JIT and Lean Operations

Outline

- ☑ *Push-Pull Systems*
- ☑ *Global Company Profile: Toyota Motor Corporation*
- ☑ *Just-in-Time, the Toyota Production System, and Lean Operations*
  - ☑ *Eliminate Waste*
  - ☑ *Remove Variability*
  - ☑ *Improve Throughput*

Outline – Continued

- ☑ *Just-in-Time*
  - ☑ *JIT Partnerships*
  - ☑ *Concerns of Suppliers*
- ☑ *JIT Layout*
  - ☑ *Distance Reduction*
  - ☑ *Increased Flexibility*
  - ☑ *Impact on Employees*
  - ☑ *Reduced Space and Inventory*

Outline – Continued

- ☑ *JIT Inventory*
  - ☑ *Reduce Variability*
  - ☑ *Reduce Inventory*
  - ☑ *Reduce Lot Sizes*
  - ☑ *Reduce Setup Costs*
- ☑ *JIT Scheduling*
  - ☑ *Level Schedules*
  - ☑ *Kanban*

Outline – Continued

- ☑ *JIT Quality*
- ☑ *Toyota Production System*
  - ☑ *Continuous Improvement*
  - ☑ *Respect for People*
  - ☑ *Standard Work Practices*
- ☑ *Lean Operations*
  - ☑ *Building a Lean Organization*
- ☑ *Lean Operations in Services*

Learning Objectives

When you complete this chapter you should be able to:

1. *Define push-pull systems, just-in-time, TPS, and lean operations*
2. *Define the seven wastes and the 5 Ss*
3. *Explain JIT partnerships*
4. *Determine optimal setup time*

Learning Objectives

When you complete this chapter you should be able to:

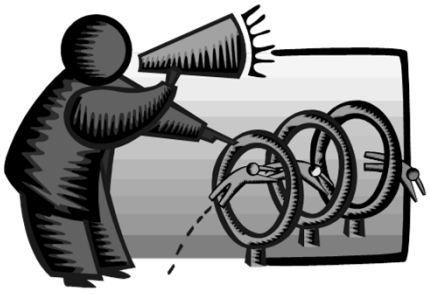
5. ***Define kanban***
6. ***Compute the required number of kanbans***
7. ***Explain the principles of the Toyota Production System***

Push - Pull

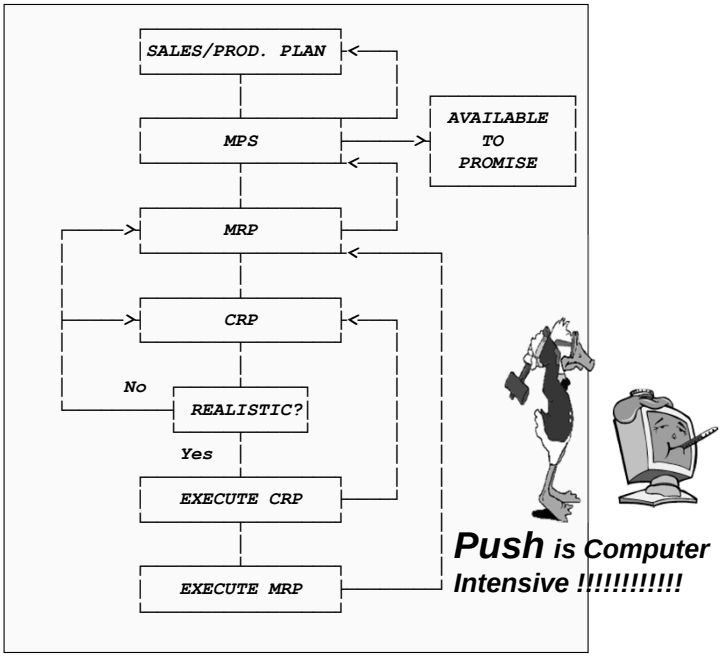
Push

A "push system" of production - distribution is one where replenishment of material items begins in advance of customer needs.

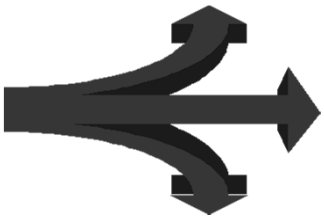
For a "push system" customer orders for materials are promised for delivery at a given future date, production is started at the first workstation of the production/distribution pipeline and pushed ahead to the next operation.



