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

IPPD 4/6/00 Mfg. strategy

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

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Risk/Uncertainty

IPPD 4/6/00 Mfg. strategy

- 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

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Tradeoffs/Decision

IPPD 4/6/00 Mfg. strategy

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

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Fully Automated

- Higher quality
- Lower wages
- Produce prototypess on production equipment
- Global sourcing
- Better control
- Reusable
- more efficient

Mixed

IPPD 4/6/00 Mfg. strategy

- 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

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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 potential 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?

IPPD 4/6/00 Mfg. strategy

- 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 (?)

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Cellular mfg. Vs. Batch

IPPD 4/6/00 Mfg. strategy

- **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

Kaizen

- **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

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Two decision factors

IPPD 4/6/00 Mfg. strategy

	Flexible	Dedicated
Automated	NC Machine Cells	Automotive line
Manual	Job shop/ skunk works	Aircraft manufacture

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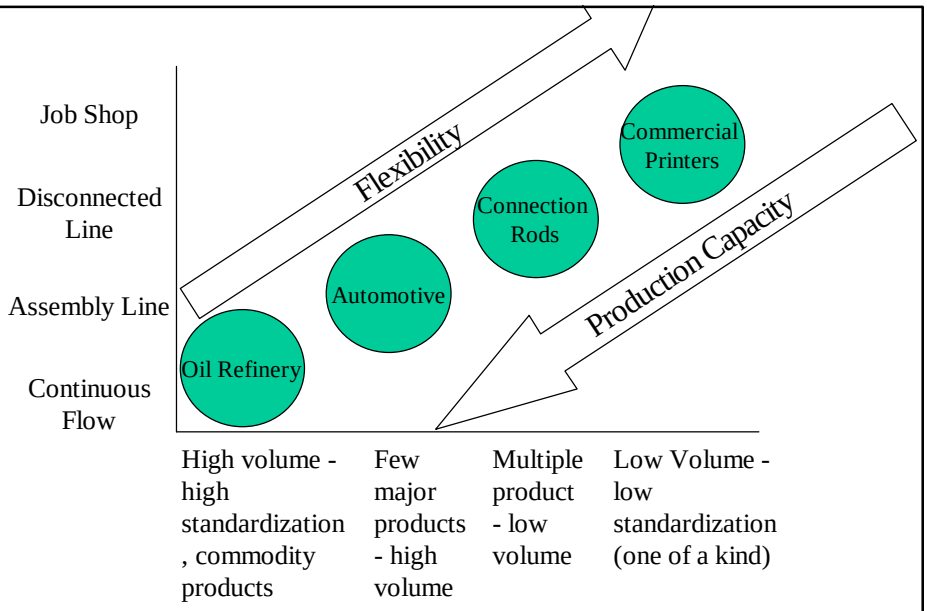

Hays and Wheelwright, "Link Manufacturing Process and Product Life Cycle", *Harvard Business Review*

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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*?

IPPD 4/6/00 Mfg. strategy

- 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

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5 attributes of Lean

IPPD 4/6/00 Mfg. strategy

- 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

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What are barriers to Lean?

IPPD 4/6/00 Mfg. strategy

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

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Improvement steps to Lean in production

IPPD 4/6/00 Mfg. strategy

- 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

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Lean Design Process

IPPD 4/6/00 Mfg. strategy

- 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)

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Lean Design

IPPD 4/6/00 Mfg. strategy

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

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Logistics

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

IPPD 4/6/00 Mfg. strategy

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

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Why visibility into delivery times?

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

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Delayed Differentiation

IPPD 4/6/00 Mfg. strategy

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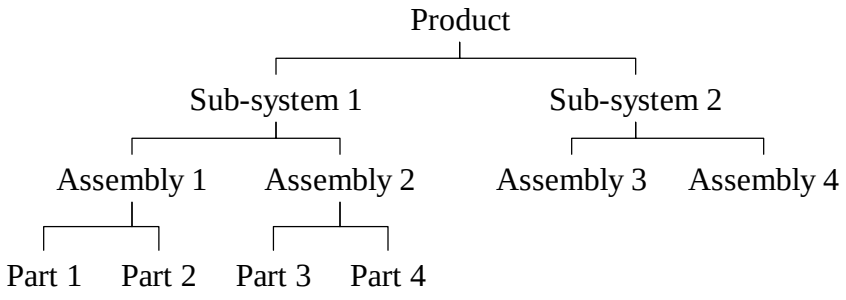
Assembly Sequence

IPPD 4/6/00 Mfg. strategy



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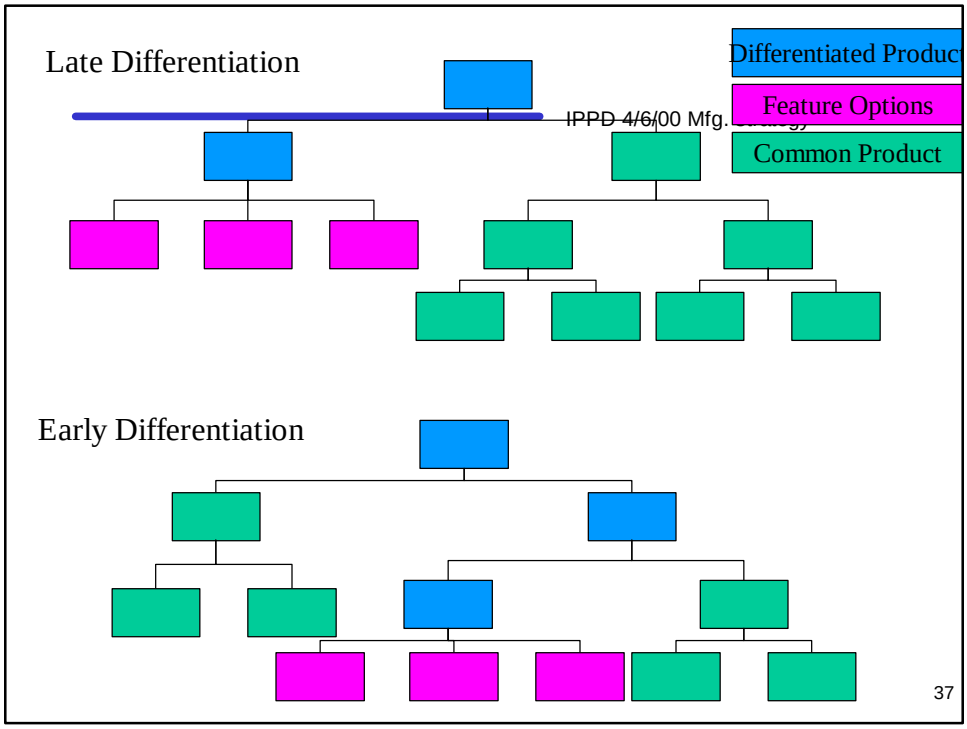

Benefits of Late Differentiation

IPPD 4/6/00 Mfg. strategy

- Easier to control
- Faster reaction to customer requirement
- Lower inventory costs
- Fewer interfaces

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Lecture 15: Make Buy Decisions, Supplier Relations

IPPD 4/6/00 Mfg. strategy

- Reading
  - Clark, K. B. and T. Fujimoto (1991). chapter 6: Product Strategy.
  - J . P. Womack, D. T. Jones, and D. Roos, The Machine that Changed the World "Chapter 6: Coordinating the Supply Chain"
  - J. H. Dyner, D. S. Cho, W. Chu, "Strategic Supplier Segmentation: The next "best practice" in supply chain management" California Management Review, 40(2), Winter 1998.
- 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" ?

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