

# 12

## JIT, TPS, and Lean Operations

PowerPoint presentation to accompany  
Heizer and Render  
Operations Management, Eleventh Edition  
Principles of Operations Management, Ninth Edition

PowerPoint slides by Jeff Heyl

# Learning Objectives

**When you complete this chapter you should be able to:**

- 1. Define** just-in-time, TPS, and lean operations
- 2. Define** the seven wastes and the 5Ss
- 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

# 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 employee learning and 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

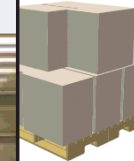
# TPS Elements



**Assembly Components**  
placed in cab for easy access rather than on shelves adjacent to the assembly line.



**Andon**  
problem display board that communicates abnormalities.



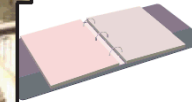
**Pull System**  
units produced only when more production is needed.

**Kanban**  
signal that indicates production of small batches of components.



**Respect for People**  
employees treated as knowledge workers.

**Empowered Employees**  
can stop production, ideas solicited, quality circles, etc.



**Standard Work Practices**  
rigorous, agreed upon, documented procedures for production.



**JIT**  
parts and supplies delivered just as needed in the quantity needed.



**Minimal machines**  
Proprietary machines designed for specific Toyota applications.



**Level Schedules**  
models mixed on production lines to meet customer orders.



**Jidoka**  
machines with built-in devices for monitoring performance and making judgements.



**Kaizen Area**  
an area where suggestions are tested and evaluated.

1 AGC Automotive Americas  
Glass assemblies

2 ARK Inc.  
Industrial waste management, recycling

3 HERO Assemblers LLP  
Assembly of tire onto wheel

4 HERO Logistics LLP  
Logistics

5 PPG Industries Inc.  
Glass assemblies

6 Reyes Automotive Group  
Interior/exterior parts

7 Tokai Rika  
Functional parts

7 Suppliers inside the main plant

# JIT/TPS/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**

# Just-In-Time, TPS, and Lean Operations

- JIT focuses on **continuous forced problem solving**
- TPS emphasizes **continuous improvement, respect for people, and standard work practices** 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, sustainable production minimizes inputs, reduces waste
- Traditional “housekeeping” has been expanded to the 5Ss

# The 5Ss

- ▶ **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 analysis tools

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Two additional Ss

- ▶ Safety – built 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

- Poor production processes resulting in improper quantities, late, or non-conforming units
- Unknown customer demands
- Incomplete or inaccurate drawings, specifications, or bills of material

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



# Improve Throughput

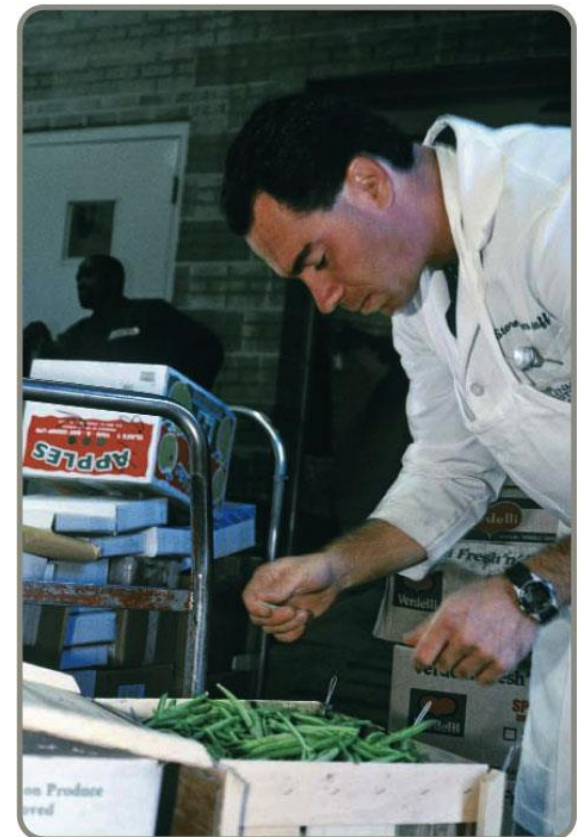
- The time it takes to move an order from receipt to delivery
- The time between the arrival of raw materials and the shipping of the finished order is called **manufacturing cycle time**
- A **pull system** increases throughput

# 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)

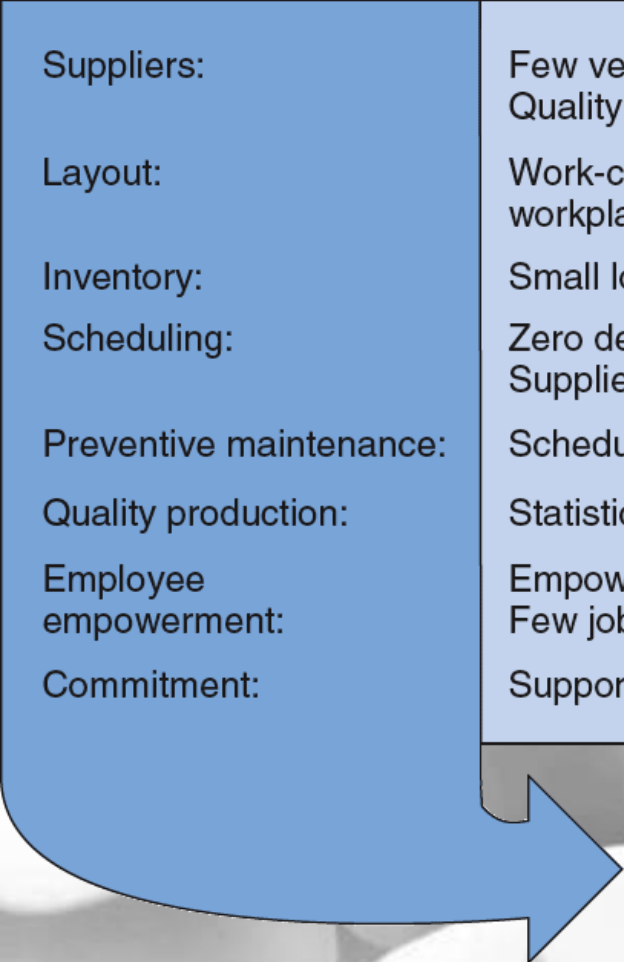
- Powerful strategy for improving operations
- Materials arrive where they are needed when they are needed
- Identifying problems and driving out waste reduces costs and variability and improves throughput
- Requires a meaningful buyer-supplier relationship



