



Just-in-Time and Lean Production Systems

Green Gear Cycling

- ***Designs and manufactures high performance travel bicycles (bike-in-a-suitcase)***
- ***Strategy is mass customization with low inventory, work cells, and elimination of machine setups***
- ***Major focus on JIT and supply-chain management***
- ***One day throughput time***
- ***Focus on quality***

Just-In-Time and Lean Production

- ***JIT is a philosophy of continuous and forced problem solving that supports lean production***
- ***Lean production supplies the customer with their exact wants when the customer wants it without waste***
- ***Key issues are continual improvement and a pull***



Waste Reduction

- ***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***



Waste Reduction

- ***Faster delivery, reduced work-in-process, and faster throughput all reduce waste***
- ***Reduced waste reduces room for errors emphasizing quality***
- ***Reduced inventory releases assets for other, productive purposes***

Variability Reduction

- ***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***

Causes of Variability

- 1. Employees, machines, and suppliers produce units that do not conform to standards, are late, or are not the proper quantity***
- 2. Engineering drawings or specifications are inaccurate***
- 3. Production personnel try to produce before drawings or specifications are complete***
- 4. Customer demands are unknown***

Pull Versus Push Systems

- ***A pull system uses signals to request production and delivery from upstream stations***
- ***Upstream stations only produce when signaled***
- ***System is used within the immediate production process and with suppliers***

Pull Versus Push Systems

- ***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***

JIT and Competitive Advantage

JIT Requires:

Suppliers:	Reduced number of vendors; Supportive supplier relationships; Quality deliveries on time
Layout:	Work-cell layouts with testing at each step of the process; Group technology; Movable, changeable, flexible machinery; High level of workplace organization and neatness; Reduced space for inventory; Delivery directly to work areas
Inventory:	Small lot sizes; Low setup time; Specialized bins for holding set number of parts
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

Table 16.1



JIT and Competitive Advantage

Which Results In:

Queue and delay reduction speeds throughput, frees assets, and wins orders

Quality improvement reduces waste and wins orders

Cost reduction increases margin or reduces selling price

Variability reduction in the workplace reduces wastes and wins orders

Rework reduction reduces wastes and wins orders

Which Yields:

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

A Competitive Advantage

Table 16.1

Suppliers

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

JIT Partnerships

Suppliers

Few suppliers

Nearby suppliers

Repeat business with same suppliers

Support suppliers so they become or remain price competitive

Competitive bidding mostly limited to new purchases

Buyer resists vertical integration and subsequent wipeout of supplier business

Suppliers encouraged to extend JIT buying to their suppliers

JIT Partnerships

Quantities

Share forecasts of demand

Frequent deliveries of small-lot quantities

Long-term contract

Minimal paperwork to release order (EDI or the Internet)

Little or no permissible overage or underage

Suppliers package in exact quantities

Suppliers reduce production lot sizes

JIT Partnerships

Quality

Minimal product specifications imposed on supplier

Help suppliers meet quality requirements

Close relationships between buyers' and suppliers' quality assurance people

Suppliers use poka-yoke and process control charts

JIT Partnerships

Shipping

Scheduling inbound freight

Gain control by using company-owned or contract shipping and warehousing

Use of advanced shipping notice (ASN)



