The Machine That Changed the World

George A. Noyes III
OUTLINE

- Background
- Parallels to the Auto Industry
- Craft Manufacturing
- Mass Production
- Ford’s Contributions
- Sloan’s Innovations
- United Auto Workers
- Line of Technical Efficiency
- Taiichi Ohno
- LEAN vs. Mass Design
- IPT Maturity Model
- Producibility
- LEAN vs. Mass Production
- LEAN vs. Mass Supply
- LEAN vs. Mass Distribution
- Lean Aerospace Initiative
- Next Steps
Line of Technical Efficiency

LOW VOLUME  PRODUCT STRUCTURE  HIGH VOLUME

PROCESS STRUCTURE
- Jumbled Flow (Job Shop)
- Disconnected Line Flow (Batch)
- Connected Line Flow (Assembly)
- Continuous Flow

1. Line of Technical Efficiency
2. Costs
3. Costs
With low volume production you get a high degree of flexibility as you are not using large, complex and expensive machines. You are probably relying more on a craftsman to make the part…but the problem is that while your flexible is low, you cannot produce a lot of the items you need and they are expensive to make.
Line of Technical Efficiency

LOW VOLUME  \[\rightarrow\]  PRODUCT STRUCTURE  \[\rightarrow\]  HIGH VOLUME

PROCESS STRUCTURE

JUMBLED FLOW (JOB SHOP)

DISCONNECTED LINE FLOW (BATCH)

CONNECTED LINE FLOW (ASSEMBLY)

CONTINUOUS FLOW

1. CONTINUOUS FLOW
   - LOW FLEXIBILITY
   - LOW COST
   - HIGH VOLUME

2. DISCONNECTED LINE FLOW (BATCH)
   - LOW FLEXIBILITY
   - LOW COST
   - HIGH VOLUME

3. JUMBLED FLOW (JOB SHOP)
   - LOW FLEXIBILITY
   - LOW COST
   - HIGH VOLUME

With high volume production you get lower cost as you are mass producing the item, but you do that using large expensive machines that require set-up time. Thus you are not very flexible.
With Lean Production you get the best of both worlds. Your costs are low, your flexibility is high and you can produce at any volume efficiently.
BACKGROUND

- 5-YEAR, $5M STUDY
- WORLD-WIDE AUTO INDUSTRY
  - Europe, North America and Asia
  - Very Little Change From the Days of Henry Ford
  - Turned into a study of Toyota’s Production System
  - 20 year journey (continues today)
- 5-M’s (Manpower, Machines, Methods, Material, Measurement)
The U.S. automotive industry had their significant emotional experience over 10 years ago, including:

- Rapidly declining market share
- Overcapacity in capital and labor
- Lengthening design times

They have improved, and their improvement is directly and proportionally traceable to the adoption of “Lean Production Techniques.”

Today the defense industry is facing very similar “significant emotional events.”
CRAFT

- Highly Skilled Workers
- Flexible Machines & Tools
- Quality = Craftsmanship
- Decentralized Organizations (Guild System)
- Low Volume/High Cost
- Great Amount of Variety
- 1-1 Customer Relationships
- Today: Luxury/Image Cars (Aston Martin)
MASS

- Professionals with Narrow Skills
  - Mfg., Tooling, Inspection, Design, etc.
- Semi or Unskilled Workers
  - Variable Cost, Work was Cyclical and Boring
- Expensive, Single Purpose Machines & Tools
  - Intolerant of Disruption
  - Low Flexibility
- Economies of Scale
- Keep Standard Designs a Long Time
  - Low Variety
Centralized Organizations
Reward Individuals
High Volume, Low Cost
Quality = AQL
Interchangeable Parts
- Single Gaging System

Simplicity of Design & Ease of Assembly
- Easy to Maintain
- 1908 Model T (514/minutes cycle time)
- 1913 Model T (2.3/min.)

Moving Assembly Line
- Single Task per Assembler (1.19/min.)

