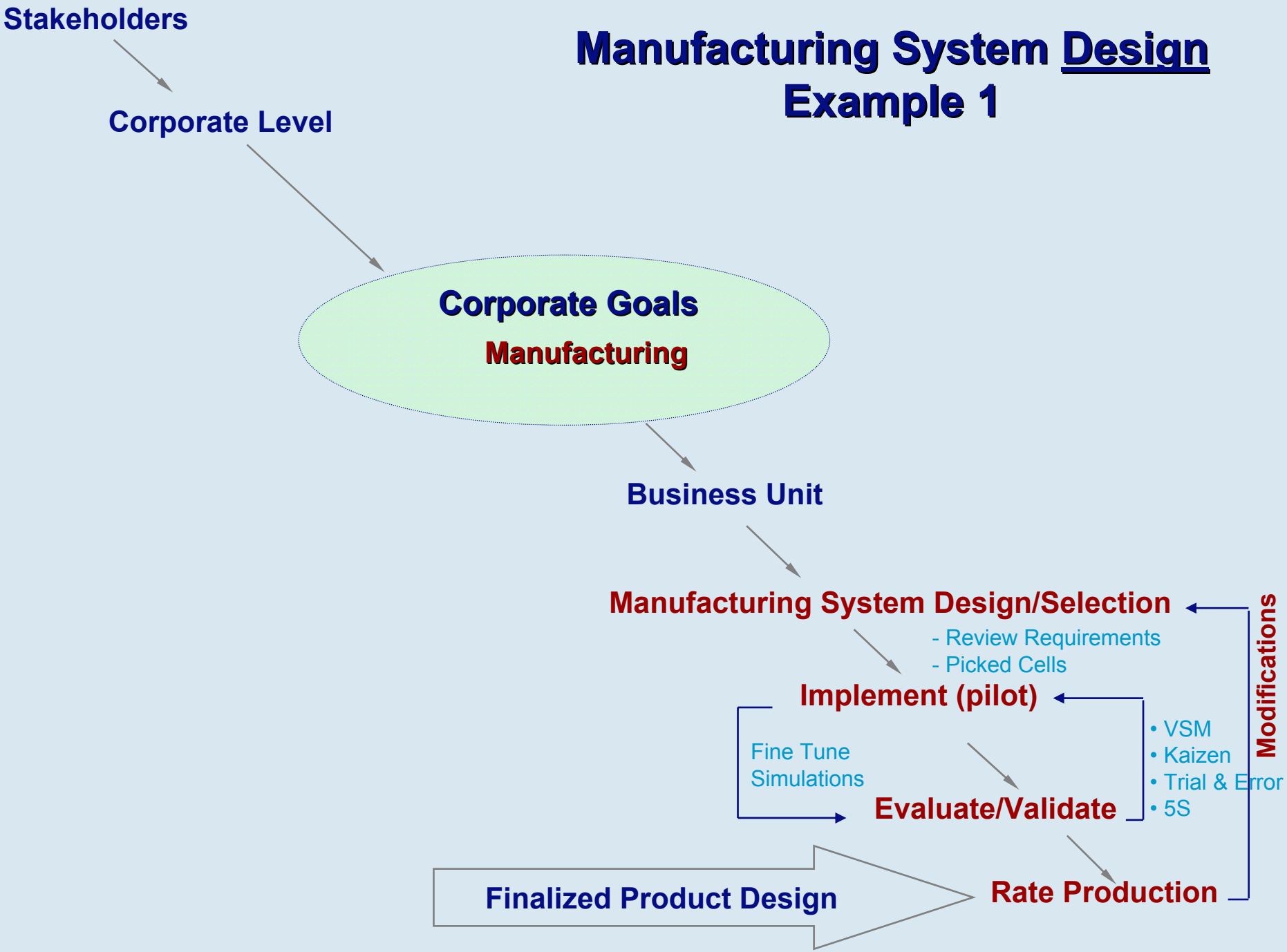
Strategy Presence Results



Scope of Results



Manufacturing System Design
Example 1



