JIT and Lean Operations

Lean Production

- Lean operation
  - A flexible system of operation that uses considerably less resources than a traditional system
  - Tend to achieve
    - Greater productivity
    - Lower costs
    - Shorter cycle times
    - Higher quality

Lean Production

- Lean operations began as lean manufacturing, also known as JIT in the mid-1900s
- Developed by Taiichi Ohno and Shigeo Ohno of Toyota
- Focus was on eliminating all waste from every aspect of the process
  - Waste is viewed as anything that interfered with, or did not add value to, the process of producing automobiles

Lean System: Basic Elements

- Lean systems have three basic elements:
  - A system that is
    1. Demand driven
    2. Focused on waste reduction
    3. Has a culture dedicated to excellence and continuous improvement

Lean: Ultimate Goal

- The ultimate goal:
  - A balanced system
    - One that achieves a smooth, rapid flow of materials through the system to match supply to customer demand

Goals and Building Blocks of Lean Systems
Lean: Supporting Goals

• The degree to which lean’s ultimate goal is achieved depends upon how well its supporting goals are achieved:
  1. Eliminate disruptions
  2. Make the system flexible
  3. Eliminate waste, especially excess inventory

Sources of Waste

• Waste
  • Represents unproductive resources
  • Seven sources of waste in lean systems:
    1. Inventory
    2. Overproduction
    3. Waiting time
    4. Unnecessary transporting
    5. Processing waste
    6. Inefficient work methods
    7. Product defects

Kaizen (continuous improvement)

• The kaizen philosophy for attacking waste is based upon these ideas:
  1. Waste is the enemy and to eliminate waste it is necessary to get the hands dirty
  2. Improvement should be done gradually and continuously; the goal is not big improvements done intermittently
  3. Everyone should be involved
  4. Kaizen is built on a cheap strategy, and it does not require spending great sums on technology or consultants
  5. It can be applied everywhere
  6. It is supported by a visual system
  7. It focuses attention where value is created
  8. It is process oriented
  9. It stresses that the main effort for improvement should come from new thinking and a new work style
  10. The essence of organizational learning is to learn while doing

Lean: Building Blocks

• Product design
• Process design
• Personnel/organizational elements
• Manufacturing planning and control

Building Blocks: Product Design

• Standard parts
• Modular design
• Highly capable production systems
• Concurrent engineering

Building Blocks: Process Design

• Seven aspects of process design that are important for lean systems:
  1. Small lot sizes
  2. Setup time reduction
  3. Manufacturing cells
  4. Quality improvement
  5. Production flexibility
  6. A balanced system
  7. Little inventory storage
  8. Fail-safe methods
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**Process Design: Small Lot Sizes**
- In the lean philosophy, the ideal lot size is one
- Benefits of small lot size
  - Reduced in-process inventory
  - Lower carrying costs
  - Less storage space is necessary
  - Inspection and rework costs are less when problems with quality do occur
  - Less inventory to “work off” before implementing product improvements
  - Increased visibility of problems
  - Permits greater flexibility in scheduling
  - Increased ease of balancing operations

**Process Design: Setup Time Reduction**
- Small lot sizes and changing product mixes require frequent setups
- Unless these are quick and relatively inexpensive, they can be prohibitive
- Setup time reduction requires deliberate improvement efforts
  - Single-minute exchange of die (SMED)
    - A system for reducing changeover time
    - Group technology may be used to reduce setup time by capitalizing on similarities in recurring operations

**Process Design: Manufacturing Cells**
- One characteristic of lean production systems is multiple manufacturing cells
- Benefits include
  - Reduced changeover times
  - High equipment utilization
  - Ease of cross-training workers

**Process Design: Quality Improvement**
- Quality defects during the process can disrupt operations
- Autonomation (jidoka)
  - Automatic detection of defects during production
  - Two mechanisms are employed
    - One for detecting defects when they occur
    - Another for stopping production to correct the cause of the defects

**Process Design: Work Flexibility**
- Guidelines for increasing flexibility
  - Reduce downtime due to changeovers by reducing changeover time
  - Use preventive maintenance on key equipment to reduce breakdowns and downtime
  - Cross-train workers so they can help when bottlenecks occur or other workers are absent
  - Use many small units of capacity; many small cells make it easier to shift capacity temporarily and to add or subtract capacity
  - Use off-line buffers. Store infrequently used safety stock away from the production area
  - Reserve capacity for important customers

**Process Design: Balanced System**
- Takt time
  - The cycle time needed to match customer demand for final product
  - Sometimes referred to as the heartbeat of a lean system
  - Takt time is often set for a work shift
  - Procedure:
    1. Determine the net time available per shift
    2. If there is more than one shift per day, multiply the net time by the number of shifts
    3. Compute the takt time by dividing the net available time by demand
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Process Design: Inventory Storage

- Lean systems are designed to minimize inventory storage
  - Inventories are buffers that tend to cover up recurring problems that are never resolved
    - partly because they are not obvious
    - partly because the presence of inventory makes them seem less serious

Process Design: Fail-Safe Methods

- Poka-yoke (Fail safing)
  - Building safeguards into a process to reduce or eliminate the potential for errors during a process
  - Examples
    - Electric breakers
    - Seatbelt fastener warnings
    - ATMs that signal if a card is let in a machine
    - Designing parts that can only be assembled in one position

Building Blocks: Personnel/Organizational

- Five personnel/organizational elements that are important for lean systems:
  - Workers as assets
  - Cross-trained workers
  - Continuous improvement
  - Cost accounting
  - Leadership/project management