Work-in-process inventories are accumulated in the production - distribution pipeline in anticipation of shipping the completed order on the promised date.



***Push** is Computer Intensive !!!!!!!!!!!*



Pull

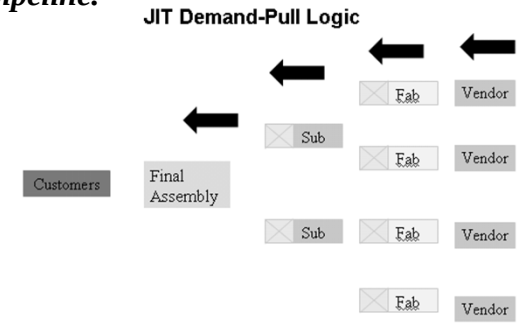
A "pull system" of production - distribution is one where customer demand activates production - distribution of the item.

For A "pull system" production and distribution activities are not performed in anticipation of customer actions. Customer orders initiate all production - distribution pipeline activities.

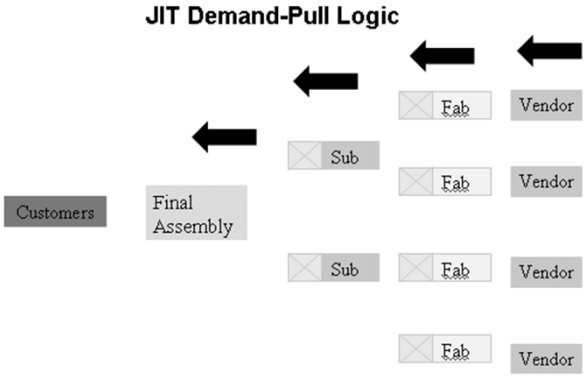
Pull** systems are characterized as **Just-in-Time Systems.

The logic of JIT is based on the concept that nothing will be ordered for replenishment until it is needed and need is created by the void left in a production - distribution pipeline when a product is pulled away or used.

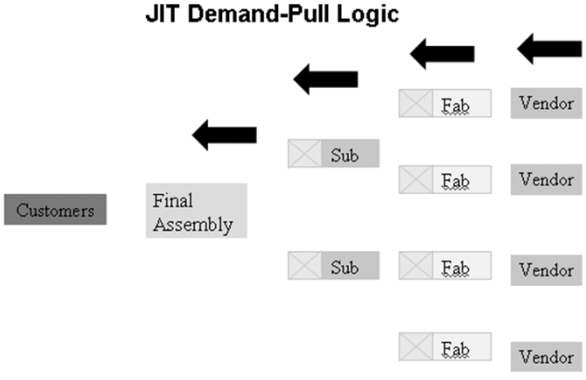
In theory, when an item is sold to a customer the market "pulls" a replacement from the last position within the production - distribution pipeline. An order from this last pipeline position pulls a replacement unit from the next to last pipeline position to replace the pipeline void. Then an order from the next to last pipeline position pulls a unit from the third from last position to fill the void in the next to last position, and so on all the way back to the original release of materials at the beginning of the production - distribution pipeline.



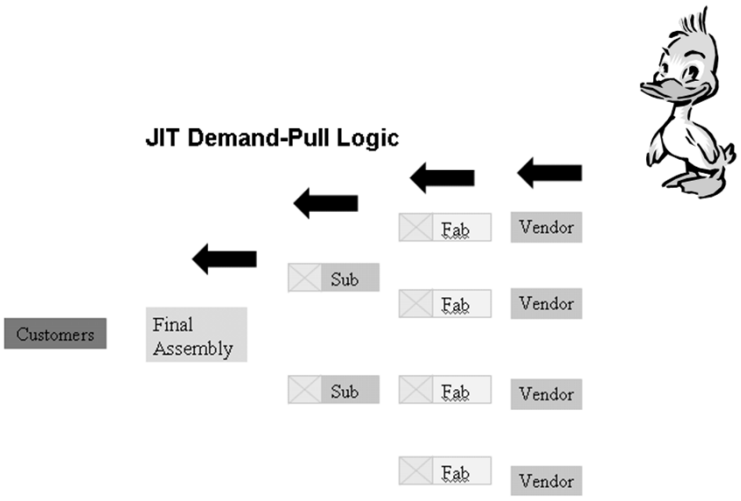
In this way, total pipeline flow is equally maintained throughout the pipeline and if, as assumed, customer demand is smooth and continuous, total pipeline flow will be smooth and continuous and pipeline inventories are minimized.



