

***Growing the
Lean Community***
An LAI Plenary Conference

**Lean
Aerospace
Initiative**



Manufacturing System Design:

An Overview

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Research Sponsored By LAI



- **Present a new perspective on the role of manufacturing in the enterprise**
- **Offer a new concept of what it means to take lean beyond the factory floor**
- **Influence thinking on enterprise strategy in a maturing industry**



What is a Manufacturing System?

- **A manufacturing system is NOT just ...**
 - The product, machines, tools, materials or assembly line
 - A factory floor
 - A cell, FMS, composite center or a job shop
 - MRP, ERP, kanban or POLCA
- **A manufacturing system IS all of the above plus ...**
 - Workers
 - Processes
 - Suppliers
 - Management



What is Manufacturing System *Design?*

- Manufacturing system **design** is NOT just ...
 - Factory floor improvements
 - Kaizan activities
 - Changes within the four walls
 - Waste elimination
- Manufacturing system **design** IS the above plus ...
 - A selection of a layout that meets system demands (outputs)
 - Development of an operational policy for decision making
 - Selection of the right process technology
 - Make-Buy decisions
 - Organizational structure design and interaction methods



Product Trends Affecting Manufacturing System Design

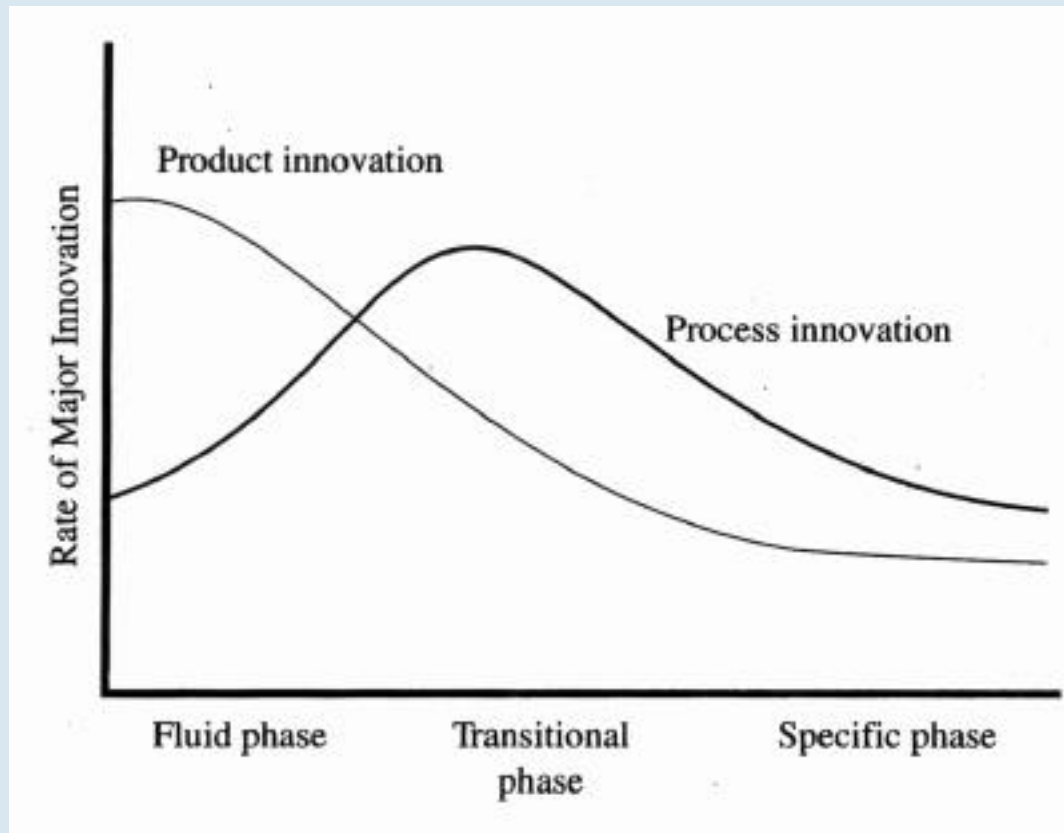
- **Focus on affordability and life cycle support**
- **Diminishing product differentiation between competitors**
- **Reduced advantages in competing with product features or product performance**
- **Basic physical design stable**
- **Cost starting to be more important than performance improvements**

Is the industry approaching a new phase?

Have other industries gone through this?