JIT Layout

Reduce waste due to movement

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 16.3

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

Reduce Variability

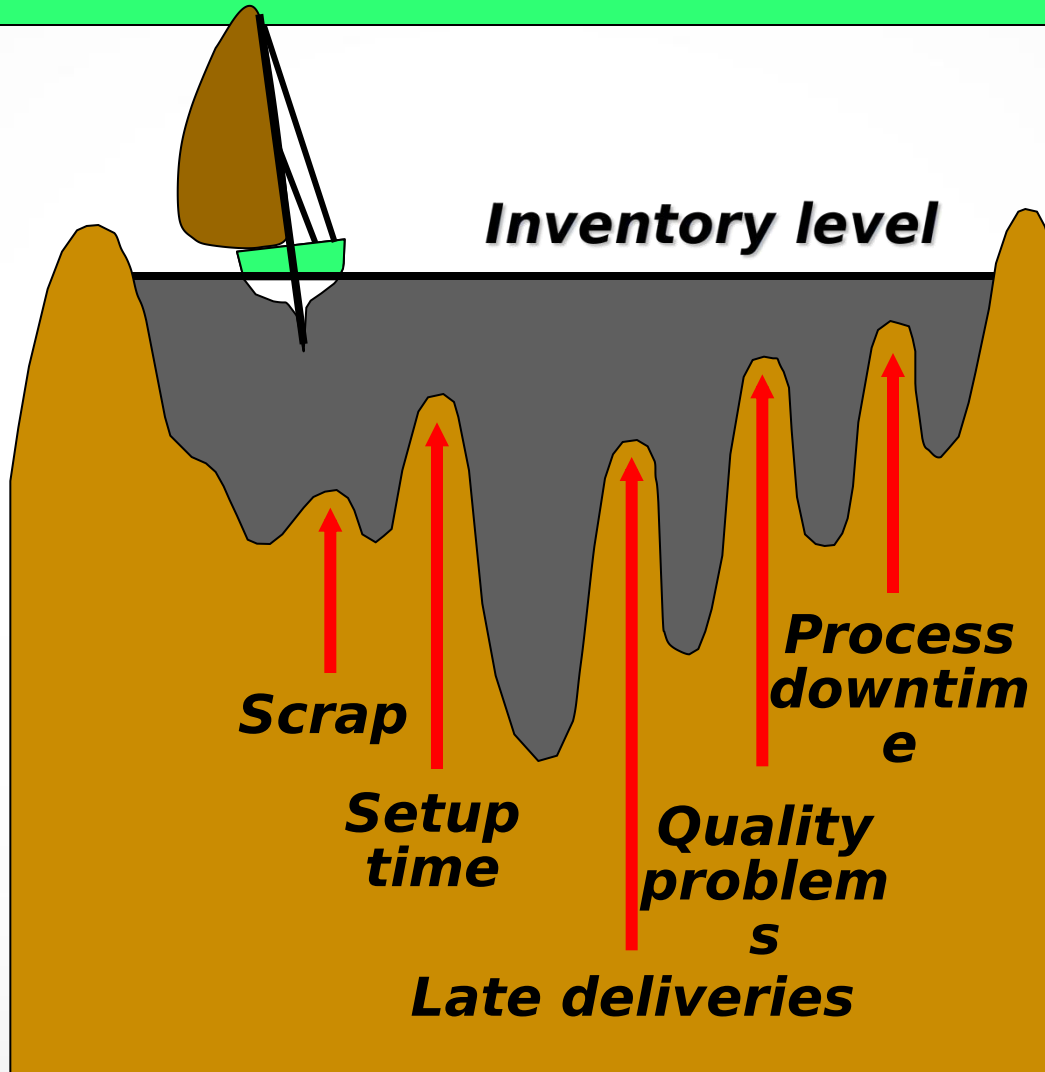


Figure 16.1

Reduce Variability

