Just-in-Time and Lean Production Systems

Introductory Quotation

Waste **is 'anything other than the** ***minimum*** **amount of equipment, materials, parts, space, and worker's time, which are absolutely essential to** ***add value*** **to the product.'**

— Shoichiro Toyoda
President, Toyota

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JIT/Lean Operations

Good production systems require that managers address three issues that are pervasive and fundamental to operations management: eliminate waste, remove variability, and improve throughput

1. 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, sustainable 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
- **Simplify/straighten** – methods

- Two additional Ss
- Safety – build in good practices
- Support/maintenance – reduce variability and unplanned downtime

2. 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

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

3. Improve Throughput

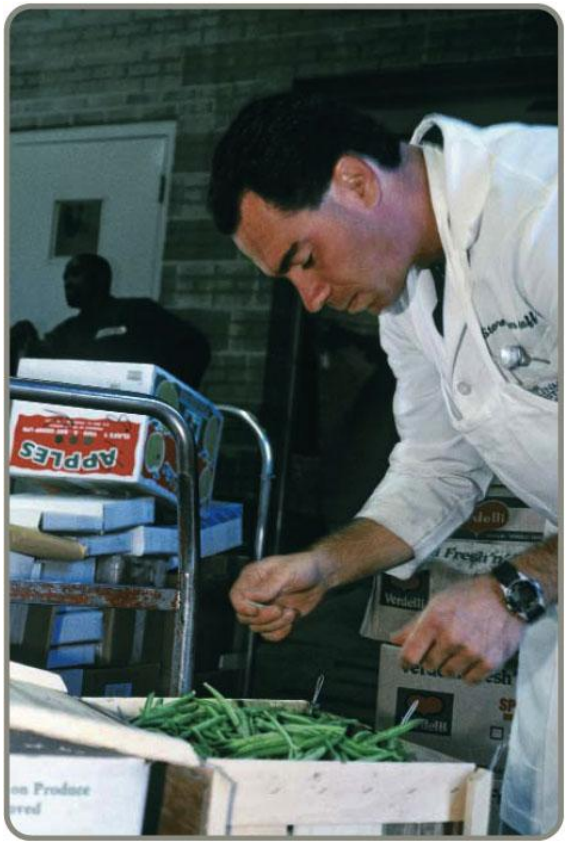
- The time it takes to move an order from receipt to delivery
- The time between the arrival of raw materials and the shipping of the finished order is called manufacturing cycle time
- A pull system increases throughput