Personnel/Organizational: Workers as Assets

- Workers as assets
  - Well-trained and motivated workers are the heart of the lean system
  - They are given greater authority to make decisions, but more is expected of them

Personnel/Organizational: Cross-Trained Workers

- Cross-trained workers
  - Workers are trained to perform several parts of a process and operate a variety of machines
    - Facilitates flexibility
    - Helps in line balancing

Personnel/Organizational: Continuous Improvement

- Continuous improvement
  - Workers in lean systems have greater responsibility for quality, and they are expected to be involved in problem solving and continuous improvement
  - Lean workers receive training in
    - Statistical process control
    - Quality improvement
    - Problem solving
Personnel/Organizational: Cost Accounting

- Cost accounting
  - Activity-based costing
    - Allocation of overhead to specific jobs based on their percentage of activities

Personnel/Organizational: Leadership

- Leadership/project management
  - Managers are expected to be leaders and facilitators, not order givers
  - Lean systems encourage two-way communication between workers and managers

Building Blocks: MPC

- Seven elements of manufacturing planning and control (MPC) are particularly important for lean systems:
  1. Level loading
  2. Pull systems
  3. Visual systems
  4. Limited work-in-process (WIP)
  5. Close vendor relationships
  6. Reduced transaction processing
  7. Preventive maintenance and housekeeping

MPC: Level Loading

- Lean systems place a strong emphasis on achieving stable, level daily mix schedules
  - MPS – developed to provide level capacity loading
  - Mixed model scheduling
    - Three issues need to be resolved
      - What is the appropriate product sequence to use?
      - How many times should the sequence be repeated daily?
      - How many units of each model should be produced in each cycle?

MPC: Communication

- Communication moves backward through the system from station to station
  - Each workstation (customer) communicates its need for more work to the preceding workstation (supplier)
    - Assures that supply equals demand
  - Work moves “just in time” for the next operation
    - Flow of work is coordinated
    - Accumulation of excessive inventories is avoided

MPC: Visual Systems

- Kanban
  - Card or other device that communicates demand for work or materials from the preceding station
    - Kanban is the Japanese word meaning “signal” or “visible record”
  - Paperless production control system
    - Authority to pull, or produce, comes from a downstream process.
Push vs. Pull

- Push system
  - Work is pushed to the next station as it is completed
- Pull system
  - A workstation pulls output from the preceding workstation as it is needed
  - Output of the final operation is pulled by customer demand or the master schedule
- Pull systems are not appropriate for all operations
  - Large variations in volume, product mix, or product design will undermine the system

MPC: Limited WIP

- Benefits of lower WIP
  - Lower carrying costs
  - Increased flexibility
  - Aids scheduling
  - Saves costs of scrap and rework if there are design changes
  - Lower cycle-time variability
**MPC: Close Vendor Relationships**

- Lean systems typically have close relationships with vendors
  - They are expected to provide frequent, small deliveries of high-quality goods
  - A key feature of many lean systems is the relatively small number of suppliers used

**MPC: Reduced Transaction Processing**

- Lean systems seek to reduce costs associated with the ‘hidden factory’:
  - Logistical transactions
  - Balancing transactions
  - Quality transactions
  - Change transactions

**Value Stream Mapping**

- **Value stream mapping**
  - A visual tool to systematically examine the flows of materials and information
  - Its purpose is to help identify waste and opportunities for improvement
  - Data collected:
    - Times
    - Distances traveled
    - Mistakes
    - Inefficient work methods
    - Waiting times
    - Information flows

**Transitioning to Lean System**

- Make sure top management is committed and that they know what will be required
- Decide which parts will need the most effort to convert
- Obtain support and cooperation of workers
- Begin by trying to reduce setup times while maintaining the current system
- Gradually convert operations, begin at the end and work backwards
- Convert suppliers to JIT
- Prepare for obstacles

**Obstacles to Conversion**

- Management may not be fully committed or willing to devote the necessary resources to conversion
- Workers/management may not be cooperative
- It can be difficult to change the organizational culture to one consistent with the lean philosophy
- Suppliers may resist

**Lean Services**

- In service the focus is often on the time needed to perform the service because speed is often the order winner
- Lean benefits can be achieved in the following ways:
  - Eliminate disruptions
  - Make system flexible
  - Reduce setup and lead times
  - Eliminate waste
  - Minimize WIP
  - Simplify the process
• JIT II:
  • A supplier representative works right in the company’s plant, making sure there is an appropriate supply on hand
  • It is often referred to as vendor managed inventory (VMI)

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<thead>
<tr>
<th>Factor</th>
<th>Traditional</th>
<th>JIT</th>
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</thead>
<tbody>
<tr>
<td>Inventory</td>
<td>Much to offset forecast errors, late deliveries</td>
<td>Minimal necessary to operate</td>
</tr>
<tr>
<td>Deliveries</td>
<td>Few, large</td>
<td>Many, small</td>
</tr>
<tr>
<td>Lot sizes</td>
<td>Large</td>
<td>Small</td>
</tr>
<tr>
<td>Setup; runs</td>
<td>Few, long runs</td>
<td>Many, short runs</td>
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<tr>
<td>Vendors</td>
<td>Long-term relationships are unusual</td>
<td>Partners</td>
</tr>
<tr>
<td>Workers</td>
<td>Necessary to do the work</td>
<td>Assets</td>
</tr>
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• Reduced inventory levels
• High quality
• Flexibility
• Reduced lead times
• Increased productivity

• Increased equipment utilization
• Reduced scrap and rework
• Reduced space requirements
• Pressure for good vendor relationships
• Reduced need for indirect labor

Additional Reading