In general, the philosophy of filling unit voids in the production - distribution pipeline defines the JIT goal of generating precisely the necessary units in the necessary quantities at the necessary time with zero pe



Small Lot Sizes and Short Lead Times Between Supply Chain Links!!



Toyota Motor Corporation

- ☑ *Largest vehicle manufacturer in the world with annual sales of over 9 million vehicles*
- ☑ *Success due to two techniques, JIT and TPS*
- ☑ *Continual problem solving is central to JIT*
- ☑ *Eliminating excess inventory makes problems immediately evident*

Toyota Motor Corporation

- ☑ Central to TPS is a continuing effort to produce products under ideal conditions
- ☑ Respect for people is fundamental
- ☑ Small building but high levels of production
- ☑ Subassemblies are transferred to the assembly line on a JIT basis
- ☑ High quality and low assembly time per vehicle

Just-In-Time, TPS, and Lean Operations

- ☑ JIT is a philosophy of continuous and forced problem solving via a focus on throughput and reduced inventory
- ☑ TPS emphasizes continuous improvement, respect for people, and standard work practices
- ☑ Lean production supplies the customer with their exact wants when the customer wants it without waste

Just-In-Time, TPS, and Lean Operations

- ☑ JIT emphasizes forced problem solving
- ☑ TPS emphasizes employee learning and empowerment in an assembly-line environment
- ☑ Lean operations emphasize understanding the customer

Eliminate Waste

- ☑ Waste is anything that does not add value from the customer point of view
- ☑ Storage, inspection, delay, waiting in queues, and defective products do not add value and are 100% waste

Ohno's Seven Wastes

- ☑ *Overproduction*
- ☑ *Queues*
- ☑ *Transportation*
- ☑ *Inventory*
- ☑ *Motion*
- ☑ *Overprocessing*
- ☑ *Defective products*

Eliminate Waste

- ☑ *Other resources such as energy, water, and air are often wasted*
- ☑ *Efficient, ethical, and socially responsible production minimizes inputs, reduces waste*
- ☑ *Traditional "housekeeping" has been expanded to the 5 Ss*

The 5 Ss

- ☑ Sort/segregate – when in doubt, throw it out
- ☑ Simplify/straighten – methods analysis tools
- ☑ Shine/sweep – clean daily
- ☑ Standardize – remove variations from processes
- ☑ Sustain/self-discipline – review work and recognize progress

The 5 Ss

- ☑ Sort/segregate – when in doubt, throw it out
- ☑ [illegible]

Two additional Ss

- ☑ Safety – build in good practices
- ☑ Support/maintenance – reduce variability and unplanned downtime

Remove Variability

- ☑ JIT systems require managers to reduce variability caused by both internal and external factors
- ☑ Variability is any deviation from the optimum process
- ☑ Inventory hides variability
- ☑ Less variability results in less waste

Sources of Variability

1. Incomplete or inaccurate drawings or specifications
2. Poor production processes resulting in incorrect quantities, late, or non-conforming units
3. Unknown customer demands

Sources of Variability

1. Incomplete or inaccurate drawings or specifications
2. Poor production processes resulting in incorrect quantities, late, or non-conf
3. Unkno

Both JIT and inventory reduction are effective tools in identifying causes of variability

Improve Throughput

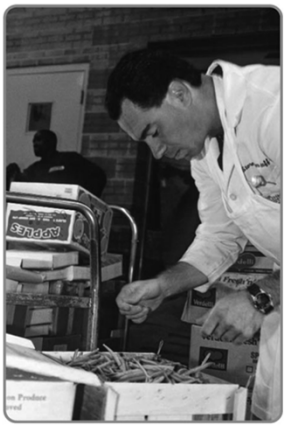
- ☑ The time it takes to move an order from receipt to delivery
- ☑ The time between the arrival of raw materials and the shipping of the finished order is called manufacturing cycle time
- ☑ A pull system increases throughput