Vertical Integration
- Tolerances & Scheduling

Lots of Support Workers
- Tooling, Quality, Foreman, Expediters, etc.
SLOAN
1920-30’s

- 12 Car Companies
  - Managed Separately
  - High Degree of Product Overlap
- Decentralized
  - 5 Car Companies, One for every pocketbook
- New Breed of Professionals
  - Finance & Marketing
  - Management By-the-Numbers
  - Stovepiped Top-to-Bottom
- Standard Mechanical Parts for all Cars
- Endless Series of Add-On Features
  - Internal Self-Starter, Radio, Heater, Roll-Up Windows, etc.
UNITED AUTO WORKERS
1930’s

- Big “3” Agreement
  - Based on Seniority & Job Rights
  - Attempt to Dampen Impact of Cyclical Layoffs
  - Final Wedge Between Management & Worker
  - Final Stovepiping in Factory Operations
- Mass Production in it’s Final Mature Form
Factories of the Future

- 1900-1970: Mass production used 150 machine tools to create 10-15 products, with 25% or more of the products requiring rework because of poor quality.
- 1971-2000: Flexible production uses 30-50 machine tools to create 100-1,000 products, with 0.02% of the products requiring rework because of poor quality.
- 2001-2020: Mass customization will use only 20-25 machine tools to create an unlimited number of products, with less than 0.0005% or the products requiring rework due to poor quality.

Taiichi Ohno

- Ford’s System Rife with **Muda (Waste)**
  - 20% of Floor Space Dedicated to Rework
  - 25% of Total Hours Involved in Fixing Mistakes
- Only the Assembly Worker “Adds Value” - **Value Stream**
- Workers Given Additional Jobs
  - QC, Housekeeping, Minor Tool Repair, etc.
  - Time Set Aside for Continuous Improvement (Kaizen)
- No Rework
  - Cord to Stop the Line - Five Why’s
  - Poka-Yoke (Foolproofing)
- Group Works in Teams with a Leader
  - Accomplishes Groups of Tasks
  - Leader is also a Worker
Quality Grid
(Phillip Crosby)
LEAN DESIGN ELEMENTS

- Integrated Product/Process Development
  - Multifunctional Teams
  - Well-Defined Development Processes
  - Design for Manufacturing & Assembly
  - Supplier Participation
  - Cycle-Times Reduced
  - Funding Profiles Changes
  - More Designs for the same Development Budget

- Prototypes with Production Processes & Workers
- Production Experienced Design Teams
Project Team Leader Carries Great Power and Prestige (Shusa)
- Assigned for the duration of the Project

Teams are Small Tightly Knit Groups
- Get Report Card from the Team Leader
- Advancement is Through Performance on the Team
- Groups Forced to Confront all Difficult Trade-Offs Early
- Team Starts-Off Large and Gradually Shrinks
MASS DESIGN ELEMENTS

- Classic Design Methodology
  - Throw Over the Wall to Manufacturing
  - No Supplier Participation
  - Design Stays Fixed for a Long Production Run
- Design Requires Extensive Collaboration, but the Process is Fractured
  - Stovepiping Between Divisions and Functions
  - Designers have no Factory Floor Experience
  - Design Keeps Changing, even through Production
- The PM is a Coordinator not a Manager
  - PM given a Budget, but no Home
  - PM Changes Several Times before Production
Teams are Large and Loosely Connected

- Assigned for Limited Period of Time
- May get Report Card from PM, but Future Success is Through Functional Boss
- Groups Avoid Early Decisions, no Process to Force Decisions
- Teams Start-Off Small and Grow as Problems Mount

Products Developed 1st, then the Processes to Make Them

- Product Development Cycle Time is High
- Developing a New Product is Very Expensive
- Funding Profile Does Not Support Teaming
<table>
<thead>
<tr>
<th>IPT Maturity Model</th>
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<tbody>
<tr>
<td>TEAMWORK</td>
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<td>TECHNOLOGIES</td>
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<td>COMMUNICATIONS</td>
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<td>PROJECT FOCUS</td>
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<td>ANALYTICAL</td>
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<td>APPROACH</td>
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<td>DEPLOYMENT</td>
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<td>CREATIVITY</td>
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<td>REINFORCEMENT</td>
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<thead>
<tr>
<th>TIME</th>
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</table>
KOLBE CONCEPT