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

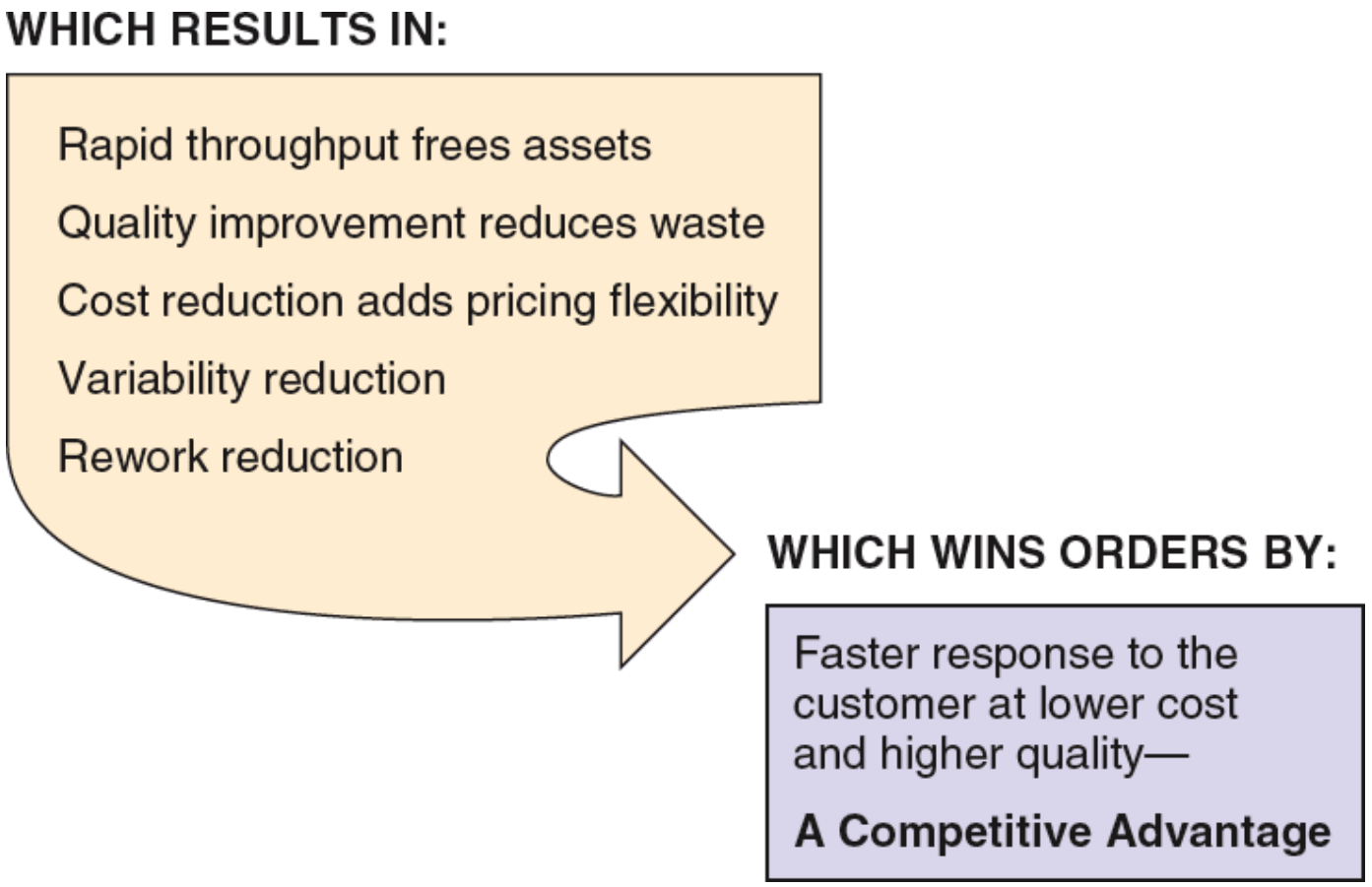


Figure 16.1

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

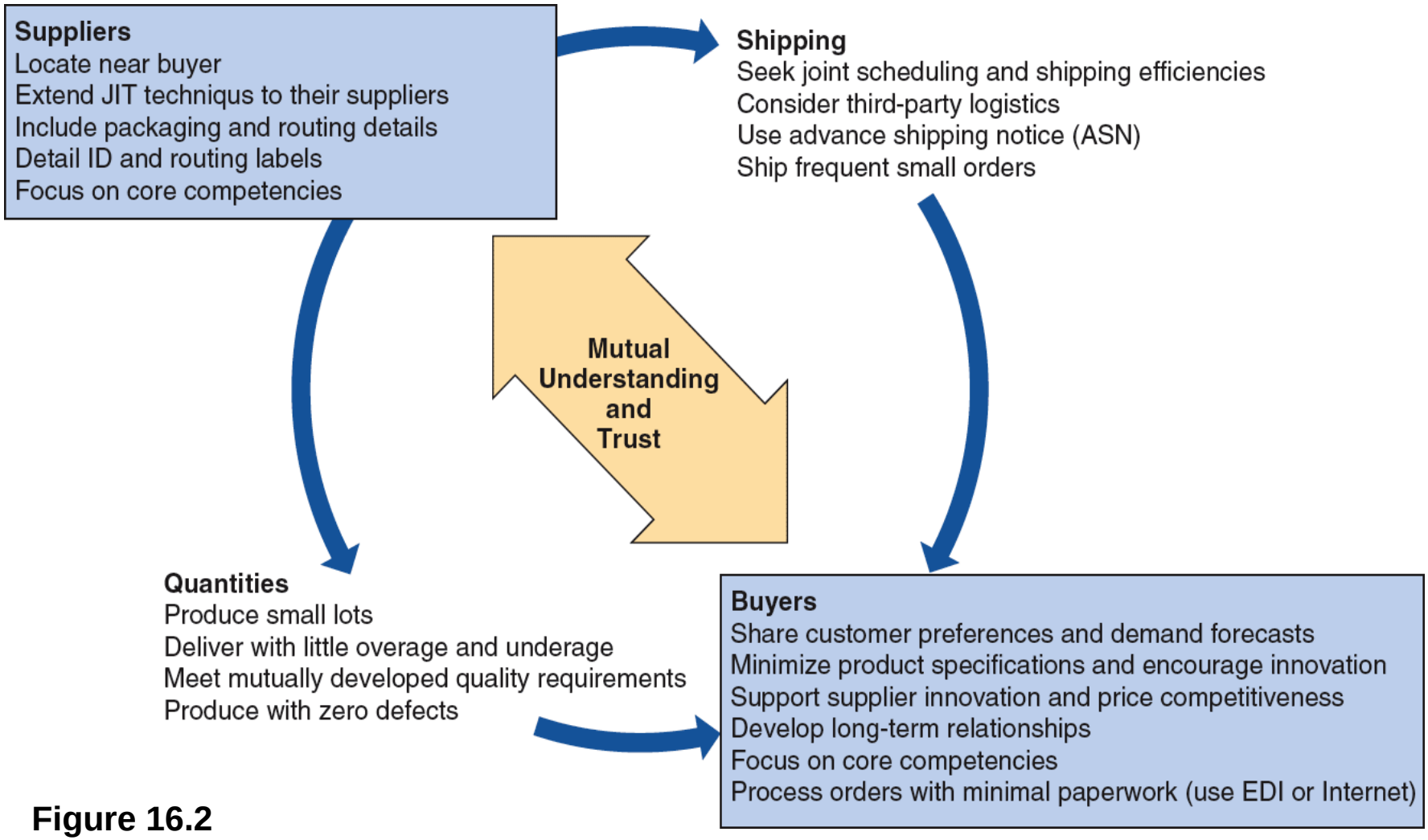


Figure 16.2

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 (fail safe) 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 may be 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**