Improve Throughput

- ☑ *By pulling material in small lots, inventory cushions are removed, exposing problems and emphasizing continual improvement*
- ☑ *Manufacturing cycle time is reduced*
- ☑ *Push systems dump orders on the downstream stations regardless of the need*

Just-In-Time (JIT)

- *Powerful strategy for improving operations*
- *Materials arrive where they are needed when they are needed*
- *Identifying problems and driving out waste reduces costs and variability and improves throughput*
- *Requires a meaningful buyer-supplier relationship*



JIT and Competitive Advantage

JIT TECHNIQUES:

Suppliers:	Few vendors; Supportive supplier relationships; Quality deliveries on time, directly to work areas.
Layout:	Work-cells; Group technology; Flexible machinery; Organized workplace; Reduced space for inventory.
Inventory:	Small lot sizes; Low setup time; Specialized parts bins
Scheduling:	Zero deviation from schedules; Level schedules; Suppliers informed of schedules; Kanban techniques
Preventive maintenance:	Scheduled; Daily routine; Operator involvement
Quality production:	Statistical process control; Quality suppliers; Quality within the firm
Employee empowerment:	Empowered and cross-trained employees; Training support; Few job classifications to ensure flexibility of employees
Commitment:	Support of management, employees, and suppliers

Figure 16.1

JIT and Competitive Advantage

WHICH RESULTS IN:

Rapid throughput frees assets
Quality improvement reduces waste
Cost reduction adds pricing flexibility
Variability reduction
Rework reduction

WHICH WINS ORDERS BY:

Faster response to the customer at lower cost and higher quality—

A Competitive Advantage

Figure 16.1

JIT Partnerships

- ☑ *JIT partnerships exist when a supplier and purchaser work together to remove waste and drive down costs*
- ☑ *Four goals of JIT partnerships are:*
  - ☑ *Removal of unnecessary activities*
  - ☑ *Removal of in-plant inventory*
  - ☑ *Removal of in-transit inventory*
  - ☑ *Improved quality and reliability*

JIT Partnerships

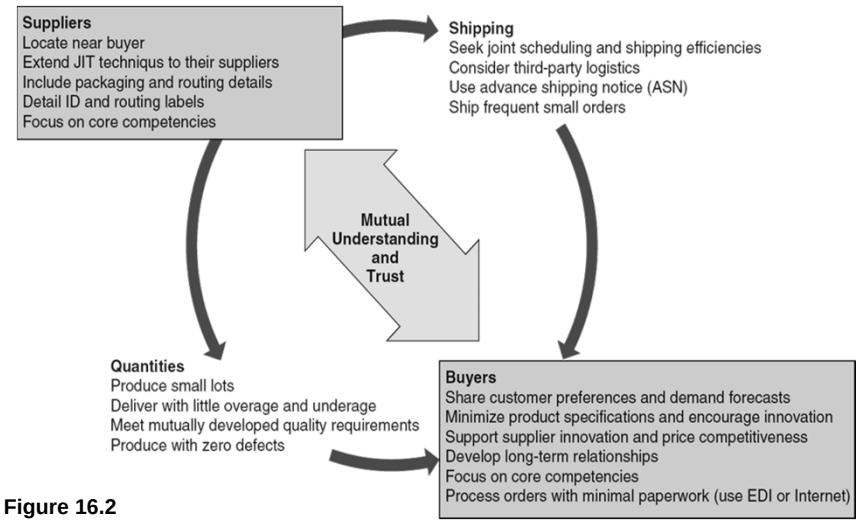


Figure 16.2

Concerns of Suppliers

- ☑ Diversification – ties to only one customer increases risk
- ☑ Scheduling – don't believe customers can create a smooth schedule
- ☑ Changes – short lead times mean engineering or specification changes can create problems
- ☑ Quality – limited by capital budgets, processes, or technology
- ☑ Lot sizes – small lot sizes may transfer costs to suppliers

JIT Layout

Reduce waste due to movement

JIT Layout Tactics
Build work cells for families of products
Include a large number operations in a small area
Minimize distance
Design little space for inventory
Improve employee communication
Use poka-yoke devices
Build flexible or movable equipment
Cross-train workers to add flexibility