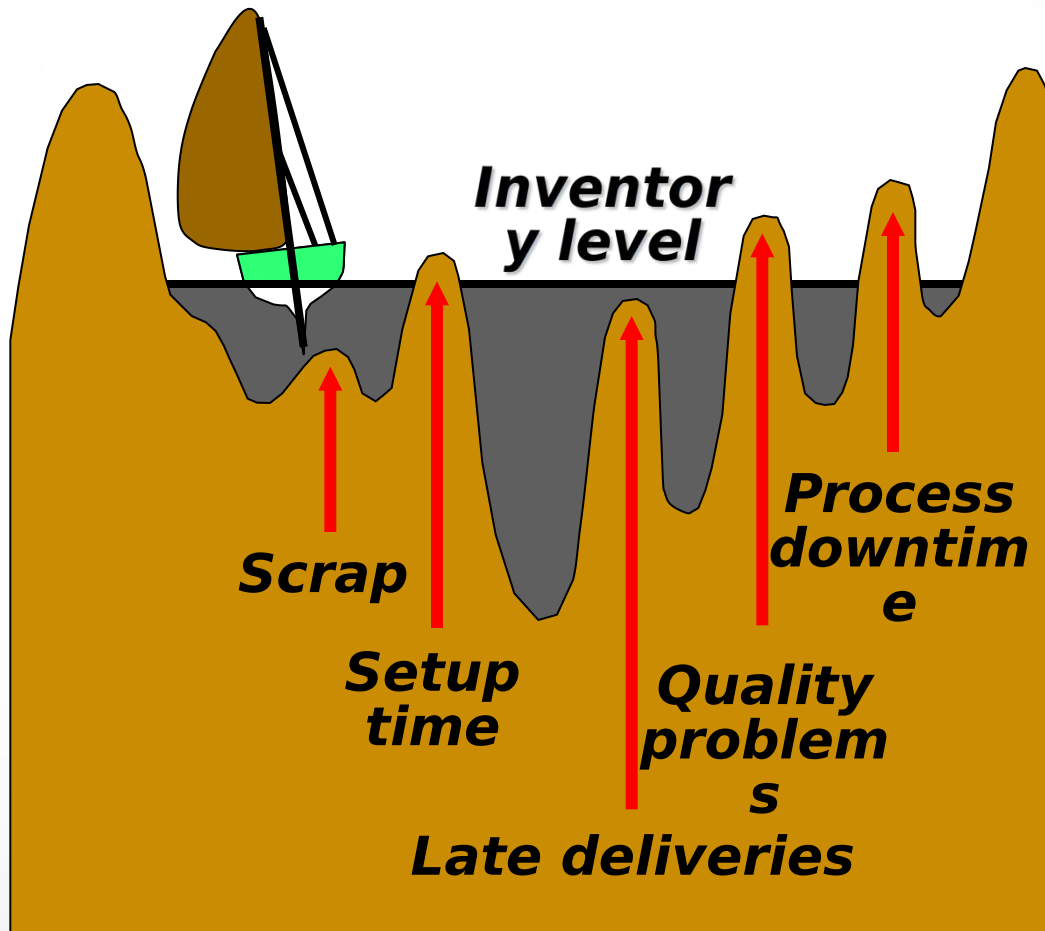


Figure 16.1

Reduce Lot Sizes

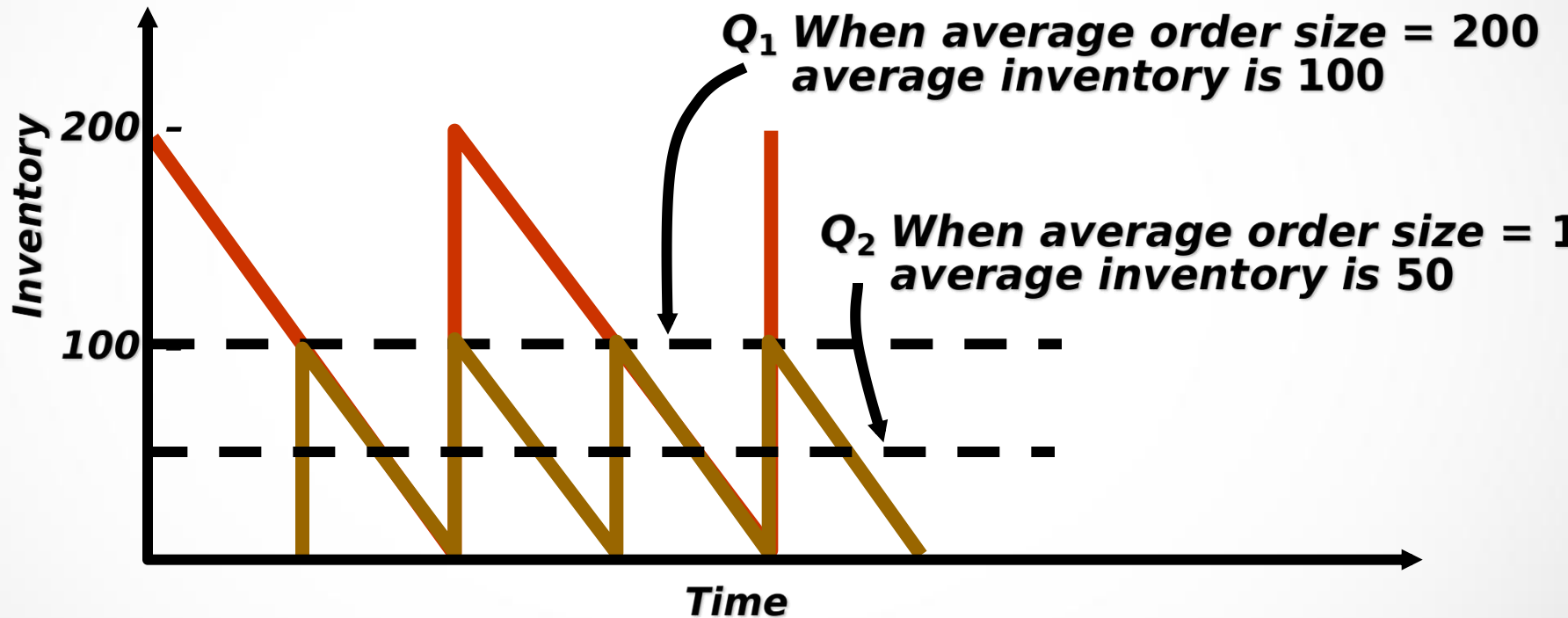


Figure 16.2

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***
 - ***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)