- Individuals have three mental faculties:
  - Cognitive (intellectual) controls thought
  - Affective (emotional) controls feelings
  - Conative (functional) controls actions
- The conative faculty translates instinct into acts & deeds
- Individuals have four instincts:
  - Instinct to Probe
  - Instinct to Pattern
  - Instinct to Innovate
  - Instinct to Demonstrate
- The Power of the Will propels people to act on their creative instincts
KOLBE BALANCED TEAMS

- Increase team productivity by identifying and harnessing an individual’s natural striving pattern
  - the instinct to Probe deals with detail, complexity and provides the perspective of experience, FACT FINDER Mode
  - the instinct to Pattern deals with structure, order, and provides focus and continuity, FOLLOW THRU Mode
  - the instinct to Innovate deals with originality, risk-taking, and provides intuition & a sense of vision, QUICK START Mode
  - the instinct to Demonstrate deals with physical space and the ability to operate manually, and provides durability and a sense of the tangible, IMPLEMENTOR Mode
- GOAL: Put the right people into the right jobs, balance the team
EC Continuum

- Integration of EDI & Internal Systems
- Electronic Data Interchange
- Technical Data Interchange
- Distributed Collaborative Engineering
- Product/Process Data Driven Manufacturing
- Outsourcing Over The NII
- Virtual Enterprises
- Network Enabled Business Practices
Analytical Approach

- LEAN (Uses tools to help solve problems)
  - Fix the Problem
  - 7 Quality Tools
  - Cause & Effect Diagrams
  - Structured Brainstorming
  - 5 Whys
  - 7 Management Tools
  - QFD, DOE, SPC
  - Key Characteristics
  - Real Integration

- MASS (Limited tool use)
  - Fix the Blame
  - SPC used by QA only
Key Characteristics

- Features or characteristics whose variability has the greatest impact on fit, performance, or service life
  - Key characteristics provide a focus for product improvement
  - Quality if conformance to nominal on all key characteristics
  - Quality improvement comes from reducing variation by:
    -- Eliminating special causes
    -- Improving consistency of measurement systems
    -- Controlling the product by controlling the processes
    -- Reducing losses and eliminating waste

- But - How do you identify the features that are the most vital?
Transformation Methodology
From Customer Requirements to Material & Manufacturing Processes

Customer Requirement
- Support the SIOP
  (Be on time is a Key Reqmt)

Subsystem Requirement
- Clock
  Keys = Readability & Accuracy
- Power Supply
- Display Assembly
  Voltage is Key
  - Photo Diode
  - LCD
  - Panel Lamp

Manufacturing Requirements
- Hardware Requirements
  - MIL-SPEC Diode
  - Good Solder Joints
- Process Requirements
  - MIL-STD 2000
  - Wave Solder Machine
- Verification Requirements
  - DOE to Identify Key Characteristics
  - SPC to control key process factors
Quality Function Deployment
“The Start of Lean Thinking”
## Maturity Models (Deployment)