Table 16.1

Distance Reduction

- ☑ Large lots and long production lines with single-purpose machinery are being replaced by smaller flexible cells
- ☑ Often U-shaped for shorter paths and improved communication
- ☑ Often using group technology concepts

Increased Flexibility

- ☑ Cells designed to be rearranged as volume or designs change
- ☑ Applicable in office environments as well as production settings
- ☑ Facilitates both product and process improvement

Impact on Employees

- ☑ *Employees are cross trained for flexibility and efficiency*
- ☑ *Improved communications facilitate the passing on of important information about the process*
- ☑ *With little or no inventory buffer, getting it right the first time is critical*

Reduced Space and Inventory

- ☑ *With reduced space, inventory must be in very small lots*
- ☑ *Units are always moving because there is no storage*

Inventory

Inventory is at the minimum level necessary to keep operations running

JIT Inventory Tactics
Use a pull system to move inventory
Reduce lot sizes
Develop just-in-time delivery systems with suppliers
Deliver directly to point of use
Perform to schedule
Reduce setup time
Use group technology

Table 16.2

Reduce Variability

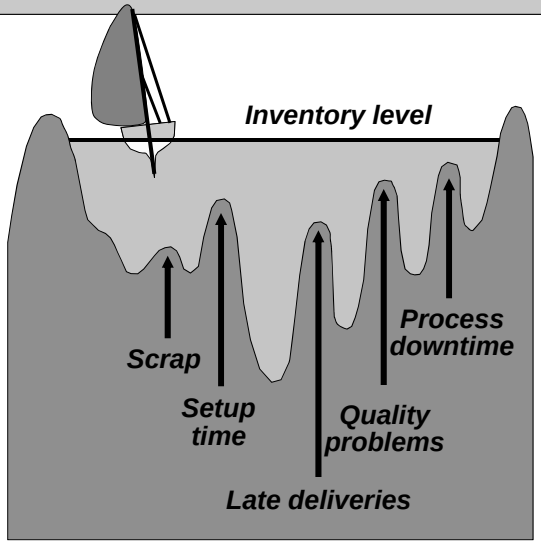


Figure 16.3

Reduce Variability

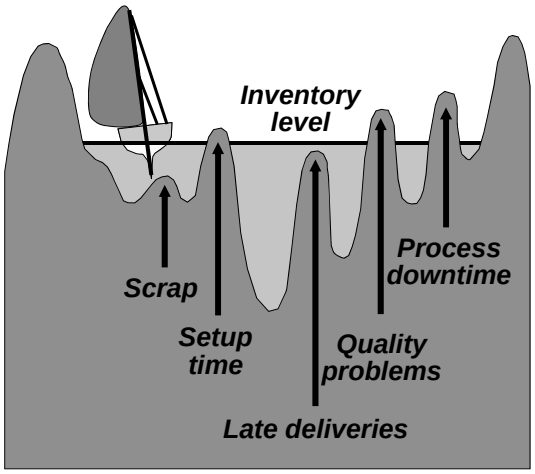


Figure 16.3

Reduce Lot Sizes

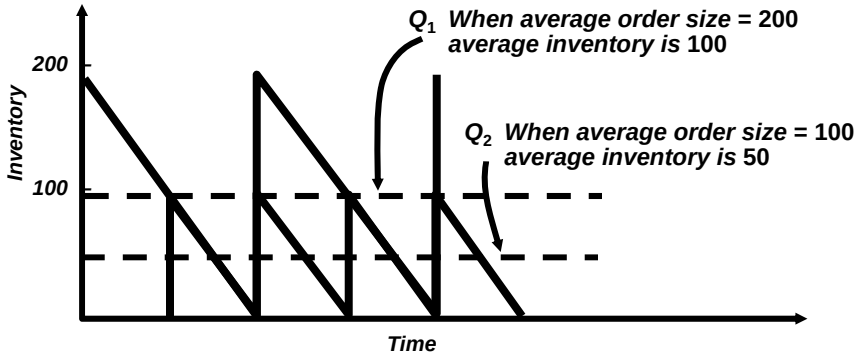


Figure 16.4

Reduce Lot Sizes

- ☑ *Ideal situation is to have lot sizes of one pulled from one process to the next*
- ☑ *Often not feasible*
- ☑ *Can use EOQ analysis to calculate desired setup time*
- ☑ *Two key changes necessary*
  - ☑ *Improve material handling*
  - ☑ *Reduce setup time*