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

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

Lower Setup Costs

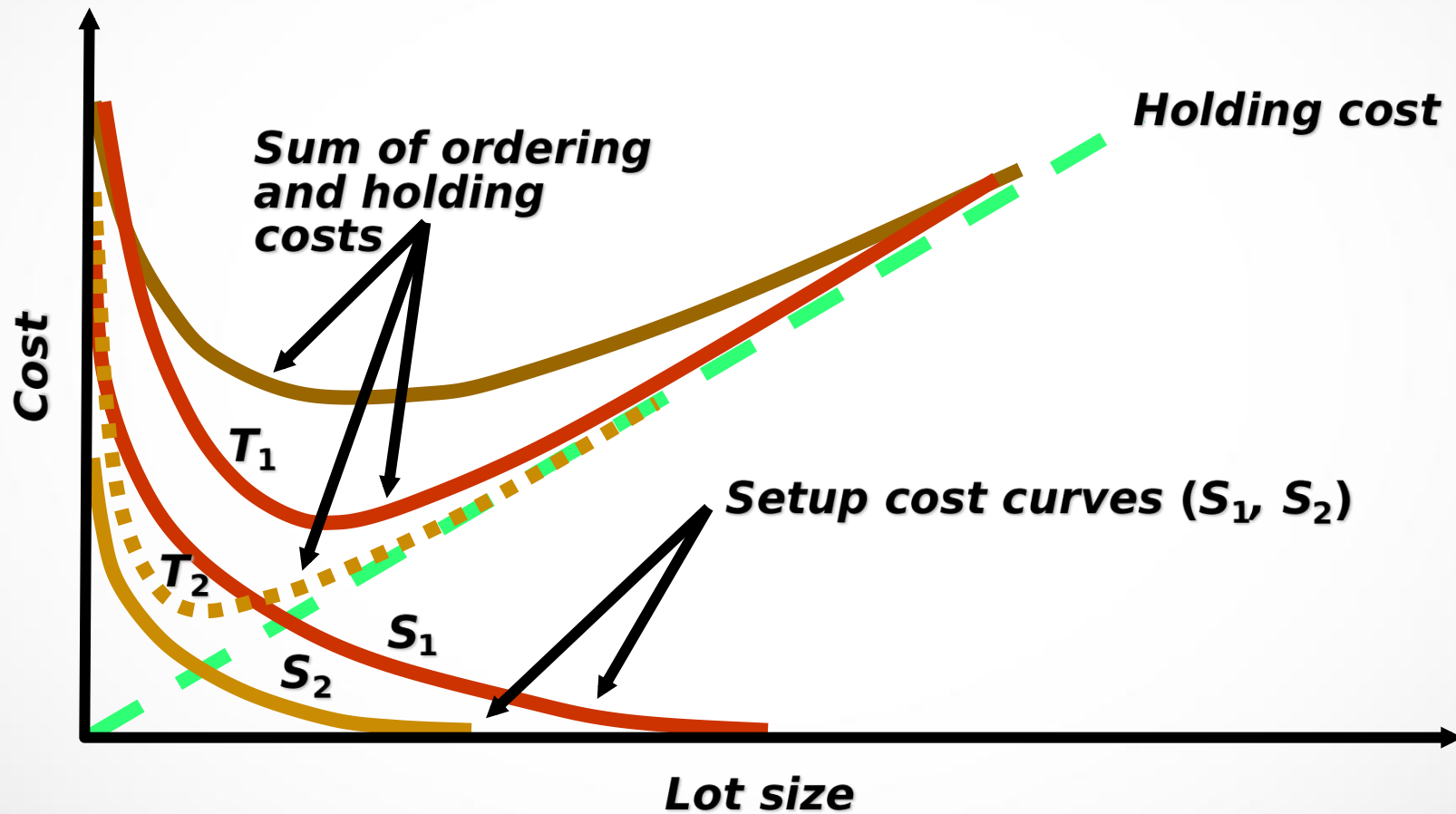


Figure 16.3

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***

Reduce Setup Times

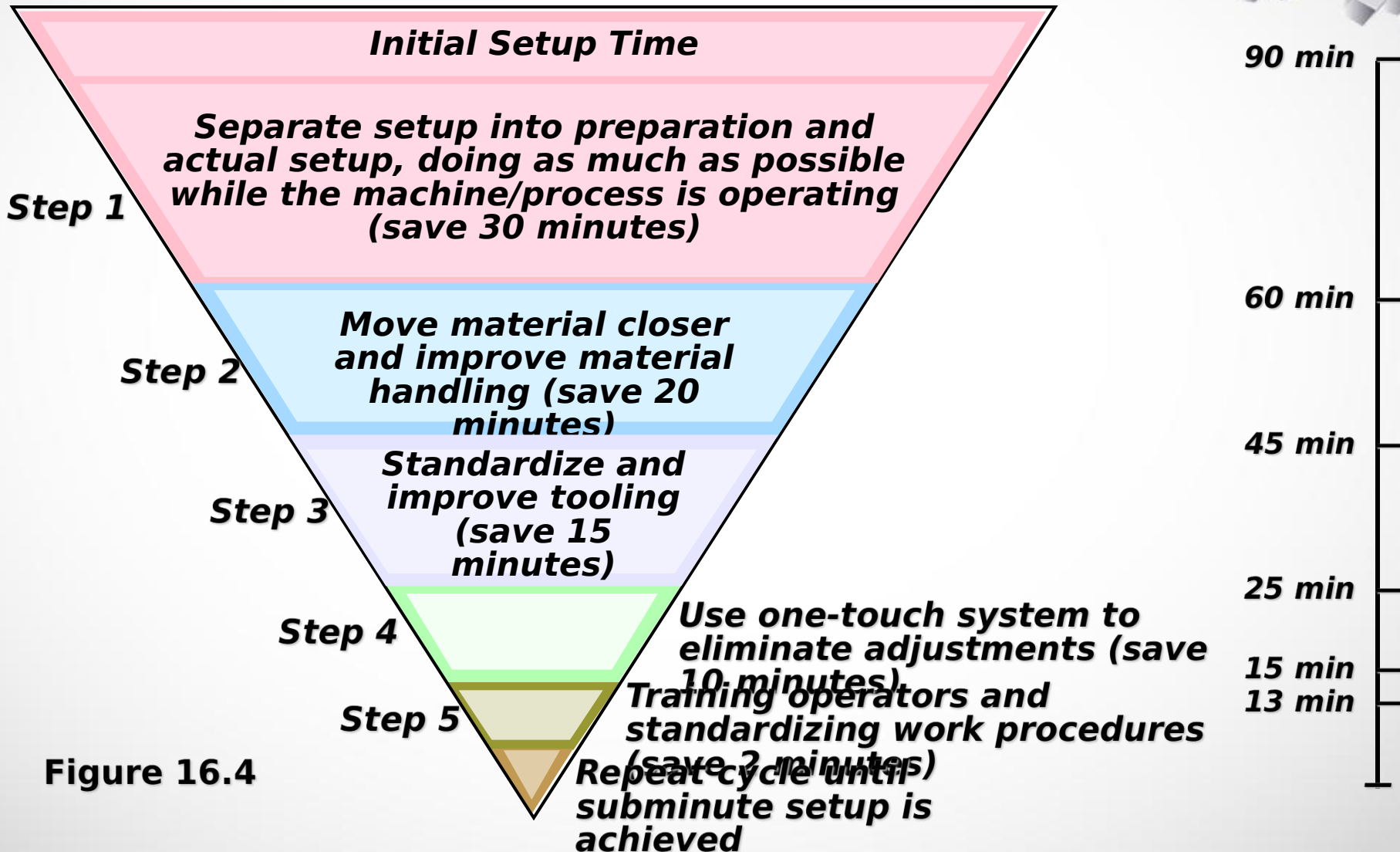