<table>
<thead>
<tr>
<th>SCORE</th>
<th>APPROACH/DEPLOYMENT</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failed</td>
<td>Failed to meet SOW requirements</td>
<td>Major shortcomings in execution or understanding</td>
</tr>
<tr>
<td></td>
<td>Early systematic approach evident to meeting the requirements</td>
<td>No results or poor results in most areas</td>
</tr>
<tr>
<td></td>
<td>Major shortcomings in understanding the requirements</td>
<td>In the early stages of developing trends</td>
</tr>
<tr>
<td></td>
<td>Early stages of transition from reacting to problems to problem prevention</td>
<td>Some improvements in or good performance in a few areas results are not reported for most areas of importance or for key requirements</td>
</tr>
<tr>
<td>Meets Standard</td>
<td>Improvements required in some areas</td>
<td>Good performance or improvement trends in many areas</td>
</tr>
<tr>
<td></td>
<td>Good performance or improvement trends in many areas</td>
<td>There is no pattern of adverse trends or poor performance</td>
</tr>
<tr>
<td></td>
<td>Some trends or performance levels are benchmarked and show they are areas of strength</td>
<td></td>
</tr>
<tr>
<td>Exceeds Standard</td>
<td>Exceeds the requirements in most areas</td>
<td>Clearly above the standard</td>
</tr>
<tr>
<td></td>
<td>A sound &amp; systematic approach to most purposes</td>
<td>Current performance is good to excellent in most areas</td>
</tr>
<tr>
<td></td>
<td>Fact-based improvement is a key management tool</td>
<td>Sustained performance levels in some areas</td>
</tr>
<tr>
<td></td>
<td>Clear evidence of the use of improvement cycles &amp; analysis</td>
<td>Most trends or performance levels are benchmarked and show areas of leadership</td>
</tr>
<tr>
<td></td>
<td>Approach is well deployed in most areas</td>
<td></td>
</tr>
<tr>
<td>Best of Breed</td>
<td>Best of the Breed in some areas</td>
<td>Clearly above the standard in most areas</td>
</tr>
<tr>
<td></td>
<td>A sound &amp; systematic approach to all requirements</td>
<td>Best throughout the ECRC system</td>
</tr>
<tr>
<td></td>
<td>Very strong fact-based improvement process with excellent analysis</td>
<td>Current performance is excellent in most areas</td>
</tr>
<tr>
<td></td>
<td>Approach is fully deployed with no (even minor) gaps</td>
<td>Excellent improvement trends or sustained excellence in most areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strong evidence of benchmark leadership in most areas</td>
</tr>
</tbody>
</table>
PRODUCIBILITY

A design accomplishment resulting from a coordinated effort by all engineering functions to create a functional hardware design that optimizes ease and economy of fabrication, assembly, inspection, test, and acceptance without sacrificing desired function, performance, or quality.
PRODUCIBILITY
(Continued)

- **MAXIMIZE**
  - Modularity
  - Use of Standard Components
  - Design of Parts for Multi-use
  - Design for Ease of Assembly
  - Design for Ease of Fabrication