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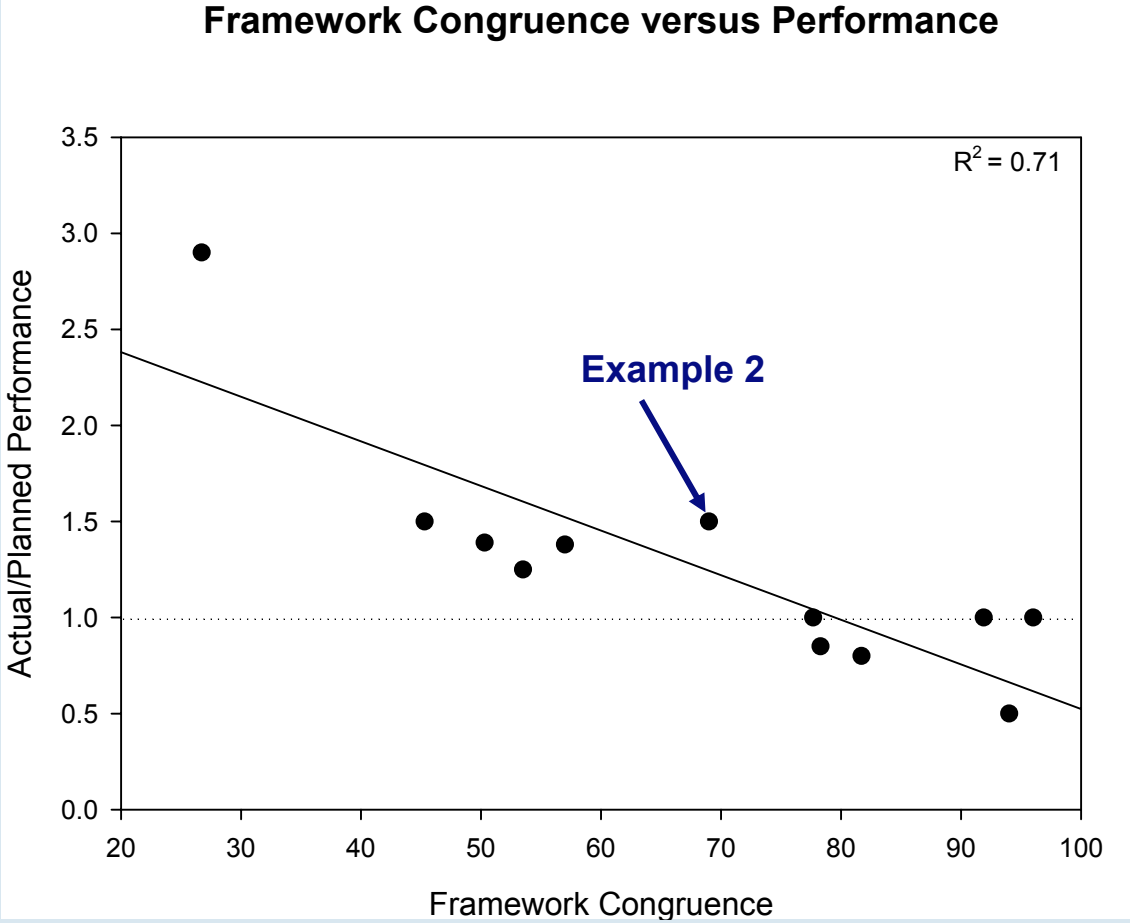
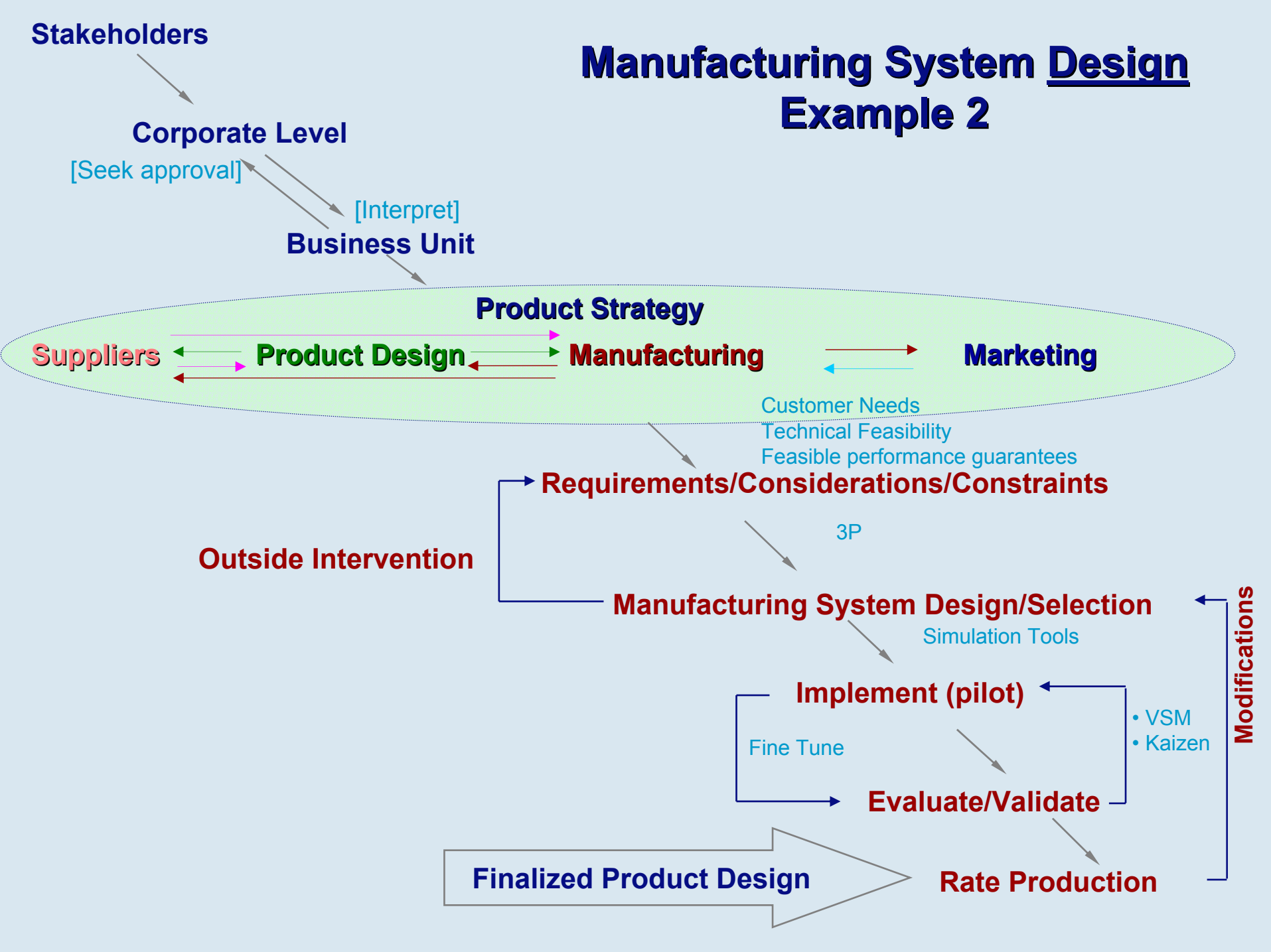