Figure 16.4

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***

Kanban

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

Signal marker on boxes

Part numbers mark location

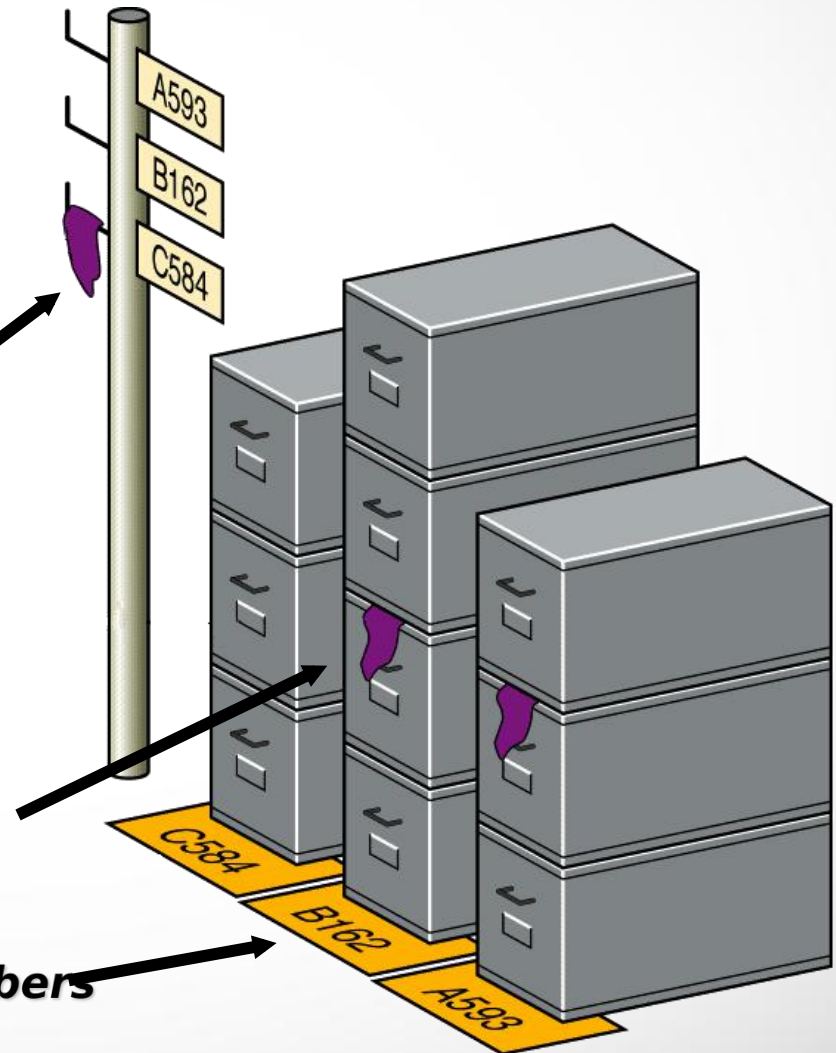
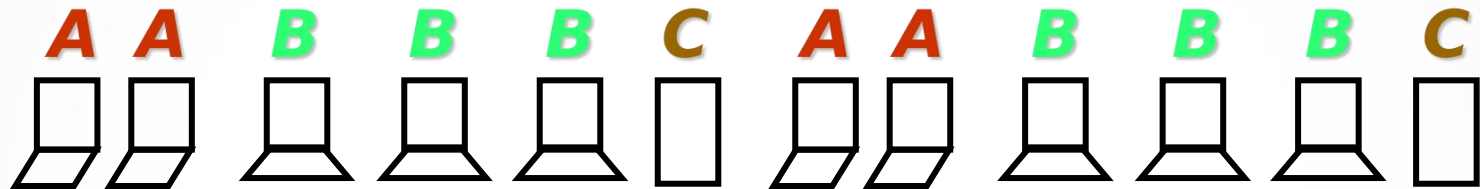


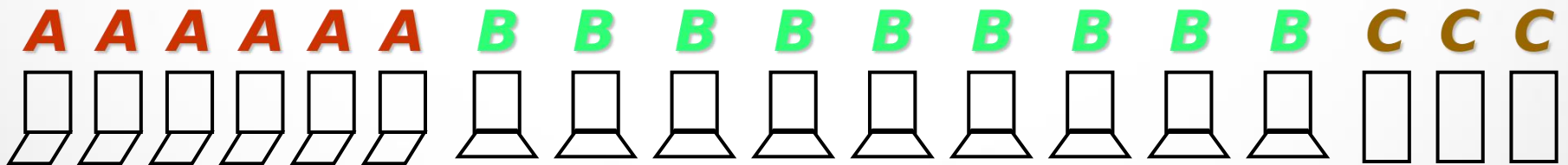
Figure 16.6

Scheduling Small Lots

JIT Level Material-Use Approach



Large-Lot Approach



Time

Figure 16.5

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***
- ***Kanban cards provide a direct control and limit on the amount of work-in-process between cells***