JIT 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

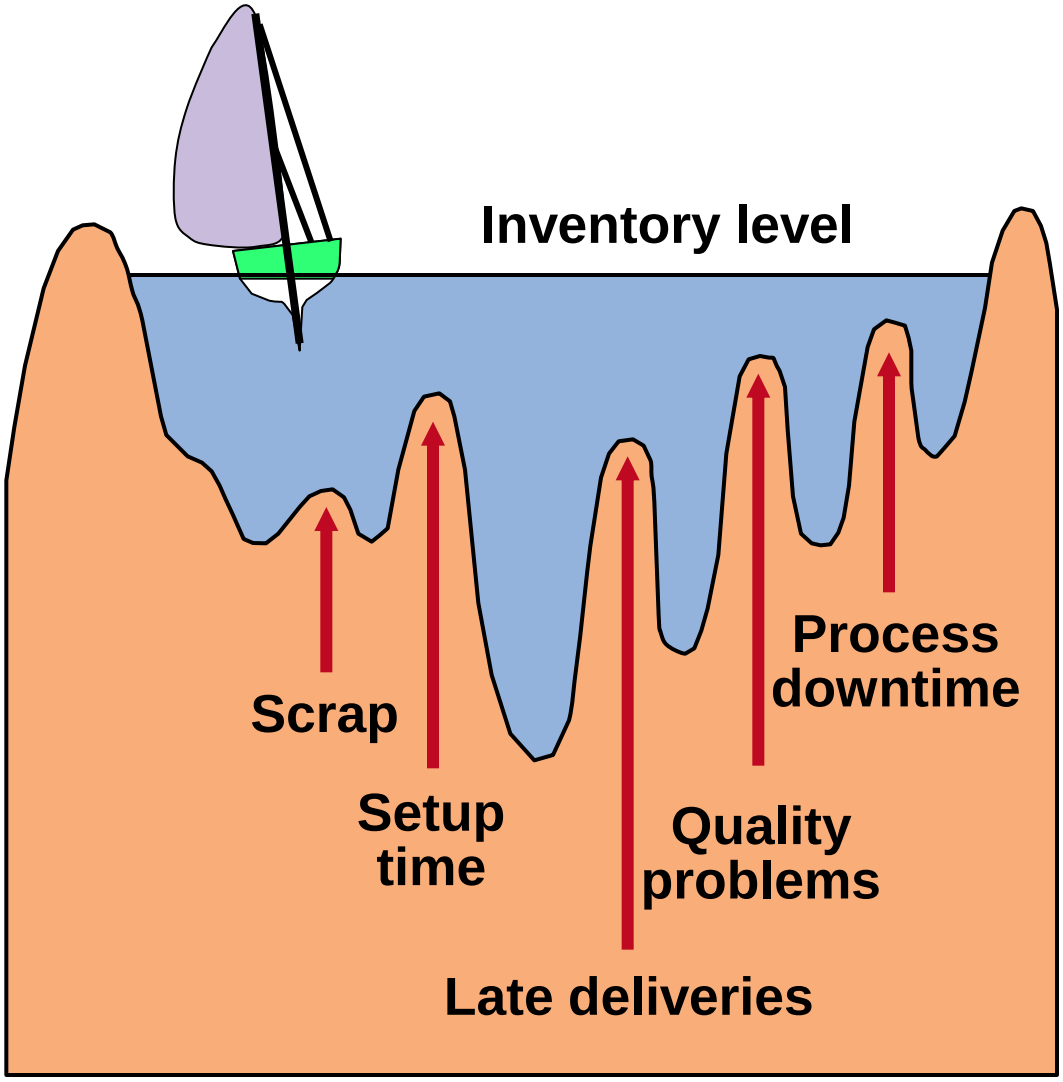


Figure 16.3

Reduce Variability

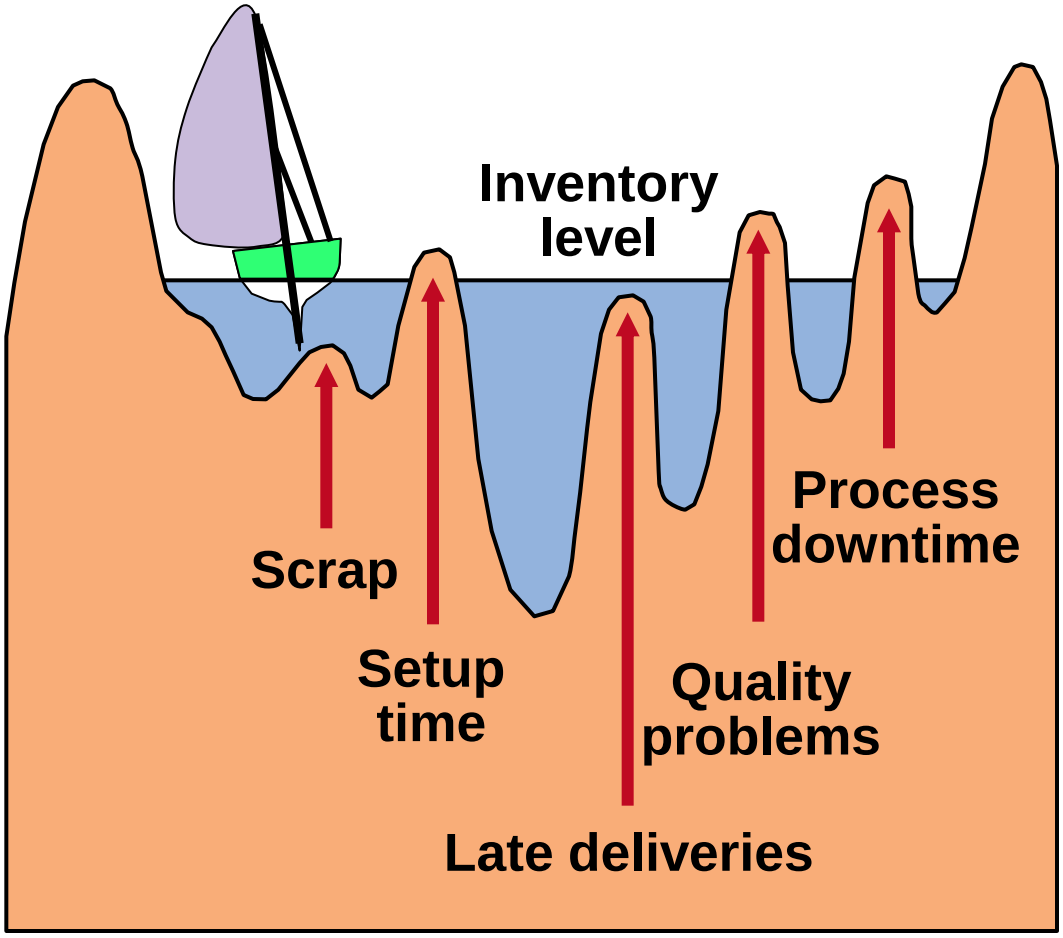


Figure 16.3

Reduce Variability

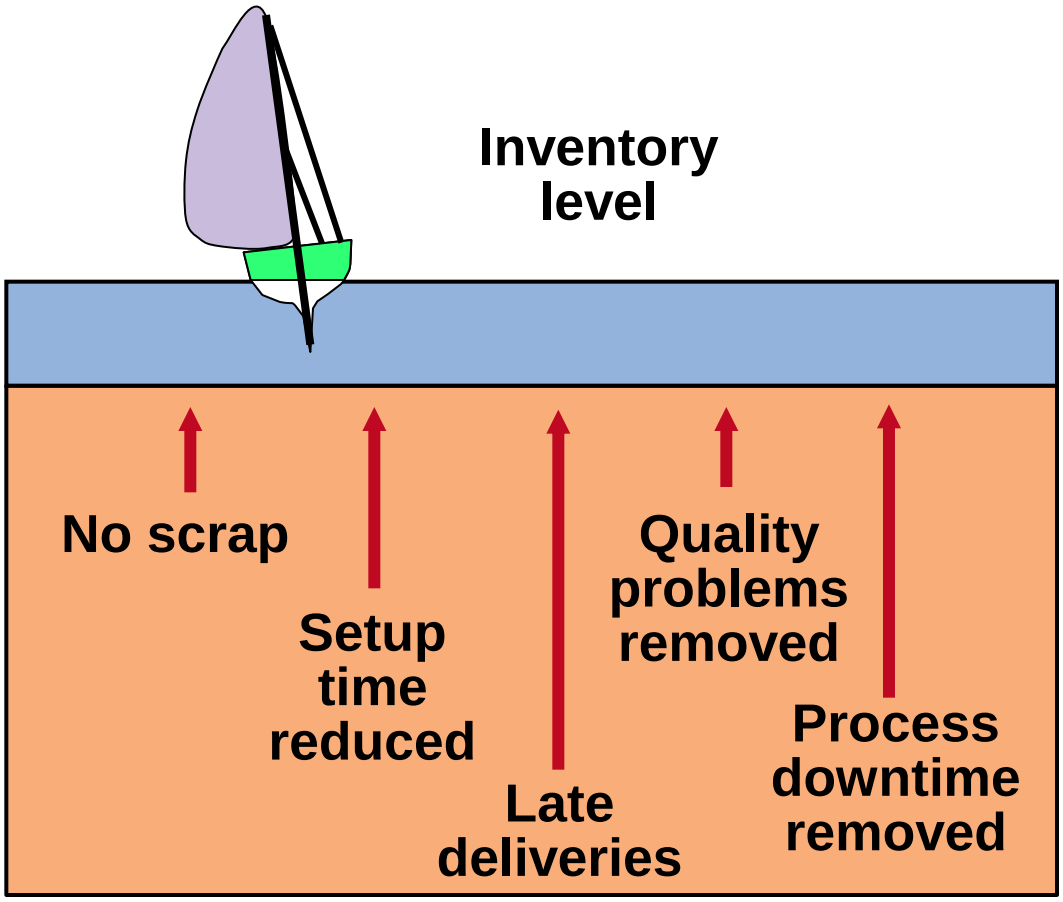


Figure 16.3

Reduce Inventory

- Reducing inventory uncovers the "rocks"
- Problems are exposed
- Ultimately there will be virtually no inventory and no problems

- Shingo says "Inventory is evil"

