Lecture 14: Manufacturing Strategies

Outline

- Review Case
- Strategy
- Delayed differentiation
- Logistics
- Lean
  - Design for Lean
ITT Case

• Metrics
• Decisions
• Methods
• Resource Allocation
• Risk/Uncertainty
• Tradeoffs

Metrics

• Product
  – Features
  – Product life
  – Weight
  – Size
• Cost
  – Unit cost
  – Margins

• Production
  – Volume
  – Ramp time
  – Product variety
  – Flexibility
    • $ to change over
    • t to change over
Methods

• Copy exactly
• Simultaneous engineering
• DFM
• Architecture
  – Integrated
  – Modular
• DFA
  – remove screws
• Automated equipment
  – robotic assembly
  – routing
  – inspection

Risk/Uncertainty

• Next generation is different (can’t share equipment)
• Customer wants more variety
• Does automation increase or decrease quality
• Product life cycle (does it justify equipment)
• Lower margins
• Ramp critical but bringing up complex equipment time consuming
• Engineering changes
• Quality
Tradeoffs/Decision

• DFA required more precise parts
• Variety vs. customer needs
• Copy exactly vs. not
• Automatic vs. people

Fully Automated
• Higher quality
• Lower wages
• Produce prototypes on production equipment
• Global sourcing
• Better control
• Reusable
• More efficient

Mixed
• Have to have people inspect
• Our parts aren’t as good of a quality
• Wages aren’t an issue
• Customers want a dedicated line
• Can’t improve the process
• The product will change too much
• More flexible
Questions

• How did the architecture help, hurt, impact manufacturing strategy
• Does automation always mean high quality
• Where should flexibility come from
• What questions would you ask
• What information would you want to make the decision

Strategy
What are companies trying to achieve

- Low-cost manufacture
  - low inventory
  - fast throughput
- Flexibility/Reusability
- Product mix at low cost
  - simultaneous variety
  - upgrades
- Minimize complexity

Strategy selection

- Strategy selection
  - flexible/dedicated?
  - automated/manual?
  - batch/single piece flow?
Metrics

- **Flexibility** - how fast can a system respond to change
  - short-term response
    - engineering change
    - process changes
    - machine unavailability
    - cutting tool failure
    - mix change
  - long-term response
    - new product

- **Productivity** - time and resources required to build a single product
  - labor
  - inventory
  - machine time

Why Flexibility?

- **Why not?**
  - It is expensive
  - It is risky
  - It is hard to control

- **Why?**
  - Have to do it to be competitive
  - Product cycles are too short to depend on dedicated lines

75% of all parts are in batches of 50 or less
**Flexibility as a real option**

- Paying extra now to potentially reduce costs later
- Metrics
  - Extra cost now
  - Possiblity of being wrong about later needs
  - Cost of rebuilding dedicated machinery

**Why Dedicated Systems?**

- Why not?
  - Not reusable
  - Not easily changed
- Why?
  - Fast
  - Don’t have to sub-optimize system for a given product
Why Automation?

- Why not?
  - Expensive
  - Hard to control
  - Risk that you can’t use it on the next generation
  - Not able to respond to design changes
- Why?
  - Higher productivity
  - Lower labor
  - Higher quality (?)

Cellular mfg. Vs. Batch

- Batch
  - Process oriented
  - Long set ups/volume independent process
- Advantages
  - Process efficiency
  - Quality control on single step
- Disadvantages
  - System inventory
  - Picking up and putting down parts a lot
  - Errors are caught later when it is hard to fix (i.e. disruption)
  - In process inventory
- Cellular
  - Everything happens in one location
  - Product focused
  - Single part flow
- Advantages
  - People are flexible -- many steps
  - Lower in process inventory
  - Errors are caught by the person who created them
- Disadvantages
  - Process inefficiencies
  - Higher skill worker
### Two decision factors

<table>
<thead>
<tr>
<th>Flexible</th>
<th>Dedicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated</td>
<td>NC Machine Cells</td>
</tr>
<tr>
<td>Manual</td>
<td>Job shop/ skunk works</td>
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</tbody>
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**Job Shop**
- Disconnected Line
- Assembly Line
- Continuous Flow

**Flexibility**
- Oil Refinery
- Automotive
- Commercial Printers
- Connection Rods

**Production Capacity**
- High volume - high standardization, commodity products
- Few major products - high volume
- Multiple product - low standardization
- Low Volume - low standardization (one of a kind)

Decision variables

- functional requirements
- volumes
- complexity
- cycle time
- labor costs
- quality requirements (repeatable vs. quality)
- product life
- design stability

Lean
Where did Lean come from?