Model of Product and Process Innovation

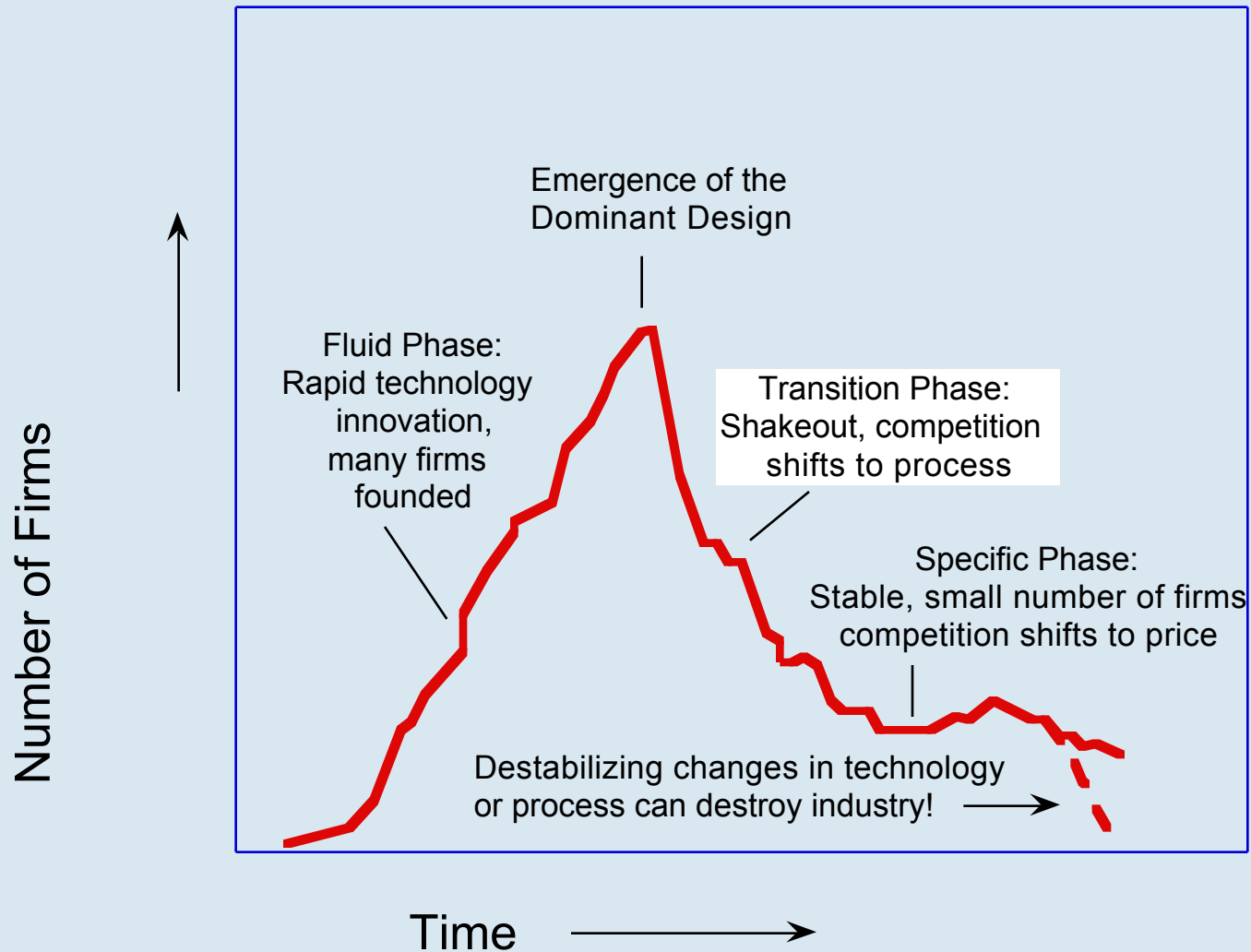


Source: William Abernathy & James Utterback, 1978

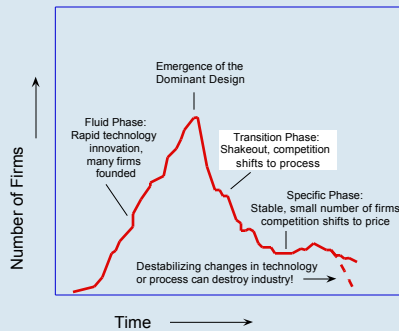
- Rate of product innovation highest during formative years
- As product matures rate of process innovation overcomes product innovation
- Very mature products have low levels of both product & process innovations



Utterback's Dynamics of Innovation Model



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



➤ **Dominant design - that design that wins allegiance of the marketplace and meets all *known* user needs**

- **Dominant designs occur through**
 - **Refinement of product attributes**
 - **Possession of necessary collateral assets**
 - **Government regulations**
 - **Strategic maneuvering**
 - **Communication with users**



Dominant Design and the Aerospace Industry

➤ Dominant designs?