More Kanban

- ***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***
- ***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***

Kanban Signals

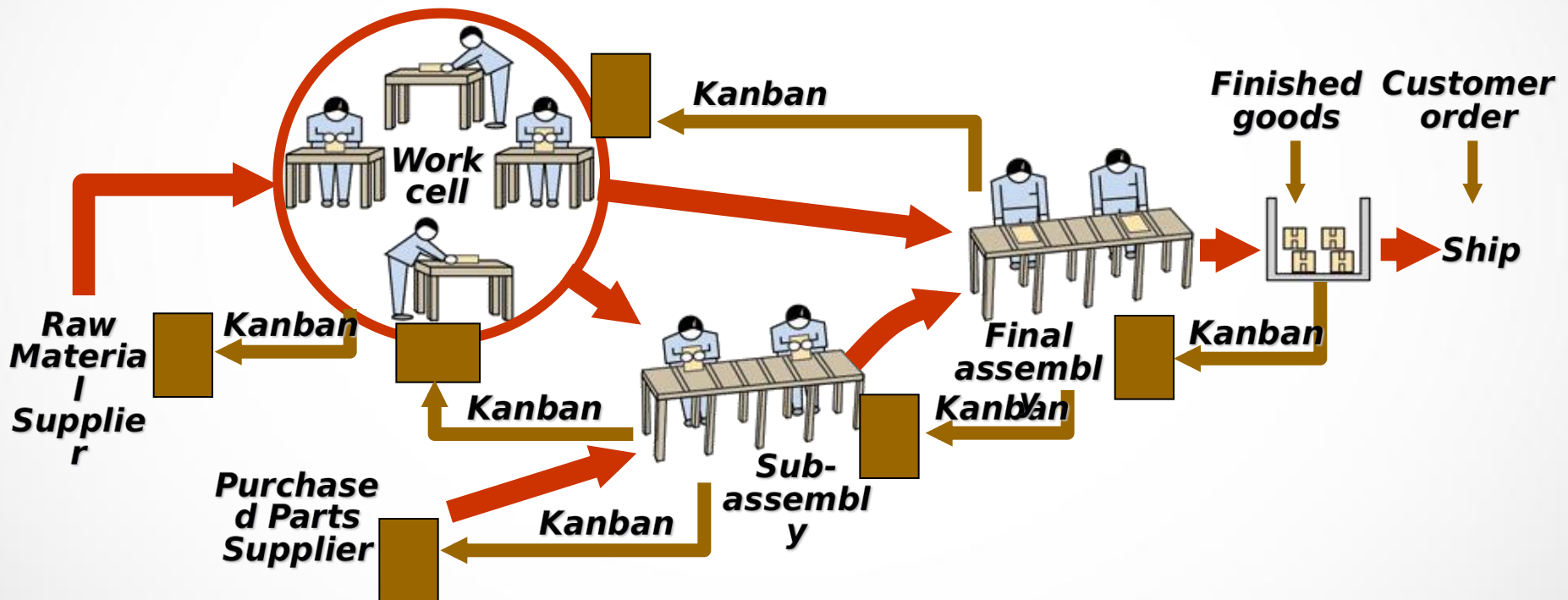


Figure 16.7

The Number of 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***

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

Number of Kanbans Example

Daily demand = 500 cakes

Production lead time = 2 days

**(wait time +
material handling time +
processing time)**

Safety stock = 1/2 day

Container size = 250 cakes

Demand during lead time = 2 days x 500 cakes =

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

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 16.6

Employee Empowerment

- ***Empowered employees bring their knowledge and involvement to daily operations***
- ***Some traditional staff tasks can move to empowered employees***
- ***Training, cross-training, and fewer job classifications can mean enriched jobs***
- ***Companies gain from increased commitment from employees***

Lean Production

- ***Different from JIT in that it is externally focused on the customer***
- ***Often called the Toyota Production System (TPS)***
- ***In practice, JIT, Lean Systems, and TPS are often essentially the same***