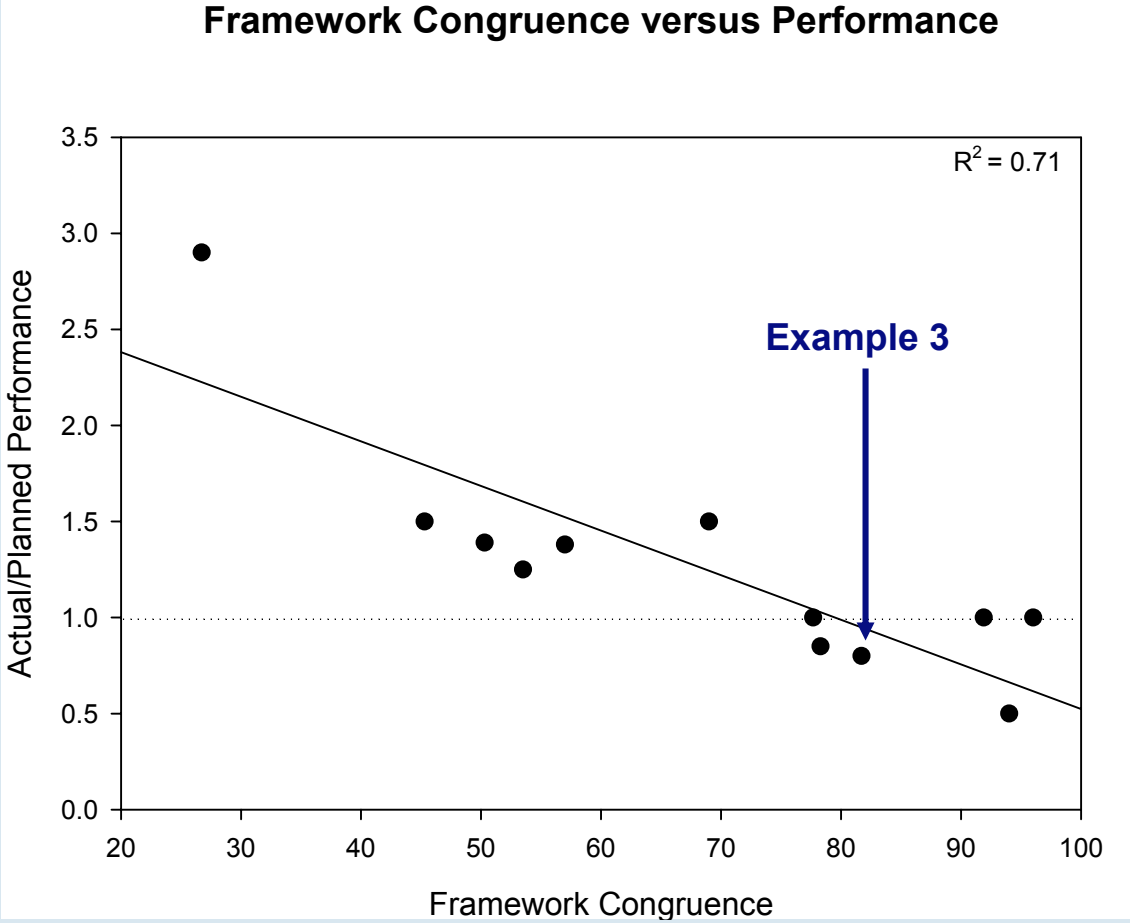


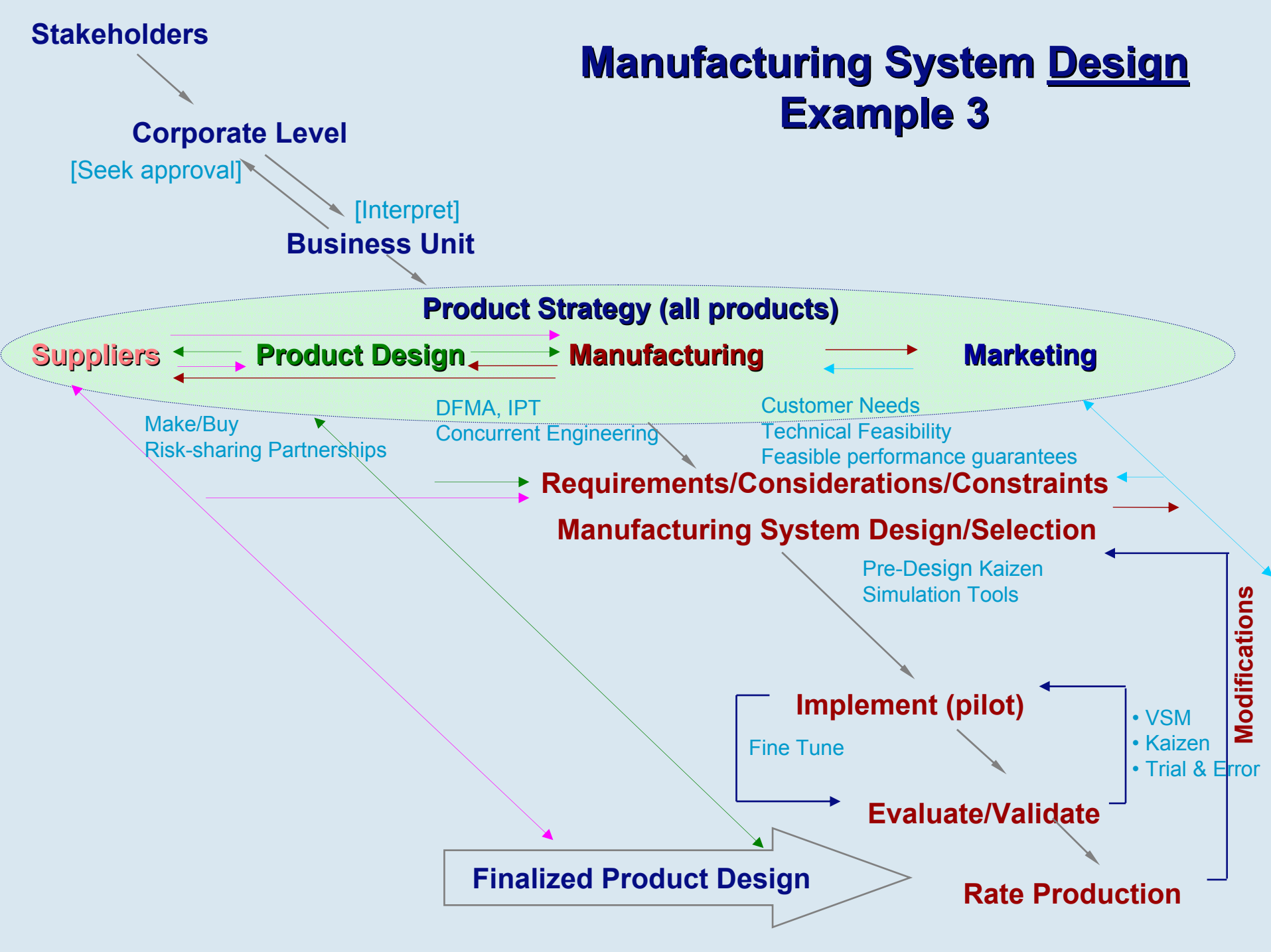
Manufacturing System Design
Example 2