Lot Size Example

D = *Annual demand* = 400,000 *units*
d = *Daily demand* = 400,000/250 = 1,600 *per day*
p = *Daily production rate* = 4,000 *units*
Q = *EOQ desired* = 400
H = *Holding cost* = $20 *per unit*
S = *Setup cost (to be determined)*

$$Q = \sqrt{\frac{2DS}{H(1 - d/p)}} \qquad Q^2 = \frac{2DS}{H(1 - d/p)}$$

$$S = \frac{(Q^2)(H)(1 - d/p)}{2D} = \frac{(3{,}200{,}000)(0.6)}{800{,}000} = \$2.40$$

Setup time = $2.40/($30/*hour*) = 0.08 *hr* = 4.8 *minutes*

Reduce Setup Costs

- ☑ *High setup costs encourage large lot sizes*
- ☑ *Reducing setup costs reduces lot size and reduces average inventory*
- ☑ *Setup time can be reduced through preparation prior to shutdown and changeover*

Lower Setup Costs

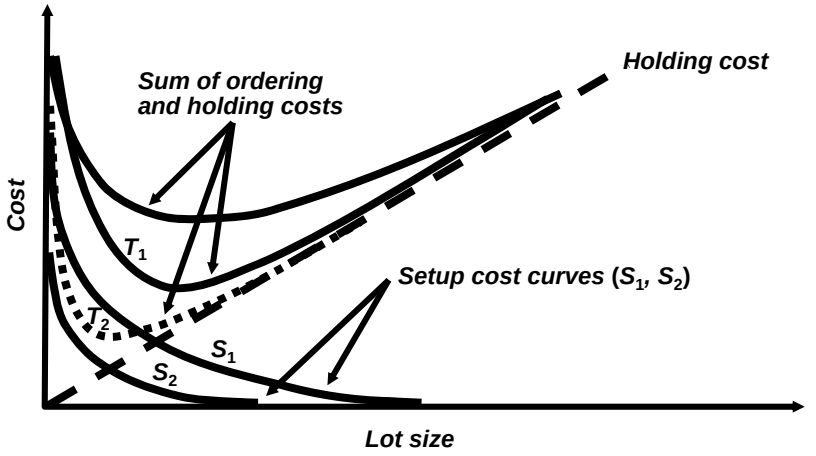


Figure 16.5

Reduce Setup Times

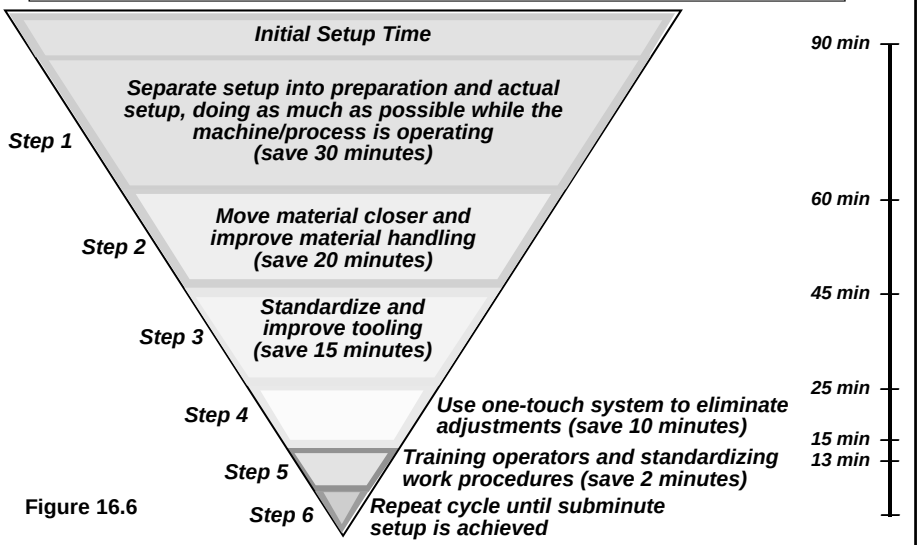


Figure 16.6

JIT Scheduling

- ☑ Schedules must be communicated inside and outside the organization
- ☑ Level schedules
  - ☑ Process frequent small batches
  - ☑ Freezing the schedule helps stability
- ☑ Kanban
  - ☑ Signals used in a pull system