Reduce Lot Sizes

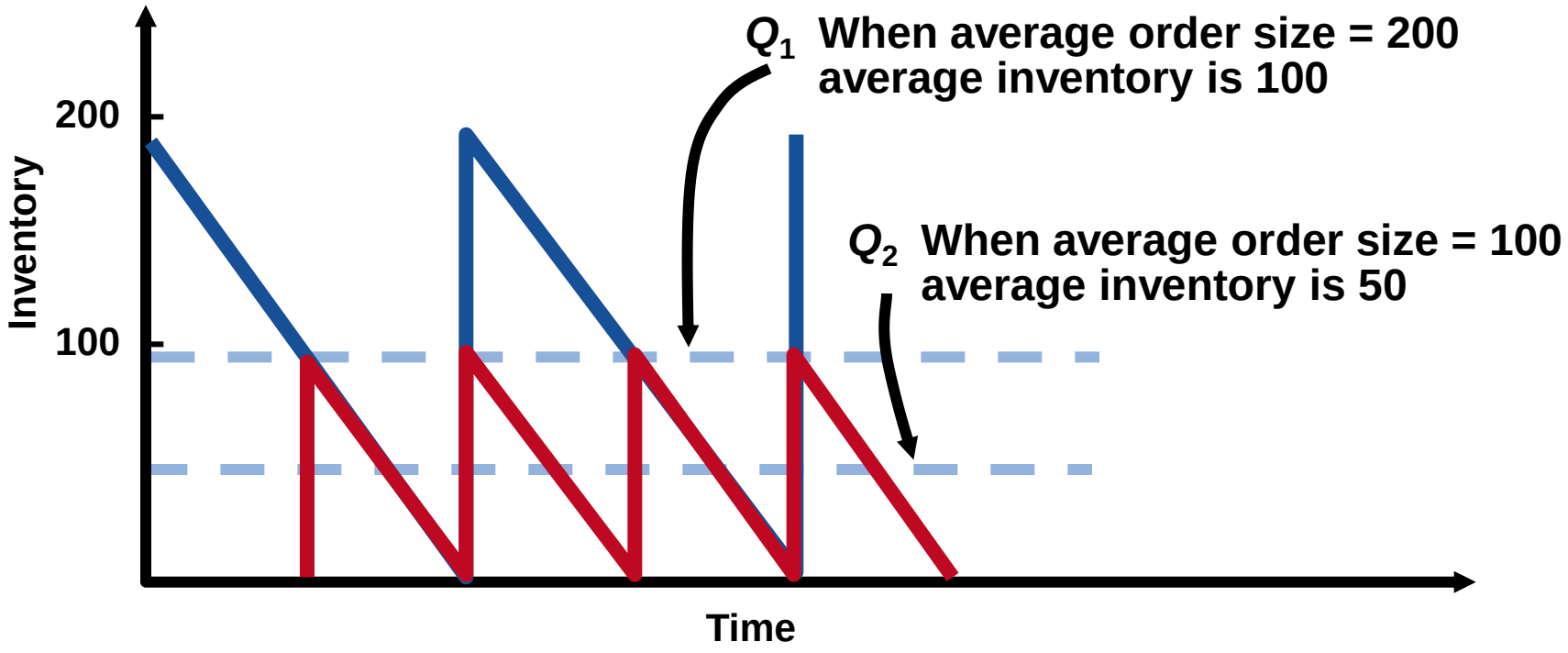


Figure 16.4

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

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

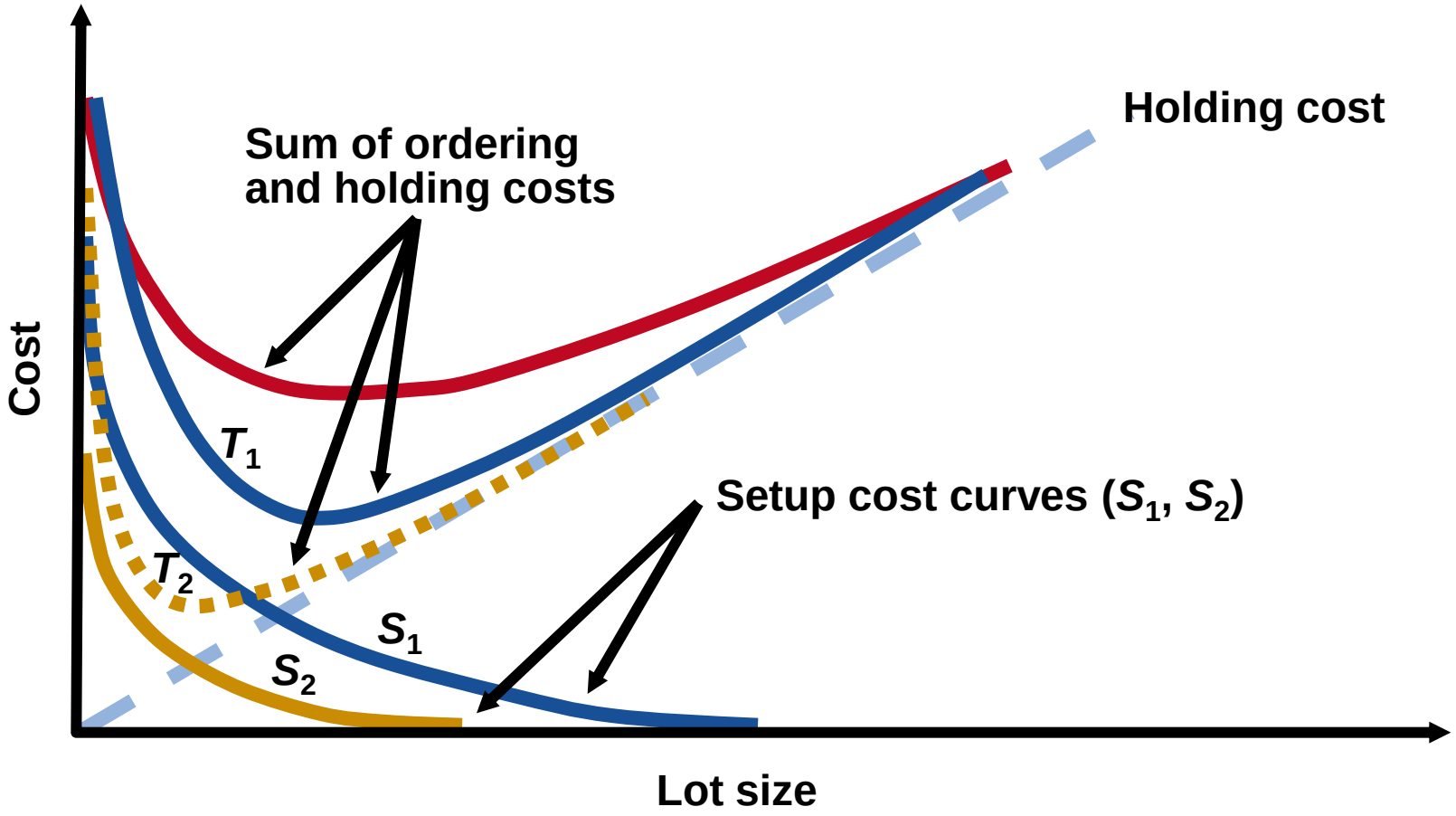


Figure 16.5

Reduce Setup Times

