Principles of Lean Manufacturing

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Mass Production

Value-Added Time: Minutes
Time in Plant: Weeks

Order
Cash
### History of Manufacturing

<table>
<thead>
<tr>
<th>People</th>
<th>Pre-industrial 1890</th>
<th>Mass 1920</th>
<th>Lean 1980</th>
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<tbody>
<tr>
<td></td>
<td>• Craftsmen perform all aspects of task&lt;br&gt;• Self-taught or apprenticeship training</td>
<td>• Employees contribute minimally to total product&lt;br&gt;• Training for limited skills&lt;br&gt;• Management makes decisions</td>
<td>• Clusters of employees working in teams&lt;br&gt;• Extensive, continuing training</td>
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<tr>
<td>Product</td>
<td>• Customized, non-standard products&lt;br&gt;• Variations in quality</td>
<td>• Standardized; focused on volume not quality</td>
<td>• Focused on internal/external customer</td>
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<td>Work Environment</td>
<td>• Independence, discretion&lt;br&gt;• Variety of skills&lt;br&gt;• Responsibility</td>
<td>• Limited skills and knowledge&lt;br&gt;• Repetitive, mind-numbing work&lt;br&gt;• Little discretion, simplified tasks</td>
<td>• Some discretion, group effectiveness, empowerment, team accountability, work cells</td>
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“One of the most noteworthy accomplishments in keeping the price of Ford products low is the gradual shortening of the production cycle. The longer an article is in the process of manufacture and the more it is moved about, the greater is its ultimate cost.”

Henry Ford, 1926
Defining Lean

Lean has been defined in many different ways.

“A systematic approach to identifying and eliminating waste (non-value-added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection.”

The MEP Lean Network
Definition of Value Added

**Value Added**

Any activity that increases the market form or function of the product or service. (These are things the customer is willing to pay for.)

**Non-Value Added**

Any activity that does not add market form or function or is not necessary. (These activities should be eliminated, simplified, reduced, or integrated.)
Lean = Eliminating the Wastes

Value Added

Non-Value Added

- Overproduction
- Waiting
- Transportation
- Non-Value Added Processing
- Excess Inventory
- Defects
- Excess Motion
- Underutilized People

Typically 95% of all lead time is non-value added
Overproduction

- Making more than is required by the next process
- Making it earlier than is required by the next process
- Making it faster than is required by the next process

Causes of overproduction
- Just-in-case logic
- Misuse of automation
- Long process setup
- Unlevel scheduling
- Unbalanced workload
- Over engineering
- Redundant inspections
Inventory Waste

- Any supply in excess of a one-piece flow through your manufacturing process

- Causes of excess inventory
  - Misconception that this protects the company from inefficiencies and unexpected problems
  - Product complexity
  - Unleveled scheduling
  - Poor market forecast
  - Unbalanced workload
  - Misunderstood communications
  - Reward system
  - Unreliable shipments by suppliers
Defects

- Inspection and repair of material in inventory
- Causes of defects
  - Weak process control
  - Poor quality
  - Unbalanced inventory level
  - Deficient planned maintenance
  - Inadequate education/training/work instructions
  - Product design
  - Customer needs not understood
Processing Waste

- Effort that adds no value to the product or service from the customers’ viewpoint
- Causes of processing waste
  - Product changes without process changes
  - Just-in-case logic
  - True customer requirements not clearly defined
  - Over-processing to accommodate downtime
  - Lack of communication
  - Redundant approvals
  - Extra copies/excessive information
Waiting Waste

• Idle time created when waiting for…?

• Causes of waiting waste
  – Unbalanced work load
  – Unplanned maintenance
  – Long process setup times
  – Misuses of automation
  – Upstream quality problems
  – Unlevel scheduling
People Waste

- The waste of not using people’s mental, creative, and physical abilities
- Causes of people waste
  - Old guard thinking, politics, the business culture
  - Poor hiring practices
  - Low or no investment in training
  - Low pay, high turn-over strategy
Motion Waste

• Any movement of people or machines that does not add value to the product or service

• Causes of motion waste
  – Poor people/machine effectiveness
  – Inconsistent work methods
  – Unfavorable facility or cell layout
  – Poor workplace organization and housekeeping
  – Extra “busy” movements while waiting
Transporting parts and materials around the plant