JIT Scheduling

Better scheduling improves performance

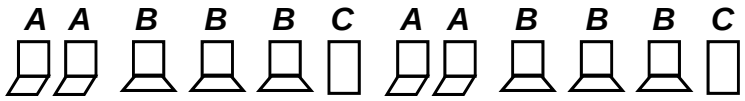
JIT Scheduling Tactics	Table 16.3
Communicate schedules to suppliers	
Make level schedules	
Freeze part of the schedule	
Perform to schedule	
Seek one-piece-make and one-piece move	
Eliminate waste	
Produce in small lots	
Use kanbans	
Make each operation produce a perfect part	

Level Schedules

- ☑ Process frequent small batches rather than a few large batches
- ☑ Make and move small lots so the level schedule is economical
- ☑ "Jelly bean" scheduling
- ☑ Freezing the schedule closest to the due dates can improve performance

Scheduling Small Lots

JIT Level Material-Use Approach



Large-Lot Approach

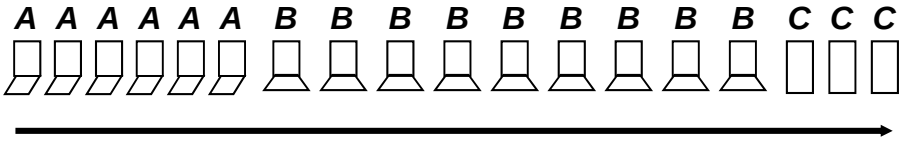


Figure 16.7

Kanban

- ☑ *Kanban is the Japanese word for card*
- ☑ *The card is an authorization for the next container of material to be produced*
- ☑ *A sequence of kanbans pulls material through the process*
- ☑ *Many different sorts of signals are used, but the system is still called a kanban*

Kanban

1. User removes a standard sized container
2. Signal is seen by the producing department as authorization to replenish

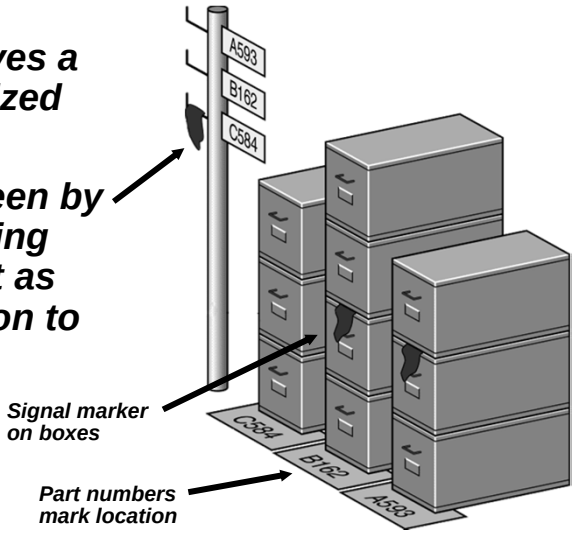


Figure 16.8

Kanban

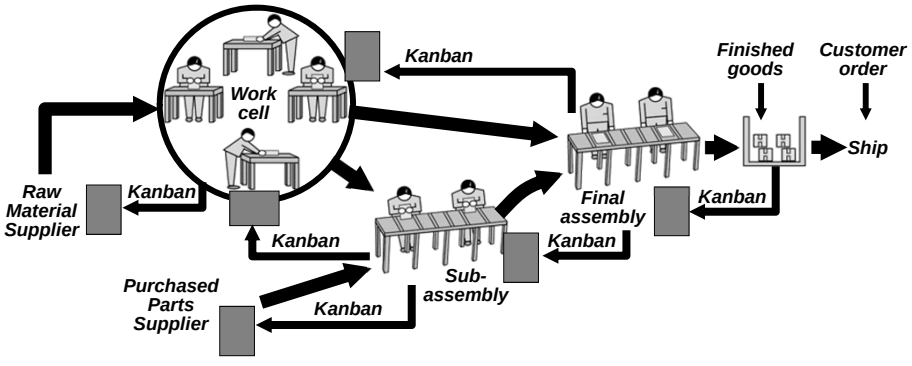


Figure 16.9

More Kanban

- ☑ When the producer and user are not in visual contact, a card can be used
- ☑ When the producer and user are in visual contact, a light or flag or empty spot on the floor may be adequate
- ☑ Since several components may be required, several different kanban techniques may be employed