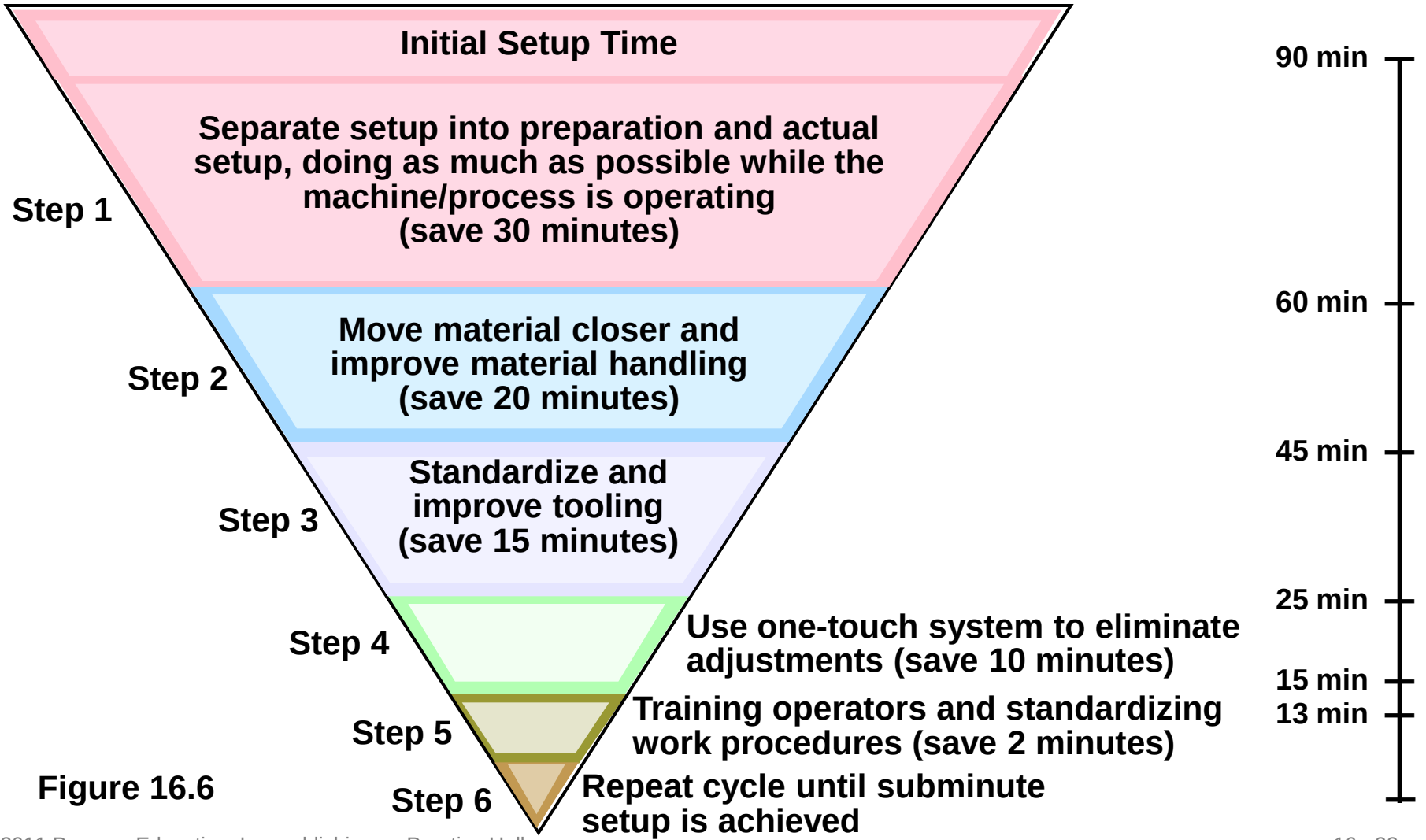


Figure 16.6

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

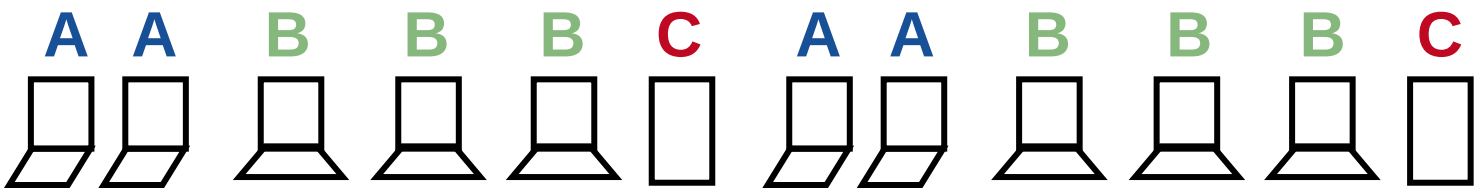
JIT Scheduling Tactics	Table 16.3
Communicate schedules to suppliers	
Make level schedules	
Freeze part of the schedule	
Perform to schedule	