- **MINIMIZE**
  - Total Number of Parts
  - Use of Separate Fasteners
  - Need for Assembly Directions
  - Handling (Time and Distance)
<table>
<thead>
<tr>
<th>MANAGEMENT</th>
<th>EMD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FUNDING</strong></td>
<td><strong>DESIGN</strong></td>
</tr>
<tr>
<td>.9 FUNDING MATCHES PROJECTED BUDGET</td>
<td>.9 EXISTING/SIMPLE DESIGN</td>
</tr>
<tr>
<td>.7 FUNDING ADEQUATE, DOES NOT EXCEED 5% OVER</td>
<td>.7 MINOR REDESIGN OR INCREASE IN COMPLEXITY</td>
</tr>
<tr>
<td>.5 FUNDING MINIMAL, OVERRUNS OF 15% LIKELY</td>
<td>.5 MAJOR REDESIGN OR MODERATE INCREASE</td>
</tr>
<tr>
<td>.3 FUNDING SKETCHY, HIGH OVERRUNS LIKELY</td>
<td>.3 COMPLEX REDESIGN OR MAJOR INCREASE</td>
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<tr>
<td>.1 FUNDING IS TOTALLY INADEQUATE</td>
<td>.1 STATE OF THE ART RESEARCH REQUIRED</td>
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<tr>
<td><strong>PRODUCIBILITY</strong></td>
<td></td>
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<tr>
<td>.9 PRODUCIBILITY ASSESSMENT DONE BEFORE AWARD</td>
<td>.9 PROVEN PROCESSES &amp; TECHNOLOGIES</td>
</tr>
<tr>
<td>.7 PRODUCIBILITY IMPLEMENTED AFTER PDR</td>
<td>.7 PREVIOUS EXPERIENCE WITH PROCESSES</td>
</tr>
<tr>
<td>.5 PRODUCIBILITY IMPLEMENTED AFTER CDR</td>
<td>.5 PROCESS EXPERIENCE IS AVAILABLE</td>
</tr>
<tr>
<td>.3 PRODUCIBILITY IMPLEMENTED AFTER EMD</td>
<td>.3 PROCESS AVAILABLE BUT NOT PROVEN</td>
</tr>
<tr>
<td>.1 PRODUCIBILITY NOT CONSIDERED</td>
<td>.1 NO EXPERIENCE, PROCESS NEEDS R&amp;D</td>
</tr>
<tr>
<td><strong>RISK ASSESSMENT</strong></td>
<td></td>
</tr>
<tr>
<td>.9 RISK IS MANAGEABLE/PREDICTABLE - PLAN IS IN PLACE</td>
<td>.9 READILY AVAILABLE</td>
</tr>
<tr>
<td>.7 RISK IS LOW</td>
<td>.7 1-3 MONTH LEAD TIMES</td>
</tr>
<tr>
<td>.5 RISK IS MEDIUM</td>
<td>.5 3-9 MONTH LEAD TIMES</td>
</tr>
<tr>
<td>.3 RISK IS HIGH</td>
<td>.3 9-18 MONTH LEAD TIMES</td>
</tr>
<tr>
<td>.1 NO RISK PLAN OR POLICY CONSIDERED</td>
<td>.1 18- MONTH LEAD TIMES OR NEEDS R&amp;D</td>
</tr>
<tr>
<td><strong>DATA REQUIREMENTS</strong></td>
<td><strong>DESIGN TO COST</strong></td>
</tr>
<tr>
<td>.9 ALL SPECs/CDRLs ARE ON CONTRACT</td>
<td>.9 BUDGET NOT EXCEEDED</td>
</tr>
<tr>
<td>.7 TAILORING OF ALL SPECs/CDRLs IS ACCOMPLISHED</td>
<td>.7 EXCEEDS BUDGET BY LESS THAN 5%</td>
</tr>
<tr>
<td>.5 ALL SPEC/CDRL COST DRIVERS IDENTIFIED</td>
<td>.5 EXCEEDS BUDGET BY 5-20%</td>
</tr>
<tr>
<td>.3 A FEW SPEC/CDRL COST DRIVERS IDENTIFIED</td>
<td>.3 EXCEEDS BUDGET BY 20-50%</td>
</tr>
<tr>
<td>.1 NONE IDENTIFIED</td>
<td>.1 EXCEEDS BUDGET BY MORE THAN 50%</td>
</tr>
</tbody>
</table>
A part is a candidate for redesign if you can answer no to the following three questions:

- During operation, does this part move relative to the part to which it is attached?
- Does this part need to be made of a different material than the part to which it is attached?
- Does this part need to be removable?

* Source: Boothroyd & Doohurst
Producers Rank Other Producers
“Manufacturability of Products in Assembly Plant”

<table>
<thead>
<tr>
<th>Producer</th>
<th>Rank</th>
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<tbody>
<tr>
<td>Toyota</td>
<td>2.2</td>
</tr>
<tr>
<td>Honda</td>
<td>3.9</td>
</tr>
<tr>
<td>Mazda</td>
<td>4.8</td>
</tr>
<tr>
<td>Fiat</td>
<td>5.3</td>
</tr>
<tr>
<td>Nissan</td>
<td>5.4</td>
</tr>
<tr>
<td>Ford</td>
<td>5.6</td>
</tr>
<tr>
<td>Volkswagen</td>
<td>6.4</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>6.6</td>
</tr>
<tr>
<td>Suzuki</td>
<td>8.7</td>
</tr>
<tr>
<td>General Motors</td>
<td>10.2</td>
</tr>
<tr>
<td>Chrysler</td>
<td>13.5</td>
</tr>
<tr>
<td>Jaguar</td>
<td>18.6</td>
</tr>
</tbody>
</table>

