2.008

Manufacturing Systems

Outline

1. Manufacturing Systems
2. Types of Plant Layouts
3. Production Rates
4. Design and Operations

Manufacture

What is mfg systems?

Time spectrum of Typical Activities in a Manufacturing Organization

How Man, Machine, and Material Spend Time in the Factory
Disruptions/Variation (Random Events)

- Machine failure
- Set-up change
- Operator absence
- Starvation/Blockage
- Demand change

Types of Plant Layout

- Job Shop
- Project Shop
- Flow Line
- Transfer Line
- Cellular System

Job Shop

Machines/Resources are brought to and removed from stationary part as required.

Project Shop

Machines/Resources are brought to and removed from stationary part as required.

Flow Line and Transfer Line

Machines/Resources are grouped in lines according to the processes sequence of part(s).

Cellular System

Machines/Resources are grouped according to the processes required for part families.
Production Rates

• Case I:
  – One machine
  – Everything works

\[
\text{Production rate} = \frac{1}{\text{Operation time}}
\]

Production Rates (cont’d)

• Case II:
  – One machine
  – Machine breaks down (disruption)
  – Everything else works

\[
\text{Efficiency} = \frac{\text{MTTF}}{\text{MTTF} + \text{MTTR}}
\]

\[
\text{Production rate} = \frac{\text{Efficiency}}{\text{Operation time}}
\]

Production Rates (cont’d)

• Case III:
  – Many machines
  – No machine breaks down
  – No buffers

Production Rates (cont’d)

• Case IV:
  – Many machines (same operation time)
  – No machine breaks down
  – No buffers

Production Rates (cont’d)

• Case V:
  – Many machines (same operation time)
  – Machine breaks down
  – No buffers
Production Rates (cont’d)

• Case VI:
  – Many machines and buffers in between
  – Machine breaks down

Disruptions
(Random Events)

• Machine failure
• Set-up change
• Operator absence
• Starvation/Blockage

Waiting

• Underutilization
• Idleness
• Inventory

Inventory/Work-in-Process (WIP)

• It costs money
• It gets damaged
• It becomes obsolete
• It shrinks
• It increases lead time

Cycle Time and Lead Time

Takt time = \frac{\text{Daily available time}}{\text{Daily average demand}}
Cycle Time

“Cycle Time”
- The time a part spends in the system

Little’s Law: \( L = \lambda w \)
- \( L \): average inventory
- \( \lambda \): average production rate
- \( w \): average cycle time

Example:
- Operation time = 1, One-piece operation
- Production rate = 1
- Cycle time = 5
- Inventory = 5

Cycle Time (cont’d)

Batch Production

1. Operation time: 3 minutes
   Batch (Lot) size: 1000
   Cycle time = 1,000*3 + 1,000*3 + 1,000*3 = 9,000min

One-Piece Production

2. Operation time = 3 minutes
   Cycle time = 1,000*3 + 2*3 = 3,006 minutes

Cycle Time and Lead Time

System Design and Operation

- Cycle time < Lead time
- Lumpiness
- Information contents
Typical Design Guidelines

- Leveling
- Balancing
- Single-piece flow
- Low materials handling
- Low setup time
- Smaller lot size
- Low WIP
- Faster feedback

Plant Operations

- Push (MRP, ERP, etc.) vs. Pull (JIT)
- Batch vs. One-piece