Seek one-piece-make and one-piece move	
Eliminate waste	
Produce in small lots	
Use kanbans	
Make each operation produce a perfect part	

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

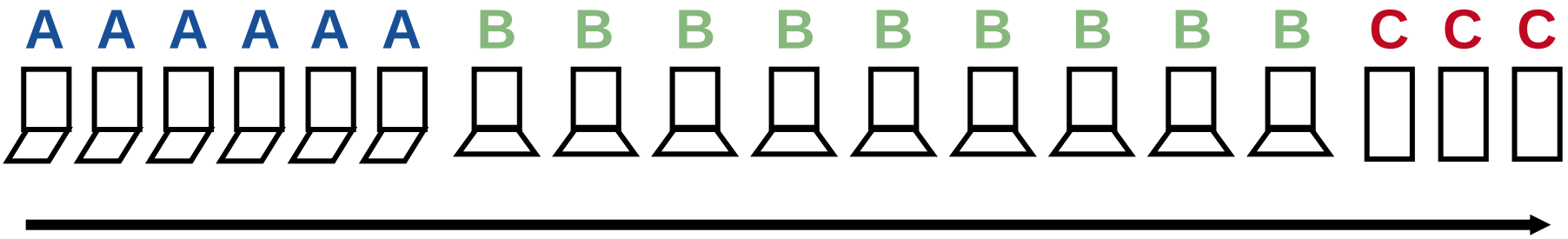
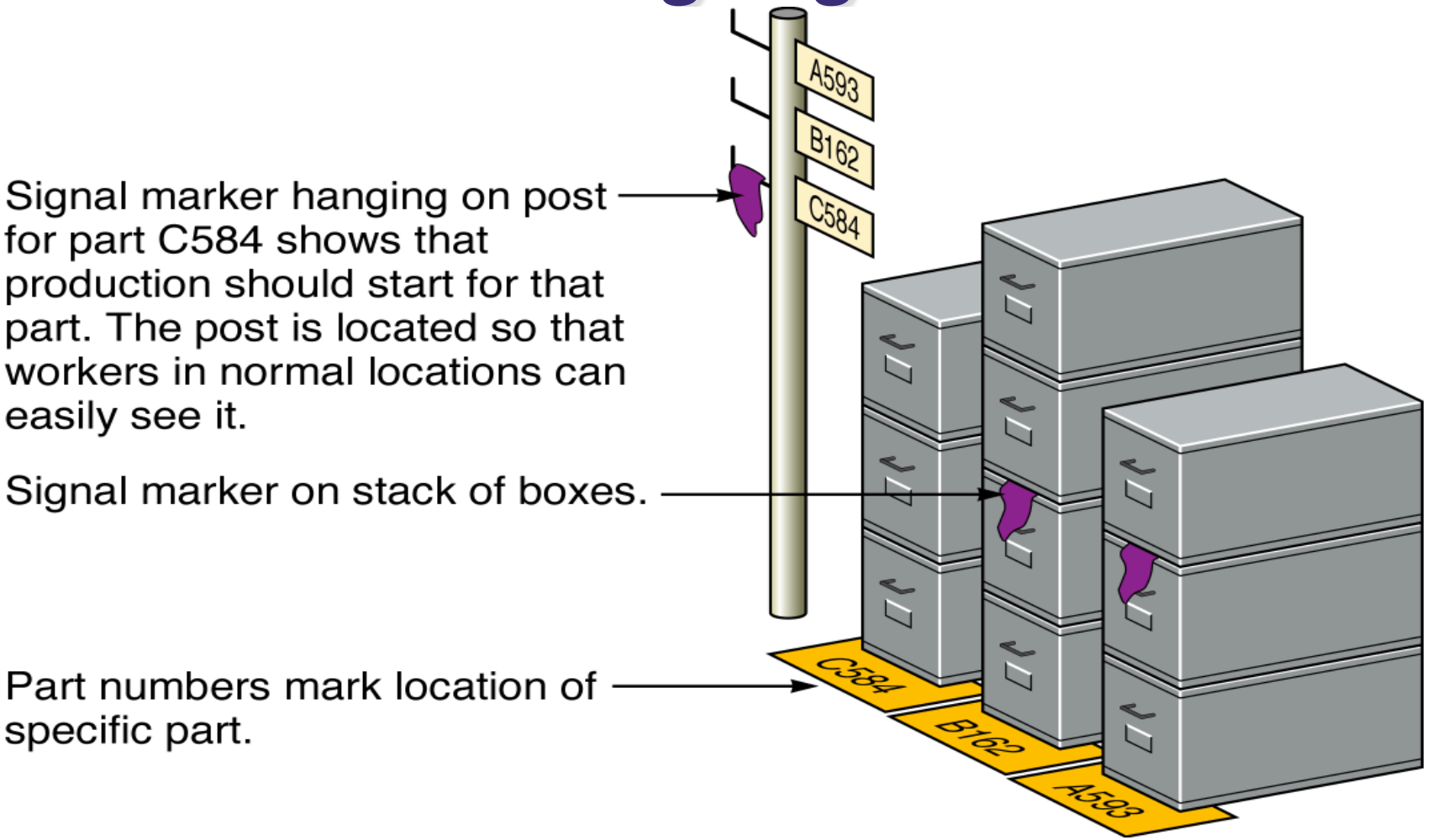