Causes of transportation waste

- Poor plant layout
- Poor understanding of the process flow for production
- Large batch sizes, long lead times, and large storage areas
Lean Building Blocks

Continuous Improvement

- Pull/Kanban
- Cellular/Flow
- TPM
- Quality at Source
- POUS
- Quick Changeover
- Standardized Work
- Batch Reduction
- Teams
- 5S System
- Visual
- Plant Layout
- Value Stream Mapping
Standardized Work

Operations safely carried out with all tasks organized in the best known sequence and using the most effective combination of these resources:

- People
- Materials
- Methods
- Machines
Workplace Organization

A safe, clean, neat, arrangement of the workplace provides a specific location for everything, and eliminates anything not required.
Elements of a 5S Program

- **Sort**—Perform “Sort Through and Sort Out,” by placing a red tag on all unneeded items and moving them to a temporary holding area. Within a predetermined time the red tag items are disposed, sold, moved or given away. “When in doubt, throw it out!”

- **Set in Order**—Identify the best location for remaining items, relocate out of place items, set inventory limits, and install temporary location indicators.

- **Shine**—Clean everything, inside and out. Continue to inspect items by cleaning them and to prevent dirt, grime, and contamination from occurring.

- **Standardize**—Create the rules for maintaining and controlling the first 3 S’s and use visual controls.

- **Sustain**—Ensure adherence to the 5 S standards through communication, training, and self-discipline.
Visual Controls

- Simple signals that provide an immediate understanding of a situation or condition. They are efficient, self-regulating, and worker-managed.

- Examples:
  - Kanban cards
  - Color-coded dies, tools, pallets
  - Lines on the floor to delineate storage areas, walkways, work areas, etc.
  - Andon lights
Lean Workforce Practices

• Teams
  – With rotation of highly specified jobs
• Cross-trained and multi-skilled employees
  – Who can work many operations within a cell and operations in different cells
• Continuous improvement philosophy
• Process quality, not inspection
• Use of participatory decision-making
  – Quality Control Circles, team-based problem solving, suggestion systems, etc.
Quick Changeover

- **Definition**: Changing over a process to produce a different product in the most efficient manner.

- **STEPS IN A CHANGEOVER** (taken from Shigeo Shingo’s *Single Minute Exchange of Dies*):
  - **Percent of time of changeover**
    - 50%
    - 30%
    - 15%
    - 5%
  - Preparation, after-process adjustment, checking, return to storage of parts, tools, fixtures, move materials
  - Removing parts, blades, jigs, etc.; mounting same for next lot, move materials
  - Machine settings, measurements
  - Making trial pieces and adjusting
Impact of Batch Size Reduction

• Batch & Queue Processing

10 minutes

• Continuous Flow Processing

12 min. for total order
3 min. for first part
Batch Size Reduction

The best batch size is one piece flow, or make one and move one!
Point of Use Storage (POUS)

- Raw material is stored at workstation where used
- Works best if vendor relationship permits frequent, on-time, small shipments
- Simplifies physical inventory tracking, storage, and handling
Quality at the Source

- **Source Inspection:** Operators must be certain that the product they are passing to the next workstation is of acceptable quality.

- Operators must be given the means to perform inspection at the source, before they pass it along.

- Samples or established standards are visible tools that can be used in the cell for such purposes.

- Process documentation defining quality inspection requirements for each workstation may need to be developed.
Push vs. Pull Systems

- **Push System**
  - Resources are provided to the consumer based on forecasts or schedules.

- **Pull System**
  - A method of controlling the flow of resources by replacing only what has been consumed.
Pull System Flow Diagram


Information Flow

Kanban Locations

Parts Flow
Cellular Manufacturing

Linking of manual and machine operations into the most efficient combination to maximize value-added content while minimizing waste.
Step 2: Establish Takt Time

\[ \text{Takt Time} = \frac{\text{Demand Rate}}{\text{Work Time Available}} \]

\[ \text{Takt Time} = \frac{\text{Number of Units Sold}}{\text{Work Time Available}} \]

\[ \text{Takt Time} = \frac{1200 \text{ Seconds}}{115 \text{ Boards}} = 10.4 \text{ Sec/Board} \]

\[ \frac{\text{Cycle Time}}{\text{Takt Time}} = \text{Minimum # of People} \]