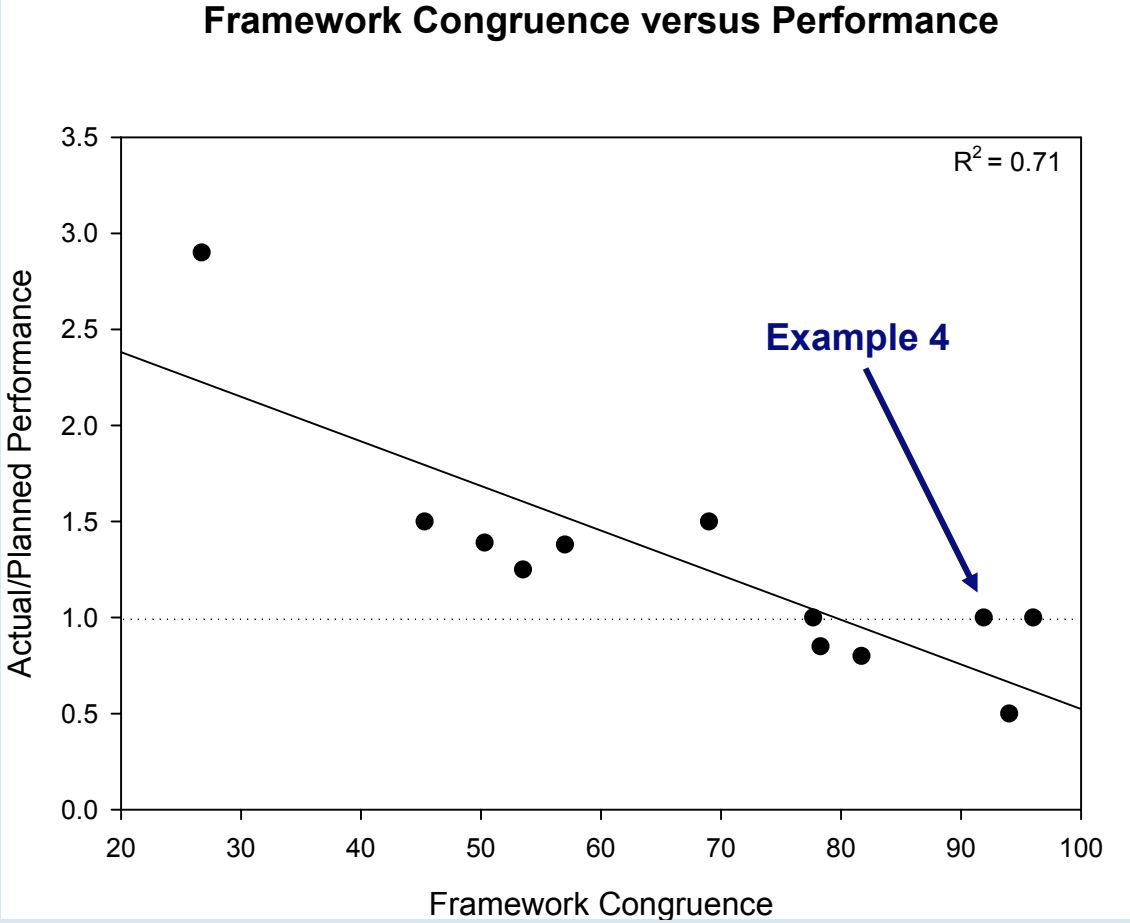
Scope of Results



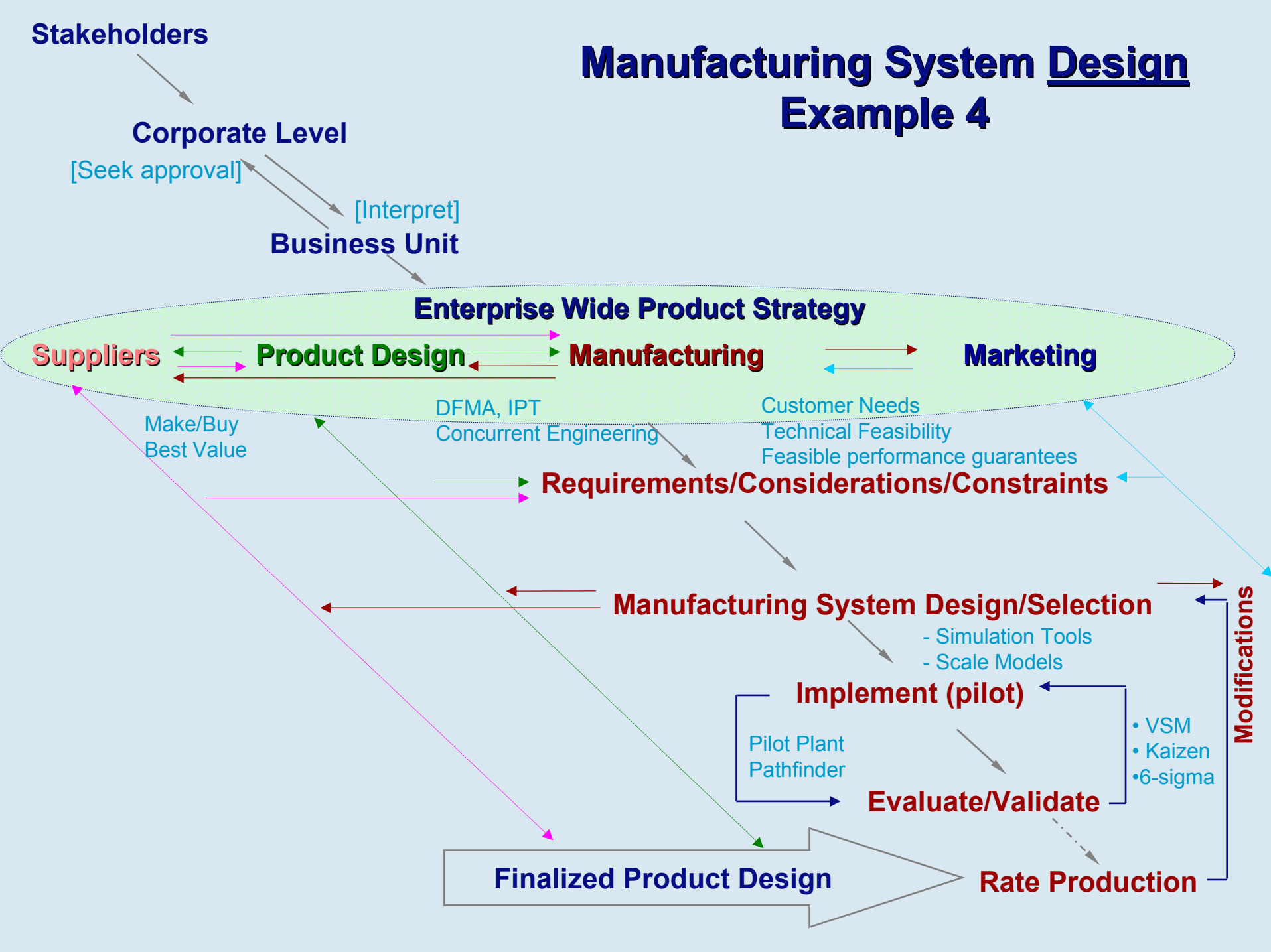
Manufacturing System Design
Example 3



Scope of Results



Manufacturing System Design Example 4



Conclusions

- The role of manufacturing as a source for competitive advantage
- Framework Validation
  - Framework congruence and system performance
- Key Characteristics
  - Breadth
  - Strategy
  - Status