- General aviation yes
- Commercial aircraft design yes
- Commercial aircraft interiors/systems no
- Military fighters flight characteristics yes
- Military fighters of stealth designs no
- Commercial/military engines yes
- Commercial/military space launch vehicles yes
- Commercial/military communication satellites yes
- Military specialty satellites no
- Industry as a whole..... predominantly yes



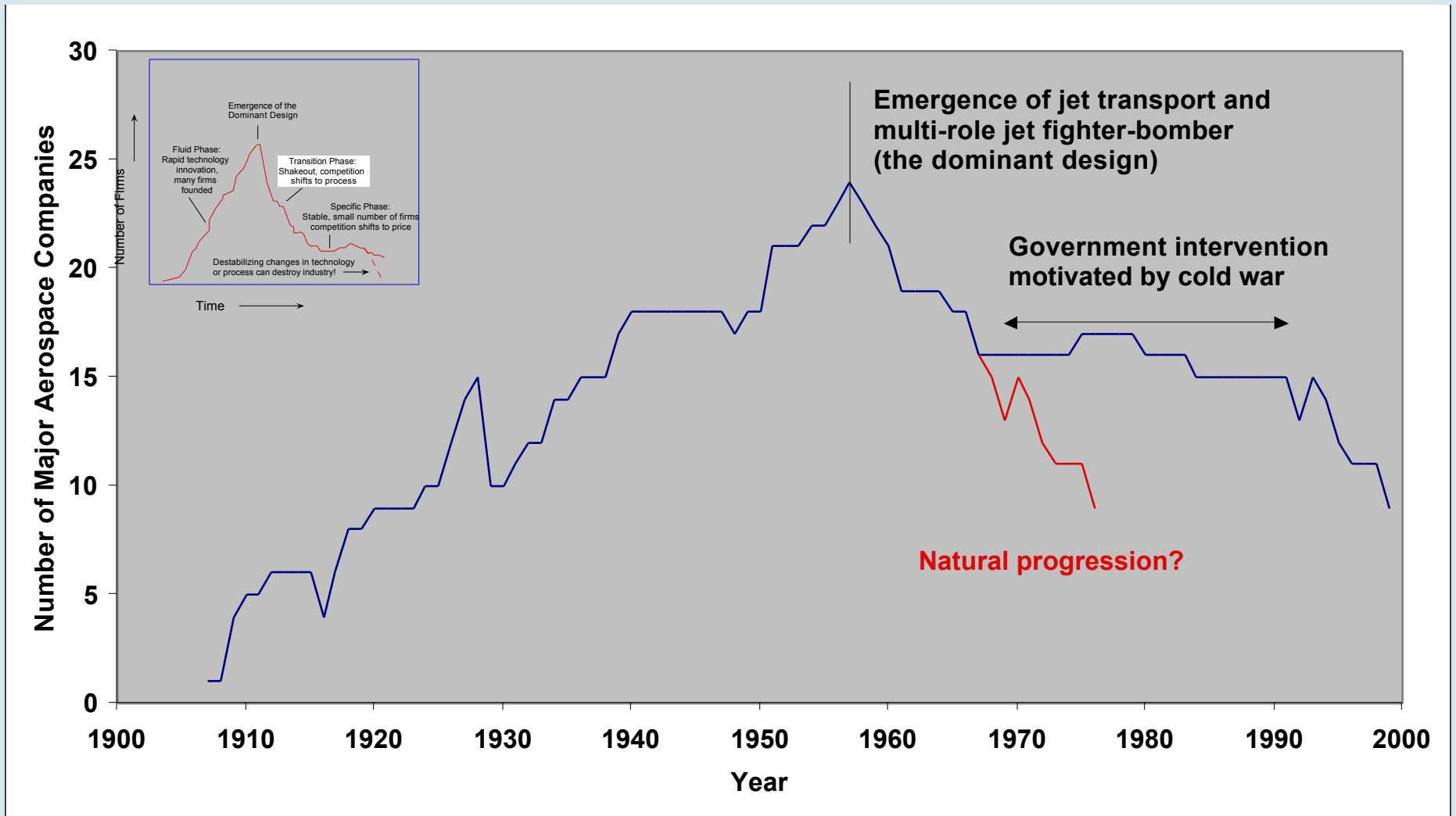
Implications of Post Dominant Design (Transition Phase)

- **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?



