Chapter 6 Designing Lean Systems

- Lean System and JIT
- Muda, Kaizen, Jidoka, Heijunka
- The Kanban System

What is a Lean System?

Operations systems that maximize the value added by each of a company's activities by removing waste and delays from them.

Just-in-time system

- A highly coordinated production system in which materials are moved through the system with precise timing, just as they are needed.
- JIT system ≈ lean system
- JIT (pull) ← → MRP (push)
- JIT is a part of TOYOTA production system.

JIT and Eight Types of Waste (Muda)

JIT: The belief that **waste** can be eliminated by cutting unnecessary capacity or inventory and removing non-value-added activities in operations.

- Overproduction 庫存過多、沒有改善品質的壓力
- Inappropriate Processing 殺雞焉用牛刀
- Waiting 人員或產品的等待過程不會創造價值
- Transportation 物料搬運不會創造價值且易造成損壞
- Motion 不必要的動作或行走不會創造價值且容易勞累
- Inventory 庫存會隱藏問題、占空間、造成等待
- Defects 增加檢查成本、時間與材料的浪費
- Underutilization of Employees 浪費員工的時間與腦力

3

Process Considerations in Lean Systems

Kaizen: continuous improvement (改善)

Pull Method of Work Flow: supplying material based on demand using Kanban (看板)

Quality at the Source:

- Jidoka: automatic detection (自働化)
- Poka-yoke: fool-proofing to reduce errors

Uniform Work loads: Heijunka (平準化)

Flexible Workforce: cross training, work rotation (兩小時換場制)

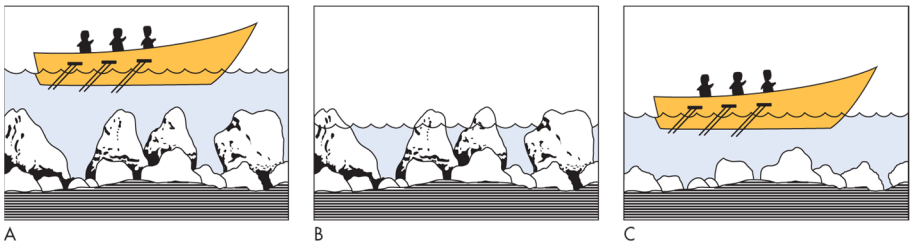
5S: 整理SEIRI、整頓SEITON、清掃SEISO、清潔SEIKETSU、素養SHITSUKE

