ME 410 Lecture 1 Notes

Lecture Outline

I. Course goals and syllabus
II. Logbook review and logbook review form
III. Mass production vs lean enterprise systems
IV. Lean manufacturing overview
V. Plant layout models.

Course Goals

I. Students: Design for manufacturing (detail design and lean thinking)
II. Mentors: Design leadership development (management experience)
III. Faculty: Design infrastructure development (equipment and proposals)

Comparison of Production Systems

• Mass Production System
  o Developed by Ford in early 1900’s (father of assembly line)
  o Based on Frederick Taylor’s work (scientific management)
  o Ford Production as of 1950:
    ▪ 8000 units/day
    ▪ Large, low-skilled immigrant workforce
    ▪ Vertical Integration
  o Features
    ▪ High Volume / Low Mix
    ▪ Capital ⇒ leading to automation
    ▪ Quantity ⇒ equipment efficient
    ▪ Repeatability ⇒ involving rules/controls
    ▪ Cost-Plus Pricing ⇒ market domination

• Lean Enterprise System
  o Toyota’s entry into auto-making, 1936
  o Taiichi Ohno (father of Toyota Production System (TPS))
  o Toyota Production as of 1950:
    ▪ 2500 units/year
    ▪ Diversified market
    ▪ Limited capital (World War II)
    ▪ Dedicated, high-skilled workforce
  o Features
    ▪ Low volume / high mix
    ▪ People ⇒ training in problem solving
    ▪ Quality ⇒ defects stop the line
    ▪ Flexibility ⇒ responsiveness to market
    ▪ Minus-Cost Pricing ⇒ competitive market
Comparison of Production Systems

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Manufacturing Terms

- **Batches** – production quantity
- **Inventory** – raw materials, work in progress, and finished goods held
- **Fixturing** – device for repeatable holding and positioning during manufacturing
- **Line Balancing** – leveling the workload across all processes
- **Plant Layout** – physical configuration of a manufacturing plant
- **Order of Operations** – required manufacturing sequence
- **Work in Progress (WIP)** – partially completed products; not raw material and not finished goods
- **Set-Up Time** – time required to set-up a machine, device, or work area for the next production run
- **Inspection** – evaluating production vs. design criteria for quality control
- **Manufacturing Lead Time (MLT)** – total time to manufacture a product, from raw material to finish product
Plant Layout Models

- **PROCESS LAYOUT** – e.g. ME Shop
  
  **Description:** Machines are arranged in groups according to general type of manufacturing. Mills are in one area, welders in another. Parts requiring different operations in different sequences can be routed from department to department. This layout is typical in job shops and batch production.

  **Pros:** flexibility, capital cost, motivation, system protection
  
  **Cons:** utilization, inventory cost, confusion

- **PRODUCT LAYOUT** – e.g. Ford, GM
  
  **Description:** This layout is typically used in plants specializing in producing one product or class of product such as automobiles. Machines and assembly stations are arranged in order of operation for the products. Products typically ride along on conveyor belts or chains. This layout may have several parallel lines of processes combining at one node such as the chassis production line and drivetrain production line. Both products can be produced independent of each other and assembled. This arrangement is relatively inflexible compared to a Process Layout.

  **Pros:** Output, Unit Cost, Utilization
  
  **Cons:** Motivation, Flexibility, System Protection

- **FIXED POSITION LAYOUT** – e.g. Dams, Houses, Boeing (pre-2000)
  
  **Description:** In this layout, the product’s position is fixed due to its size or weight such as a jetliner. Equipment, components, and labor is brought to the product for the operations. When the product is complete, it is then moved. Similar to the Fixed position layout is the Project Layout. Project layout is typically used in construction jobs. This differs from Fixed-position when the project is complete. At completion the equipment, personnel, and materials are removed from the manufacturing area instead of the product.

  **Pros:** Site-Specific, Economy of Scale
  
  **Cons:** Space, Administration

- **CELLULAR LAYOUT** – e.g. Group Technology Companies
  
  **Description:** A workcell is a combination of people, equipment, and workstations organized in the order of process flow, to manufacture all or part of a production unit. Cells are often used for a family of products, arranged in a C or U shape, and required cross-training of the workforce.

  **Pros:** Cost, Flexibility, Motivation
  
  **Cons:** Accommodating Monuments, Employee Training Requirements
Lean Manufacturing

Description: A systematic approach to identifying and eliminating waste (non value-added activities) in production activities. Lean emphasizes efficient production (flow) that responds to customer demands (pull).

- **VALUE-ADDED ACTIVITY** (typically 5% of Manufacturing Lead Time (MLT))
  
  Description: Any activity that increases the market form or function of the product or service (i.e. things the customer is willing to pay for).

- **NON VALUE-ADDED ACTIVITY** (typically 95% of Manufacturing Lead Time (MLT))
  
  Description: Any activity or use of resources that does not add market form or function or is not necessary. These activities should be reduced, integrated, simplified, or eliminated.

Lean Manufacturing Terms

- **Kaizen** – a process of continual improvement.
- **Continuous Improvement Process (CIP)** – aka Kaizen.
- **Cell** – A combination of people, equipment, and workstations organized in the order of process flow.
- **Flow** – The concept that parts and subassemblies do not stop except to be processed, and then only for value-added work. It is the primary tool used to reduce production lead time.
- **Pull** – A production system in which production at the current step is initiated only by a signal from the next step in the process (the customer), and that signal only occurs when the customer has consumed inventory by a set amount.
- **Just-in-Time** – Production goal of delivering the right quantity to the right place at the right time.
- **Kanban** – A signal (typically a card) by the future production step to initiate work in the previous step; Kanban are the predominate way of implementing a pull system.
- **Point of use Storage (POUS)** – The practice of storing raw materials and sub-assemblies next to the production process that consumes them.
- **Quality at Source** – The strategy of making all processes stable and capable of meeting customer needs.
- **Poka-yoke** – A series of techniques to achieve error-proofing of a process to achieve quality at the source.
- **Quick Changeover** – The goal for switching the tooling at a workstation between different production runs.
- **Standardized Work** – The specified components of a production task, including: cycle time, work sequence, and standard inventory. Typically this is a visual control used to audit production (not to guide work).
- **Visual Controls** – Lights, signs, and other visual material designed to communicate production status.
- **Andons** – Visual displays such as lights to indicate process status, especially process abnormalities
- **Transparency** – The concept that performance of the process should be visible from anywhere on the floor.
- **Batch Reduction** – The effort to reduce the size of a batch through a process in order to reduce lead times.
- **One Piece Flow** – The ultimate goal of batch reduction.
- **5S System** – An ordered set of techniques to improve workspace practices: Seiri (Separate), Seiton (Set in Order), Seiso (Shine), Seiketsu (Standardize), and Shitsuke (Sustain).
- **Value Stream Mapping** – Maps the process in a normal flow format, including information necessary to plan and meet the customer’s normal demands, including: cycle times, inventories held, changeover times, staffing, modes of transportation, etc. Used to find waste in the value stream of a product.
- **Takt Time** – Cycle time required to meet customer’s demand, normalized to production schedule.
- **Minus-Cost Pricing** – Concept of setting product price based on the market, not current production costs (Cost-Plus Pricing)