Utterback's Model and the Aerospace Industry



Source: Data from Weiss/Amir, 1999; plot and notations adopted by Shields/McManus, 2000

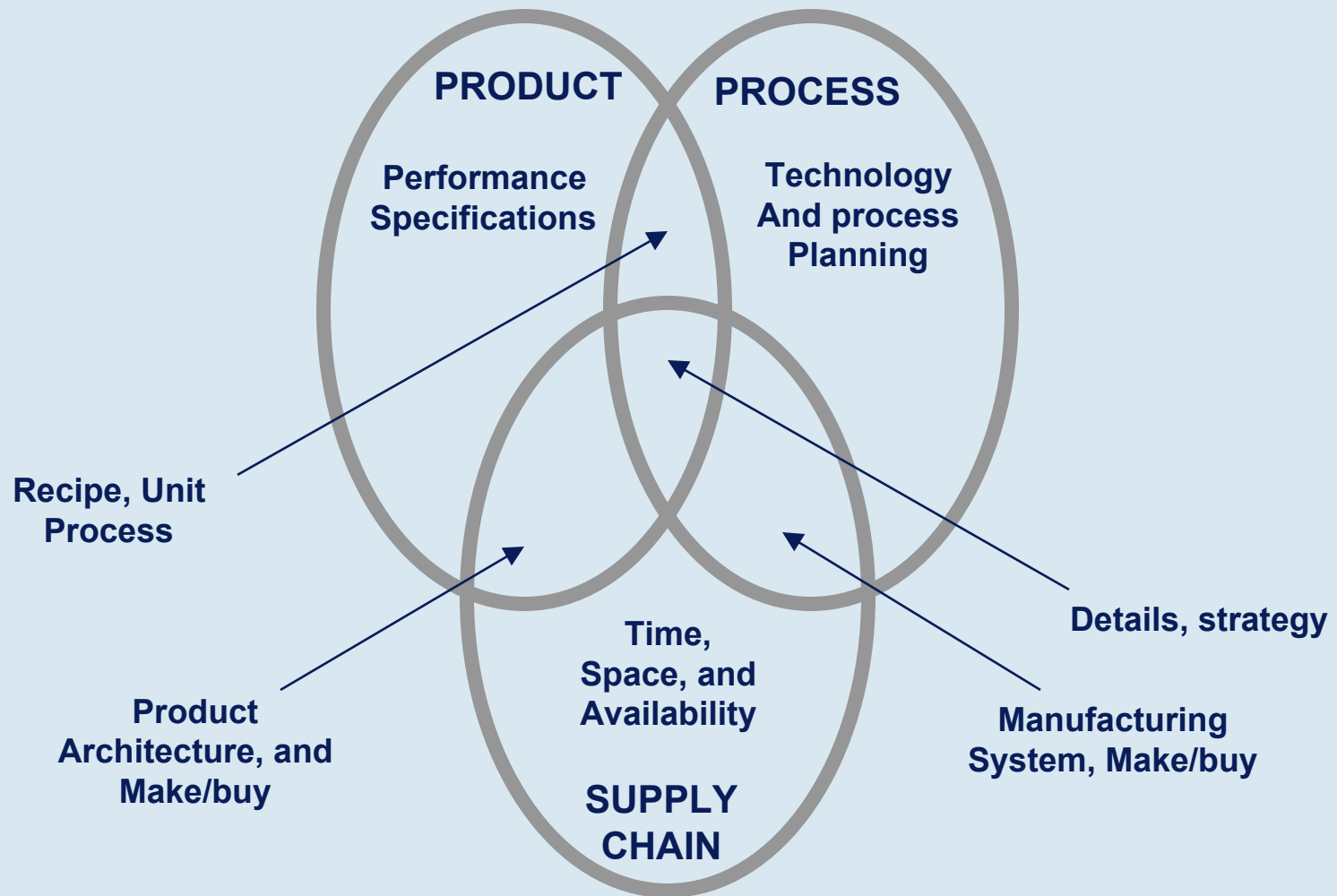


- **Product differentiation no longer wins orders**
- **Product performance enhancements best satisfied by incremental improvements**
- **Acquisition and life cycle costs predominate**
- **Insertion of process technologies has highest leverage**

