

Basics of Manufacturing Process Analyses

$$CT_q = \left(\frac{U}{1-U} \right) \cdot E[S] \cdot \left(\frac{U^{\sqrt{2C+2}-2}}{C} \right)$$

HYUNSOO LEE

Simulation & Control

- Simulation

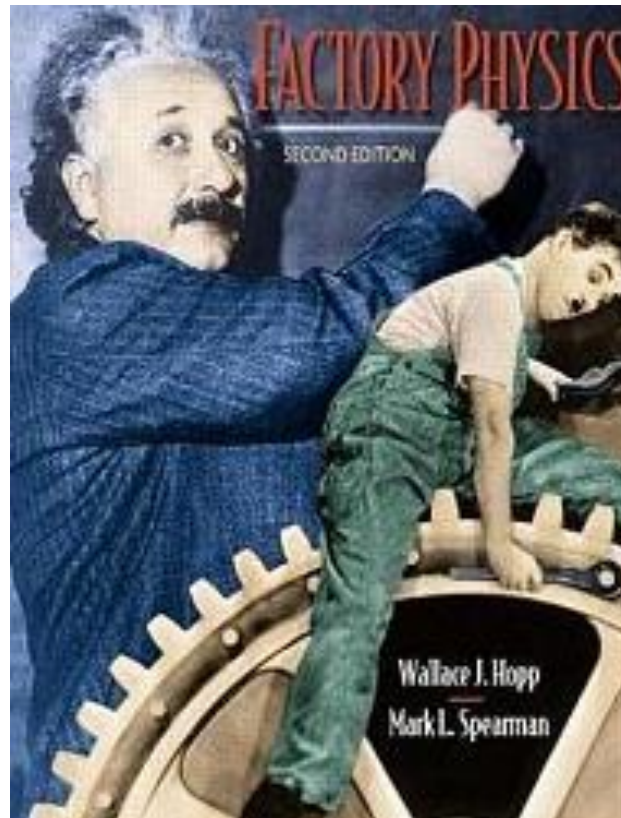
$$Y = f(X)$$

- Control

$$Y = f(X)$$

Manufacturing Process Modeling

- Factory Physics



$$L = \lambda W$$

Process Analyses (I)

- AnyLogic, ExtendSim, flexSim,

- Output of D.E.S.
 - Cycle Time
 - WIP
 - Throughput

Process Analyses (II)

- Assumption
 - Three machines & serial processing
 - Machining time = {1, 2, 1}
 - Input strategy = when one output is leaving, one input enters

T=0-



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T=15	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Process Analyses (III)

- Performances
 - # of machines = ?
 - Works in Process = ?
 - Throughput = ?
 - Cycle time = ?

 - Formula → ?

Exercise

- Assumption

- Three machines & serial processing
- Machining time = {1, 2, 1}
- Input strategy = when one output is leaving, one input enters



- 1) Draw transition diagram
- 2) Compute cycle time
- 3) Compute WIP
- 4) Compute Throughput

Control of “Process model”

- Control model 1

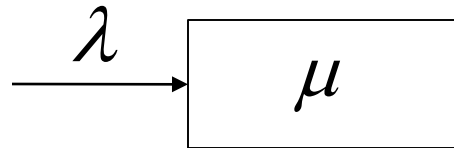
$$L = \lambda \cdot W$$

- Control model 2

$$W = f(\lambda, \mu_1, \sigma_1, \mu_2, \sigma_2, \dots)$$

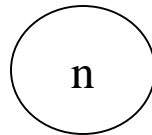
In one machine case (1)

- One machine case



In one machine case (2)

- Case of P_n



In one machine case (3)

- WIP, Cycle time and Throughput

In two machine case

- Case of $M/M/2/\infty$
 - Transition diagram
 - Balance equation

In non-identical machines

- Fast server (μ), slow server (δ)

In break-down case

- Rate
 - Arrival rate : λ
 - Service rate : μ
 - Rate of break down : γ
 - Time to repair : ν

Again, M/M/1

- WIP in Queue : $E[W_q]$
- Cycle time in Queue : CT_q
- Cycle time in System : CT_s

In M/M/2 (1)

- Transition diagram & balanced equation

In M/M/2 (2)

- WIP in Queue : $E[W_q]$
- Cycle time in Queue : CT_q
- Cycle time in System : CT_s

In M/M/3

- Cycle time in System : CT_s