Total Preventive Maintenance 全面預防保養

4

Kaizen: Continuous Improvement

水位高度相當於產能或庫存，暗礁代表生產線各種問題

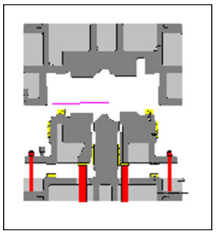


降低庫存 → 生產線必須面對並解決各種問題 → 進一步降低庫存

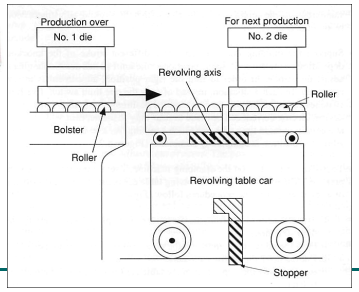
5

Single Minute Exchange of Dies = Single Digit Setup

F1 Pit Stops 1950 vs 2013_ Quick Changeover



faster set up
⇒ smaller lot sizes
⇒ smaller inventory

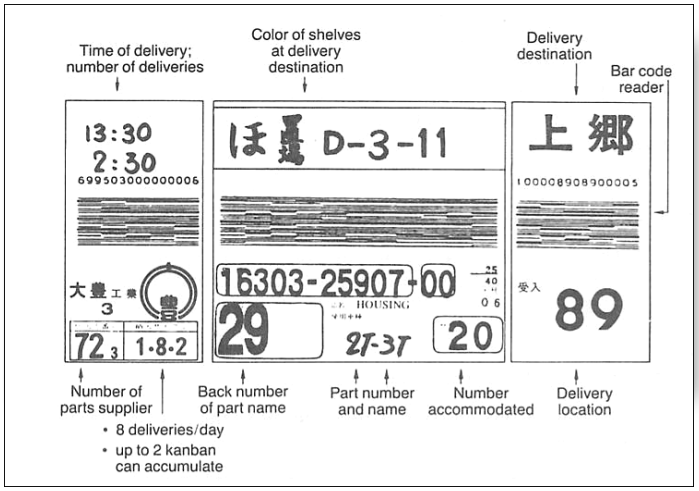


internal setup
⇒external setup

事先調整定位、簡易拆卸、預熱模具

6

Kanban 由下游往上游拉(pull)的物料控制方式，看板提供的相關資訊，包括時間、規格、數量、運送地點等



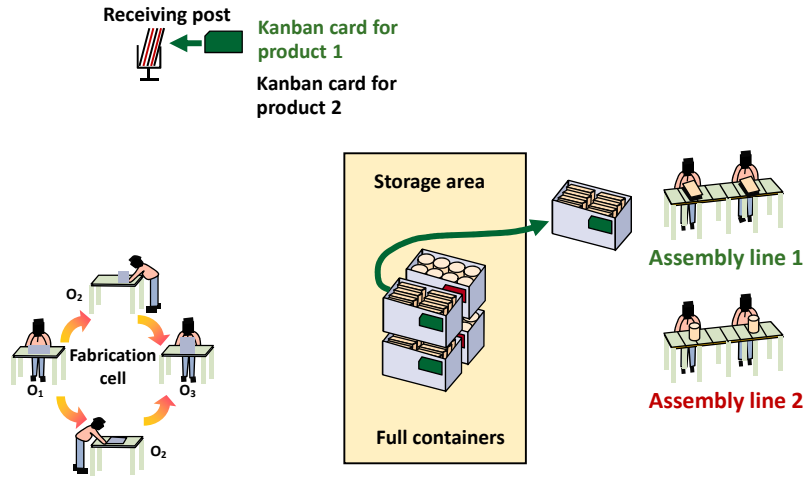
7

Operating Rules for Single-Kanban Systems

1. Each container in the process must have a Kanban card. (授權)
2. The assembly line (下游·主動權) always withdraws materials from the fabrication cell (上游). The fabrication cell never pushes parts to the assembly line.
3. Containers of parts must never be removed from a storage area without a Kanban first being posted on the receiving post. (時機)
4. The containers must always contain the same number of good parts.
5. Only nondefective parts should be passed along to the assembly line (下游) to make the best use of materials and worker's time. (品質)
6. Total production should not exceed the total amount authorized on the Kanbans in the system. (看板數=總量管制)

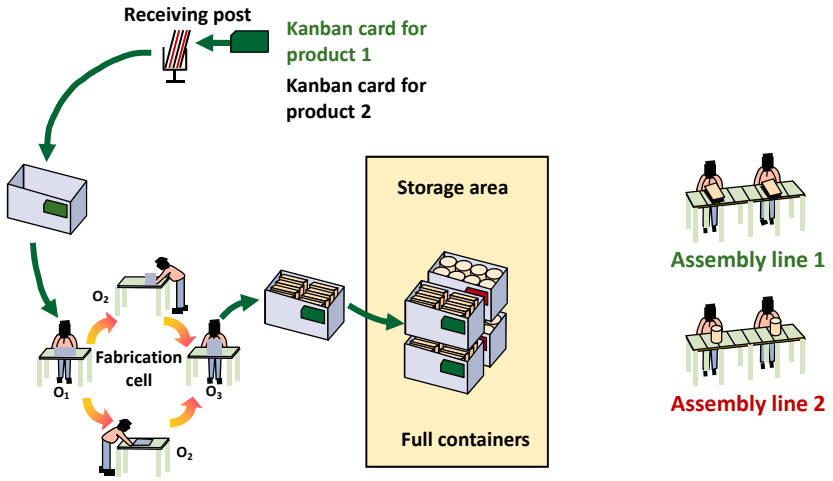
8

The Single Kanban System 1/4



9

The Single Kanban System 2/4



10

Determining the Number of Kanbans

Supplies must be shipped frequently, have short lead times, arrive on schedule, and be of high quality. In US, such arrangements may prove difficult because of the geographic dispersion of suppliers.

- Too many kanbans ⇒ excessive inventory
- Too few kanbans ⇒ not enough supply to the next station.

- 看板週期需求量 $L = d \cdot (\omega + \rho)$ ω = transportation time + waiting time

  d = daily demand ρ = processing time per container

- Number of kanbans = $L \cdot (1 + \alpha)$ / number of parts in one container

  ↑ 安全庫存係數

Example 6.2

- A container of parts spends 0.02 day in processing and 0.08 day in materials handling and waiting
- Daily demand for the part is 2,000 units
- Safety stock equivalent of 10 percent of inventory

If each container has 22 parts, how many kanbans are needed?

$$k = \frac{2{,}000(0.08 + 0.02)(1.10)}{22} = \frac{220}{22} = 10 \text{ kanbans}$$

Suppose that a proposal would cut materials handling and waiting time per container to 0.06 day. How many kanbans are needed?

$$k = \frac{2{,}000(0.06 + 0.02)(1.10)}{22} = \frac{176}{22} = 8 \text{ kanbans}$$