SOURCE: 1990 IMVP MANUFACTURABILITY SURVEY
QFD helps to identify what is important
Taguchi, FTA/RFTA and FMEA are used to make the continuous improvements (breakthroughs)
SPC is used to hold the gains and monitor the process
FTA = Fault Tree Analysis
RFTA = Reverse Fault Tree Analysis
FMEA = Failure Mode and Effect Analysis
TAGUCHI
LEAN PRODUCTION

- Transfers Maximum Number of Tasks and Responsibilities to the Worker
- Only Workers Add Value
  - Indirect Specialists Go Away or Reduce in Numbers
- Develops and Advanced Quality System
  - Root Cause Corrective Action (5-Whys)
- Workers have Multiple Stills
  - Invest Heavily in Training (TI, Motorola)
- Use Highly Flexible Machines
- Produce a Great Variety of Products
MASS PRODUCTION

Work Arranged for the Worker
- Only a Few Well Defined Tasks, Requiring Little Training
- Work Brought to the Worker
- Relentlessly Disciplined by the Pace of the Line

Many Indirect Specialists
- Industrial & Mfg. Eng., QA, Housekeeping, Tooling, etc.

Equipment
- Very Accurate, Specialized & Expensive
- Designed for High Volume (Set-Up Times Minimized)

Limited Number of Products (High Volume)

Buffers Between Production Steps
- Excess Capacity, Excess People, and Large WIPs
Inventory is the Root of All Evil

(Ohno and Goldratt)

The action you are proposing:
- Will it increase throughput?
- Will it decrease inventory?
- Will it decrease operating expenses?

(Where is Muda in all this?)

Conventional cost accounting systems make machine & employee utilization a key performance measure and treat inventory as an asset!
Making Product does not equal Making Money

People Working does not equal Making Money

Manufacturing Goals (Simultaneously):

- Throughput (Sales)
- Inventory & WIP
- Operating Expense
- Net Profit
- ROI
- Cash Flow
Theory of Constraints
(Bottlenecks Pace the Plant)

- The output of upstream operations control the output of downstream operations
- Cycle times of all work centers vary - this variability spreads throughout all downstream operations
- The maximum deviation of a preceding operation will become the starting point of the next operation, therefore:
  - Work centers with excess capacity cannot work on parts they cannot get
  - Bottlenecks cannot work on additional parts when they are at 100% capacity
  - Fluctuations in bottleneck operations only make things worse
Theory of Constraints (Continued)

- Sum of the Local Optimums ≠ Global Optimum
  - Balance Flow not Capacity
  - Bottlenecks Govern Both Throughput & Inventory
  - An Hour Lost at a Bottleneck is an Hour Lost for the Entire System
  - An Hour Saved at a non-Bottleneck is a Mirage
    (The potential of a non-bottleneck is not determined by itself but by the bottleneck)
  - If You Don’t Need a Part Don’t Make It
    - It is OK to let a non-bottleneck sit idle
    - It’s Never OK to let Bottlenecks sit idle
Drum - Buffer - Rope

- Drum: Paces the Plant (Bottleneck)
  (Takt Time)
- Buffer: Inventory to Protect the Bottleneck
  (ensures there are no work stoppages)
- Rope: Ties Everything Together: material
  releases and assembly schedules (Kanban)
  (reflects the bottleneck constraints)
Theory of Constraints (The Process)

- Identify the bottlenecks (capacity constraints)
- Protect the bottlenecks
- Use non-bottlenecks only to keep pace with bottleneck flows
- Only improve capacity & variability at existing bottlenecks & capacity constrained resources