**Use Manufacturing for Competitive
Advantage**



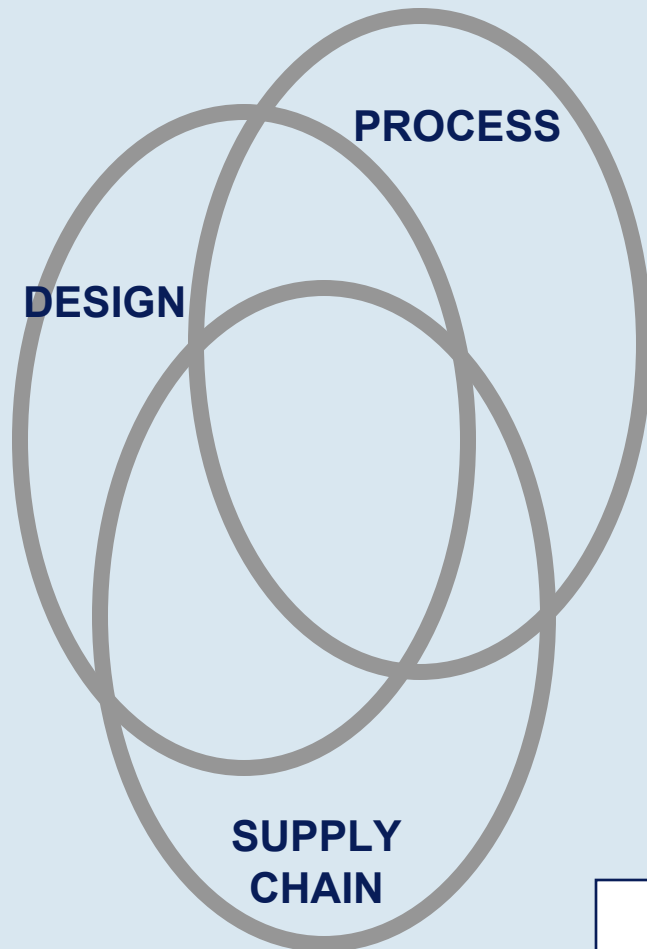
Fine's 3-D Concurrent Engineering Model



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

- Process has more leverage than design on winning orders
- Supply chain integration & sourcing impacts enterprise strategy and product cost more than design

Design must be much more interactive with mfg & suppliers



Is Manufacturing Important?

- **Industrial history lessons would indicate ...**
 - **Process emphasis now has highest leverage**
 - **Customers more interested in life cycle costs**

- **Role of manufacturing in this environment**
 - **Value recognized by product delivery & support**
 - **Other functions must support this value delivery**



- **Design is their bread and butter**
- **Manufacturing is the cost of doing business**
- **Outsource if not a core competency**
- **Manufacturing not viewed as strongest function**



How can Manufacturing be Used for Competitive Advantage?

- **Design is no longer the discriminating factor for competitive success therefore ...**
 - **Design should support manufacturing goals**
 - **Shift social regard from design to manufacturing/industrial engineering**
- **Process technology development yields most benefits**
 - **Continual introduction of new processing capabilities**
 - **Organizational elements to champion process developments**



New Meaning for “Lean Beyond the Factory Floor”

- **Lean beyond the factory floor is NOT just:**
 - Improving the requirements process
 - Improving the product development process
 - Developing long term supplier relationships
- **Lean beyond the factory floor IS the above plus:**
 - Changing emphasis from product to process design
 - Designing to ensure ease of product realization
 - Making suppliers partners in product realization



- **In a maturing industry product cost and life cycle attributes predominate and are best satisfied by process improvements**
- **Lean beyond the factory floor means shifting the enterprise focus to product realization from product design**
- **Enterprise strategy should change to champion a manufacturing and extended supplier partnership competitive strategy**



- **Manufacturing strategy and design tools**
- **Lockheed Martin JSF manufacturing system design**
- **Space vehicle production at TRW**
- **Future research direction**