Figure 16.7

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

Diagram of Outbound Stockpoint with Warning-Signal Marker



Kanban

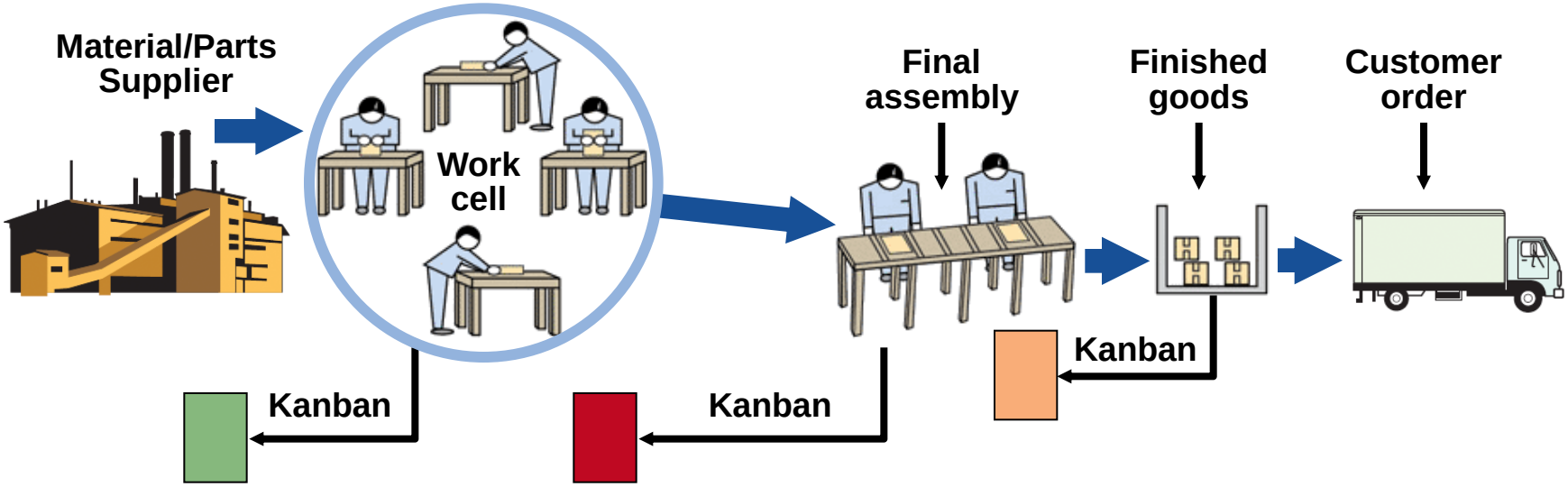
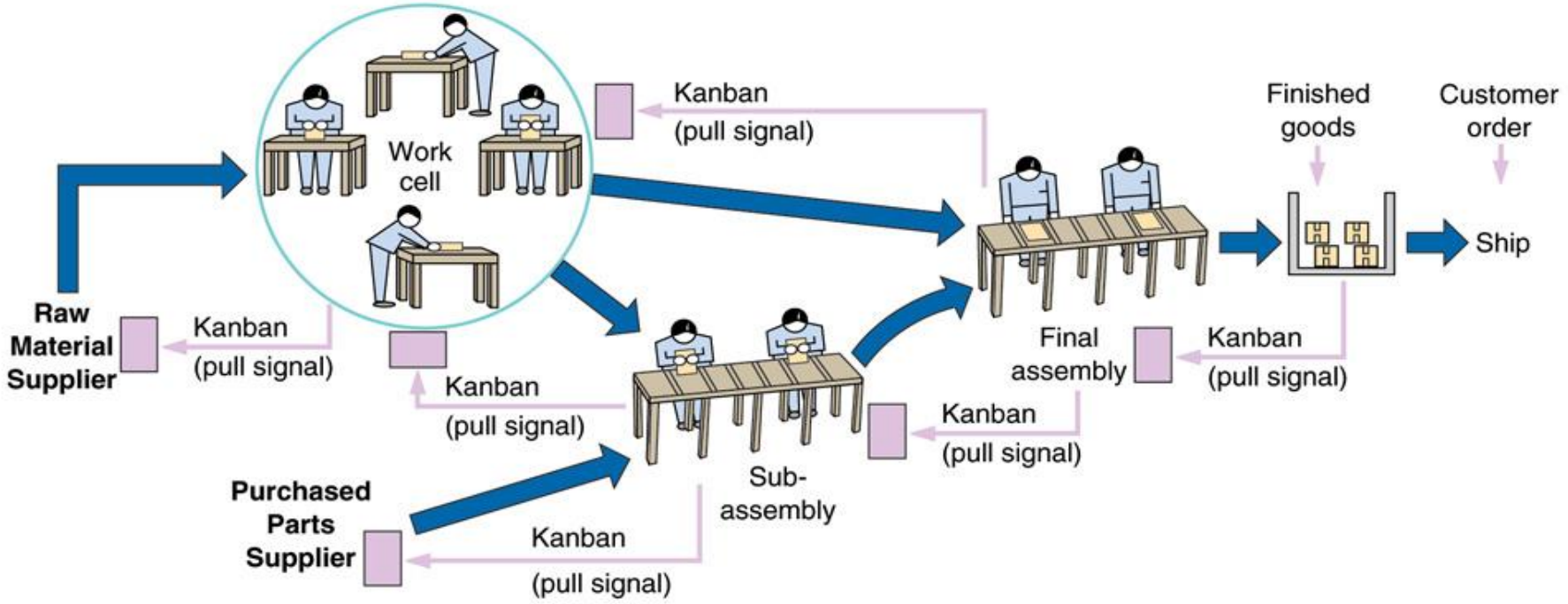
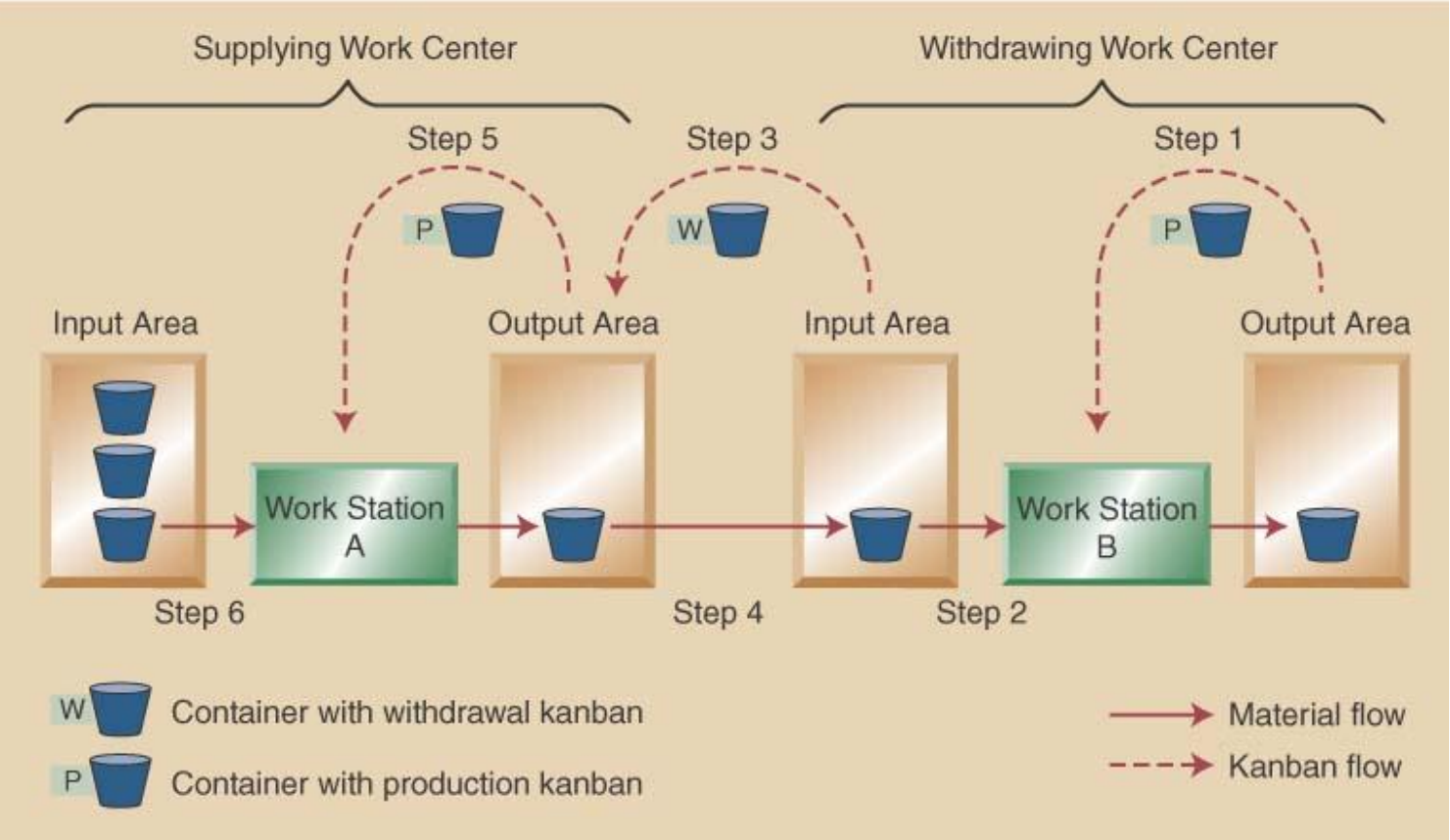


Figure 16.9

Kanban Signals "Pull" Material Through the Process



The Pull System



Number of Kanbans Required

$$N = \frac{DT + S}{C}$$

N = number of containers

D = demand rate at the withdraw station

T = lead time from supply station

C = container size

S = safety stock

Computing the Number of Kanbans: an aspirin manufacturer has converted to JIT manufacturing using kanban containers. They wish to determine the number of containers at the bottle filling operation which fills at a rate of 200 per hour. Each container holds 25 bottles, it takes 30 minutes to receive more bottles, safety stock is 10% of demand during LT.

Solution:

$$D = 200 \text{ bottles per hour}$$

$$T = 30 \text{ minutes} = .5 \text{ hour}$$

$$C = 25 \text{ bottles per container}$$

$$S = 0.10(\text{demand})(T) = 0.10(200)(.5) = 10 \text{ bottles}$$

$$N = \frac{DT + S}{C} = \frac{(200)(.5) + 10}{25} = 4.4 \text{ kanban containers}$$

Question: round up or down?

JIT 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

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

Lean Operations in Services

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