Reduce:
- Set-up Times
- Cycle Times & its Variability
- Vendor Variability (Quality, Quantity & Times)
LEAN SUPPLY CHAIN

- Designing the Parts:
  - Fewer Suppliers
  - Suppliers Selected on Basis of Past Relationships
  - Suppliers Design and Build Entire Components
  - Suppliers Work with Assemblers Early in the PD Cycle
  - Assemblers Work with Suppliers and Provide Help
  - There is a Framework and Process for Exchanging Information
Supplying the Parts:

- System for Establishing Price & Cost (Market Price Minus vs. Supplier Cost Plus)
- Continually Reduce Cost while Improving Quality
- Quality: Work with the Suppliers
- Share Proprietary Information
- Heijunka - Production Smoothing (Assembler & Supplier)
- Daily (52%) and Hourly (31%) Deliveries
- Use of VE and Kaizen
Designing the Parts:

- Design Process is Sequential, One-Step at a Time
- Suppliers Given Drawings and Asked for Bids
- Given Quality Targets and Delivery Schedule
- Contract Key Elements (Price, Quality, Reliability, and Contract Length)
- Supplier Buys-In and Makes Up on the Next Contract
- Suppliers Have No Contract with One Another
Supplying the Parts:
- Purchasing Worries About Cost not Production
- Many Suppliers
- Debugging Process After Production (Running Changes)
- Often Don’t Meet Quality Targets (Ignore or Cancel)
- Fluctuating Markets (Keep Buffers)
- Cost Estimating Difficult
- Effort to Keep Supplier Profits Low
  - Cost Continue to Rise
LEAN DISTRIBUTION

- Distribution Channels for Specific Models
- Established Link Between Customer and Assembler
- Use of Fully Trained Teams
  - Sell Door-to-Door
  - Daily Meetings to Solve Problems and Improve
- Custom Orders with Delivery within 10 Days
  - Very Accurate Build Schedule
  - Closer Handle on Trends with Flexibility to Change
- Production Smoothing
  - Done by Aggressive Selling
- Success: Market Share
  - Don’t Ever Loose a Customer
MASS DISTRIBUTION

- Geared to the Needs of Production
  - The Customer Comes Last
- Established Barriers Between Customer, Dealer and Assembler
  - Little Feedback on Design from the Customer
- Dealer Used to Buffer Production
  - Large Inventories and Inventory Cost
  - Models Customers do not Want
  - Goal: Outwit the Customer
- Salespeople Have Limited Focus
  - They Don’t Know Cars, Just Know How to Close a Deal
- Success = Number of Sales per Month per Salesman
LEAN AIRCRAFT INITIATIVE

- 3-Year Research at MIT Based on “The Machine That Changed The World”
- Uses Lean Production Principles as a Starting Point
- Aimed at Substantial Improvements in Industrial Performance
- Sponsored by 21 Companies and ASC
- All Aircraft Industry Sectors (Airframe, Engine, Avionics and Equipment)
STRUCTURE and PROCESS

EXECUTIVE BOARD

WORKING GROUP

A
B
C
D
E

Focus Group

Service Acquisition Execs, ASC/CC, WL/MT, DARPA
18 Industry Executives
2 Union Officials

Development Process
Factory Operations
Supplier relations
Human Resources
Policy and External Environment

Workshops
Research Projects
Research Teams
Research Reports

TIME
LEAN THINKING

“Value Stream”

- Value is defined by the Customer
  - Start with the Customer’s Key Characteristics
- Value is created by the Producer
  - Often hears “the Voice of the Engineer” not the customer
- Value Stream: the set of all actions required to bring a product through three critical management tasks:
  - Problem Solving:
  - Information Management:
  - Physical Transformation:
LEAN THINKING
(Five Principles)

- Organizations accurately specify value
- The entire value stream is identified
- Make value creating steps flow continuously
- Let customers pull value from the enterprise
- Perfection…becomes possible

(Hoshin Planning)
# Hoshin Planning Tools

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<th>STEPS</th>
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NEXT STEPS