More Kanban

- ☑ Usually each card controls a specific quantity or parts
- ☑ Multiple card systems may be used if there are several components or different lot sizes
- ☑ In an MRP system, the schedule can be thought of as a build authorization and the kanban a type of pull system that initiates actual production

More Kanban

- ☑ *Kanban cards provide a direct control and limit on the amount of work-in-process between cells*
- ☑ *If there is an immediate storage area, a two-card system can be used with one card circulating between the user and storage area and the other between the storage area and the producer*

The Number of Kanban Cards or Containers

- ☑ *Need to know the lead time needed to produce a container of parts*
- ☑ *Need to know the amount of safety stock needed*

$$\text{Number of kanbans (containers)} = \frac{\text{Demand during lead time} + \text{Safety stock}}{\text{Size of container}}$$

Number of Kanbans Example

Daily demand	=	500 *cakes*
Production lead time (Wait time + Material handling time + Processing time)	=	2 *days*
Safety stock	=	1/2 *day*
Container size	=	250 *cakes*

Demand during lead time = 2 *days* x 500 *cakes* = 1,000

$$\textit{Number of kanbans} = \frac{1{,}000 + 250}{250} = 5$$

Advantages of Kanban

- ☑ *Allow only limited amount of faulty or delayed material*
- ☑ *Problems are immediately evident*
- ☑ *Puts downward pressure on bad aspects of inventory*
- ☑ *Standardized containers reduce weight, disposal costs, wasted space, and labor*

Quality

- ☑ Strong relationship
  - ☑ JIT cuts the cost of obtaining good quality because JIT exposes poor quality
  - ☑ Because lead times are shorter, quality problems are exposed sooner
  - ☑ Better quality means fewer buffers and allows simpler JIT systems to be used

JIT Quality Tactics

Use statistical process control

Empower employees

Build fail-safe methods (poka-yoke, checklists, etc.)

Expose poor quality with small lot JIT

Provide immediate feedback

Table 16.4

Toyota Production System

- ☑ *Continuous improvement*
  - ☑ *Build an organizational culture and value system that stresses improvement of all processes*
  - ☑ *Part of everyone's job*
- ☑ *Respect for people*
  - ☑ *People are treated as knowledge workers*
  - ☑ *Engage mental and physical capabilities*
  - ☑ *Empower employees*

Toyota Production System

- ☑ *Standard work practice*
  - ☑ *Work shall be completely specified as to content, sequence, timing, and outcome*
  - ☑ *Internal and external customer-supplier connection are direct*
  - ☑ *Product and service flows must be simple and direct*
  - ☑ *Any improvement must be made in accordance with the scientific method at the lowest possible level of the organization*

Lean Operations

- ☑ *Different from JIT in that it is externally focused on the customer*
- ☑ *Starts with understanding what the customer wants*
- ☑ *Optimize the entire process from the customer's perspective*

Building a Lean Organization

- ☑ *Transitioning to a lean system can be difficult*
- ☑ *Lean systems tend to have the following attributes*
  - ☑ *Use JIT techniques*
  - ☑ *Build systems that help employees produce perfect parts*
  - ☑ *Reduce space requirements*

Building a Lean Organization

- ☑ *Develop partnerships with suppliers*
- ☑ *Educate suppliers*
- ☑ *Eliminate all but value-added activities*
- ☑ *Develop employees*
- ☑ *Make jobs challenging*
- ☑ *Build worker flexibility*

JIT in Services

- ☑ *The JIT techniques used in manufacturing are used in services*
  - ☑ *Suppliers*
  - ☑ *Layouts*
  - ☑ *Inventory*
  - ☑ *Scheduling*