Toyota Production System

- ***Work shall be completely specified as to content, sequence, timing, and outcome***
- ***Every customer-supplier connection must be 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 Systems

- ***Use JIT techniques***
- ***Build systems that help employees produce perfect parts***
- ***Reduce space requirements***
- ***Develop close relationships with suppliers***

Lean Systems

- ***Educate suppliers***
- ***Eliminate all but value-added activities***
- ***Develop the workforce***
- ***Make jobs more challenging***
- ***Reduce the number of job classes***

The 5 S's

- ***Sort/segregate***
 - ***Simplify/straighten***
 - ***Shine/sweep***
 - ***Standardize***
 - ***Sustain/self discipline***
- ***Safety***
 - ***Support/maintenance***

Seven Wastes

- ***Overproduction***
- ***Queues***
- ***Transportation***
- ***Inventory***
- ***Motion***
- ***Over-processing***
- ***Defective product***

A broader perspective suggests other resources like energy and water are wasted but should not be

JIT in Services

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

A philosophy of continuous and forced problem solving that drives out waste is referred to as:

- ***Just-in-time.***
- ***Lean production.***
- ***MRP.***
- ***TQM.***

A way to eliminate waste through a focus on exactly what the customer wants is referred to as:

- ***Just-in-time.***
- ***Lean production.***
- ***MRP.***
- ***TQM.***

Which of the following is not considered waste?



- ***Products being stored.***
- ***Products being machined.***
- ***Products being inspected.***
- ***Products waiting in queues.***

Which does not reduce waste?



- ***Providing faster delivery.***
- ***Reducing in-process inventory.***
- ***Speeding throughput.***
- ***Increasing inspection.***

***material being produced
only when requested and
moved to where it is
needed just as it is
needed is referred to as:***

- ***JIT.***

- ***Pull system.***

- ***Push system.***

- ***MRP.***

Work-In-progress inventories:



- ***Reduce variability.***
- ***Hide variability.***
- ***Increase variability.***

Manufacturing cycle time is best defined as:

- ***Length of the work shift.***
- ***Time it takes a unit to move from one station to another.***
- ***Sum of all the task times to make one unit of a product.***
- ***Time from raw materials receipt to finished product inventory.***

Which is not a goal of JII partnerships?



- ***Elimination of unnecessary activities.***
- ***Elimination of in-plant inventory.***
- ***Elimination of in-transit inventory.***
- ***Development of alternative back-up suppliers.***
- ***Elimination of poor suppliers.***

a concern expressed by suppliers?

- ***Elimination of in-plant inventory.***
- ***Delivery to the point of use.***
- ***Production with zero defects.***
- ***Large lot sizes.***
- ***Customer's infrequent engineering changes.***

Which is not a JII inventory tactic?



- ***Use a pull system to move inventory.***
- ***Develop just-in-time delivery systems with suppliers.***
- ***Perform to schedule.***
- ***Improve employee communication.***
- ***Reduce setup time.***

Which is not a JII scheduling tactic?



- ***Communicate schedules to suppliers.***
- ***Freeze part of the schedule.***
- ***Produce in small lots.***
- ***Use group technology.***
- ***Use kanbans.***

JIT emphasizes:



- ***Continuous improvement.***
- ***Understanding the customer.***
- ***Employee learning and empowerment in an assembly line environment.***

A manufacturer took the following actions to reduce inventory. Which of these is generally not accepted as a JIT action?

- **Used a pull system to move inventory.**
- **Produced in even smaller lots.**
- **Required deliveries directly to the point of use.**
- **Picked the supplier that offered the lowest price based on quantity discounts.**

Lean production emphasizes:



- ***Continuous improvement.***
- ***Understanding the customer.***
- ***Employee learning and empowerment in an assembly line environment.***

underlying principle of TPS?



- **Work shall be completely specified as to content, sequence, timing and outcome.**
- **Every customer-supplier connection, both internal and external, must be direct and specify personnel, methods, timing and quantity of goods or services provided.**
- **Product and service flow must be simple and direct- goods and services are directed to a specific person or machine.**
- **Any improvement in the system must be recommended by a quality circle**

**Which of the following
S's has been contributed
by U.S. managers?**

- **Sort.**
- **Simplify.**
- **Safety.**
- **Standardize.**
- **Sustain.**



Ohno's seven wastes does not include:



- ***Overproduction.***
- ***Energy.***
- ***Queues.***
- ***Motion.***
- ***Defective product.***