GOAL: Produce to Demand
Total Productive Maintenance (TPM)

- Systematic approach to the elimination of equipment downtime as a waste factor
- Enlisting the intelligence and skills of the people who are MOST familiar with the factory machines: the equipment operators
- Charting/analyzing equipment performance to identify root cause of problems, and implementing permanent corrective actions
**THE MTC'S IMPLEMENTATION ROAD MAP**

- **BASIC EDUCATION**
  - **LEAN 101:** All employees must have a basic understanding of Lean Manufacturing Principles

- **SEEING THE BIG PICTURE**
  - **LEAN 202:** Value Stream Mapping

- **IDENTIFY KAIZEN OPPORTUNITIES**
  - Create Prioritized list of events and numerical improvement targets for each

- **KAIZEN FACILITATION**
  - Implement Lean Manufacturing using the power of the Kaizen method
AN IMPLEMENTATION ROAD MAP CONTINUED

• **KAIZEN EVENTS & LE200 SERIES WORKSHOPS**
  – Cellular Design
  – Pull/KAN-BAN Systems
  – Set-up Reduction
  – 5s Workplace Organization
  – Total Productive Maintenance

• **TRAINING OF INTERNAL LEAN IMPLEMENTERS**
Lean Building Blocks

Continuous Improvement

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- Value Stream Mapping
Getting Started

Value Stream Mapping

• A simple, visual approach to:
  – Focusing on a “product family”
  – Creating a clear picture of “current” material and information flow associated with that product family
  – Revealing an overall perspective of “value added” vs “non-value added” components for the specific product family mapped
  – Identifying Lean tools and techniques that can improve flow and eliminate waste
  – Incorporating those ideas in a “future” picture of how material and information “should” flow for that product group
  – Creating an action plan that makes the new picture a reality for that product family
Implementation Success Factors

• UNYIELDING LEADERSHIP
• STRATEGIC VISION based on Lean enterprise as part of company strategy
• Planning and following a “SYSTEMATIC” approach
• Observe outside successes and failures
• Ability to question EVERYTHING
• Deep commitment to EXCELLENCE
## Conclusion

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<th>Traditional</th>
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<tr>
<td>• Simple and Visual</td>
<td>• Complex</td>
</tr>
<tr>
<td>• Demand Driven</td>
<td>• Forecast Driven</td>
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<tr>
<td>• Inventory as Needed</td>
<td>• Excessive Inventory</td>
</tr>
<tr>
<td>• Reduce Non-Value Added</td>
<td>• Speed Up Value Added Work</td>
</tr>
<tr>
<td>• Small Lot Size</td>
<td>• Batch Production</td>
</tr>
<tr>
<td>• Minimal Lead Time</td>
<td>• Long Lead Time</td>
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<tr>
<td>• Quality Built</td>
<td>• Quality Inspected-in</td>
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<tr>
<td>• Value Stream Managers</td>
<td>• Functional Departments</td>
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Benefits of Lean

Percentage of Benefits Achieved

- Lead Time Reduction
- Productivity Increase
- WIP Reduction
- Quality Improvement
- Space Utilization
CASE STUDY

- Local Automotive Components Manufacturer
  - Full Lean Manufacturing Implementation
    - (3) Lean Principles and (1) 5S Workshop
    - Value Stream Mapping of (2) Product Lines
    - (2) TPM and (2) Cell Creation Kaizen Events
  - Financial Impacts to date (Client’s Estimates)
    - Annualized Productivity Gains of $372,000.00!
    - Work in process Inventory reduced by $86,000.00!
    - Part Travel Distance reduced 70% to 246%!
    - Production Lead-time reduced 59% to 70%!
- Next Step
  - Kaizen events for Kanban Scheduling Systems
  - Kaizen events for Changeover Reduction
  - MTC Certification of Client’s in-house Lean Coordinator
WHAT CAN THE MTC DO FOR YOU?

Lead your organization through all phases of a full Lean Implementation
THANK YOU !!!

WE AT THE MTC LOOK FORWARD TO THE OPPORTUNITY TO HELP YOUR COMPANY REALIZE THE REMARKABLE BENEFITS OF LEAN MANUFACTURING