- History
  - International Motor Vehicle Program took on the task of benchmarking Japanese, US, and European automotive industries
  - The output of the IMVP was *The Machine That Changed the World*
  - Womack, Jones, and Roos attributed the success of Japan’s (and specifically Toyota’s) automotive industry to Lean production

What does Lean try to avoid

- Hidden waste
  - Moving goods without any purpose
  - Excess processing
- Faux Just-in-time delivery
  - Large stocks being transferred to the suppliers
- Excess labor content
- Complex MRP planning with expediters
- Low quality
What are the tools of Lean?

- Just-in-time inventory, pull system, Kanban systems
- Flexible work force
- Work cells
- Close supplier relations
- Lack of Muda
- Rapid product development
- Continual improvement
- Poka-Yoke
- Total Productive Maintenance
- Reduced set up times

5 attributes of Lean

- Flow
  - Inventory does not sit around
  - No batches or queues
- Pull
  - The upstream customer pulls the product, design, part, information rather than it being generated to fulfil a predicted need.
- Value
  - Understand the steps in the process that create the value (or add waste)
  - Everything that is done should add value
  - Type I Muda - waste that is designed in
  - Type II Muda - waste that can be removed without changing the system
What are barriers to Lean?

- Consolidation of units
  - Shipping
  - Paint
- Expensive Changeover
- Uncertainty about customer desires
  - Inventory
  - Excess variety
- Large processing centers
  - Steel mills
- Facilities not co-located

Improvement steps to Lean in production

- Minimize in-process inventory
- Change from batch to single piece flow
- Reduce set-ups
- Train workers to perform multiple tasks
- Minimize scrap/rework/repair
- Improve transparency of the supply chain
- Remove out-of-sequence work
- Miniaturize machines (net capacity/cost is higher)
- Reduce chance of errors
  - Poka-yoke
  - Visual checks
Lean Design Process

- Cross-functional teams increases worker flexibility
- Tasks should all contribute to the delivery of the product
  - No unnecessary steps
  - Minimal paperwork
- Tasks should be done just-in-time
- Changes made immediately, not aggregated
- Transparency in the product development flow
- Eliminate rework
- Increase sharing between products (minimal redesign)

Lean Design

- How do you
  - design to reduce inventory?
  - design to reduce waste?
  - increase worker flexibility
  - enable working in cell
Logistics

• Traditional
  – Movement of goods and materials from point to point along the supply chain
  – Aggregated information about customer needs and long-term forecasts drive production cycle
  – Use buffers and inventory to reduce uncertainty

• New Logistics
  – Continuous delivery of small batches of parts precisely as they are needed
  – Information organizers
  – Responsive to changes in customer demands
  – Automatically route the right material to the right person at the right time
  – Use good information and rapid transport to reduce uncertainty
Methods to improve logistics

- Incremental changes
  - Improve communication
  - Improve visibility
    - Extended enterprise models (I2)
- Fundamental changes
  - Levis
  - Dell

Why visibility into delivery times?

- Want to be ready when delivery comes in.
- Easier to develop contingency plans
Delayed Differentiation

Assembly Sequence
Benefits of Late Differentiation

- Easier to control
- Faster reaction to customer requirement
- Lower inventory costs
- Fewer interfaces
Lecture 15: Make Buy Decisions, Supplier Relations

• Reading
  – J. P. Womack, D. T. Jones, and D. Roos, The Machine that Changed the World "Chapter 6: Coordinating the Supply Chain"

• Questions
  – What are the different supplier relationships?
  – How are supplier relationships dependent on the product architecture?
  – Why are companies still struggling with implementing "best practices"?