# 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



# 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**

# 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

## Suppliers

- Locate near buyer
- Extend JIT techniques to their suppliers
- Include packaging and routing details
- Detail ID and routing labels
- Focus on core competencies

## Shipping

- Seek joint scheduling and shipping efficiencies
- Consider third-party logistics
- Use advance shipping notice (ASN)
- Ship frequent small orders

Mutual  
Understanding  
and  
Trust

## Quantities

- Produce small lots
- Deliver with little overage and underage
- Meet mutually developed quality requirements
- Produce with zero defects

## Buyers

- Share customer preferences and demand forecasts
- Minimize product specifications and encourage innovation
- Support supplier innovation and price competitiveness
- Develop long-term relationships
- Focus on core competencies
- Process orders with minimal paperwork (use EDI or Internet)

# Concerns of Suppliers

- *Diversification* – ties to only one customer increases risk
- *Scheduling* – don't believe customers can create a smooth schedule
- *Lead time* – 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

TABLE 16.1

### 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

# 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

TABLE

## JIT INVENTORY TACTICS

Use a pull system to move inventory

Reduce lot sizes

Develop just-in-time delivery systems with suppliers

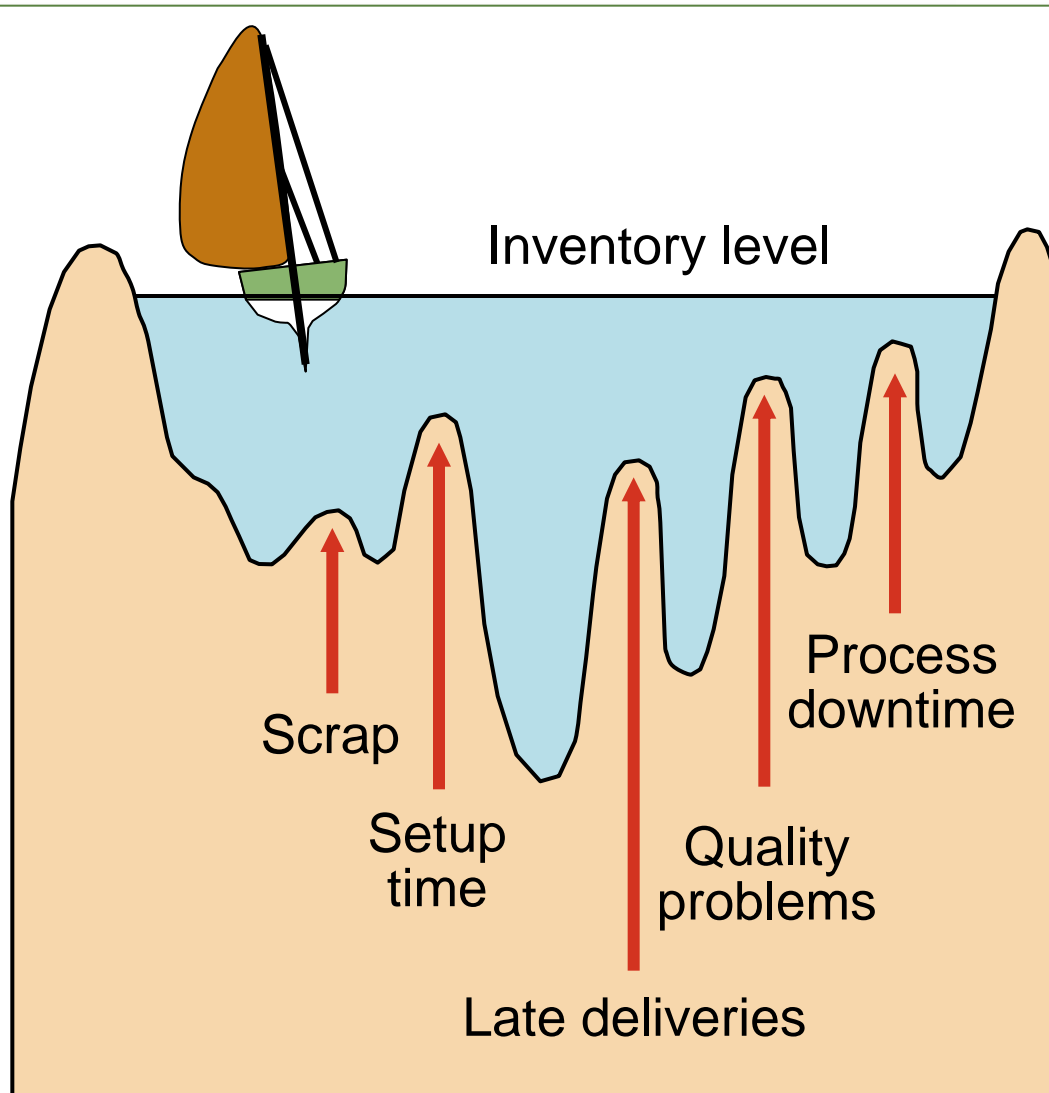
Deliver directly to point of use

Perform to schedule

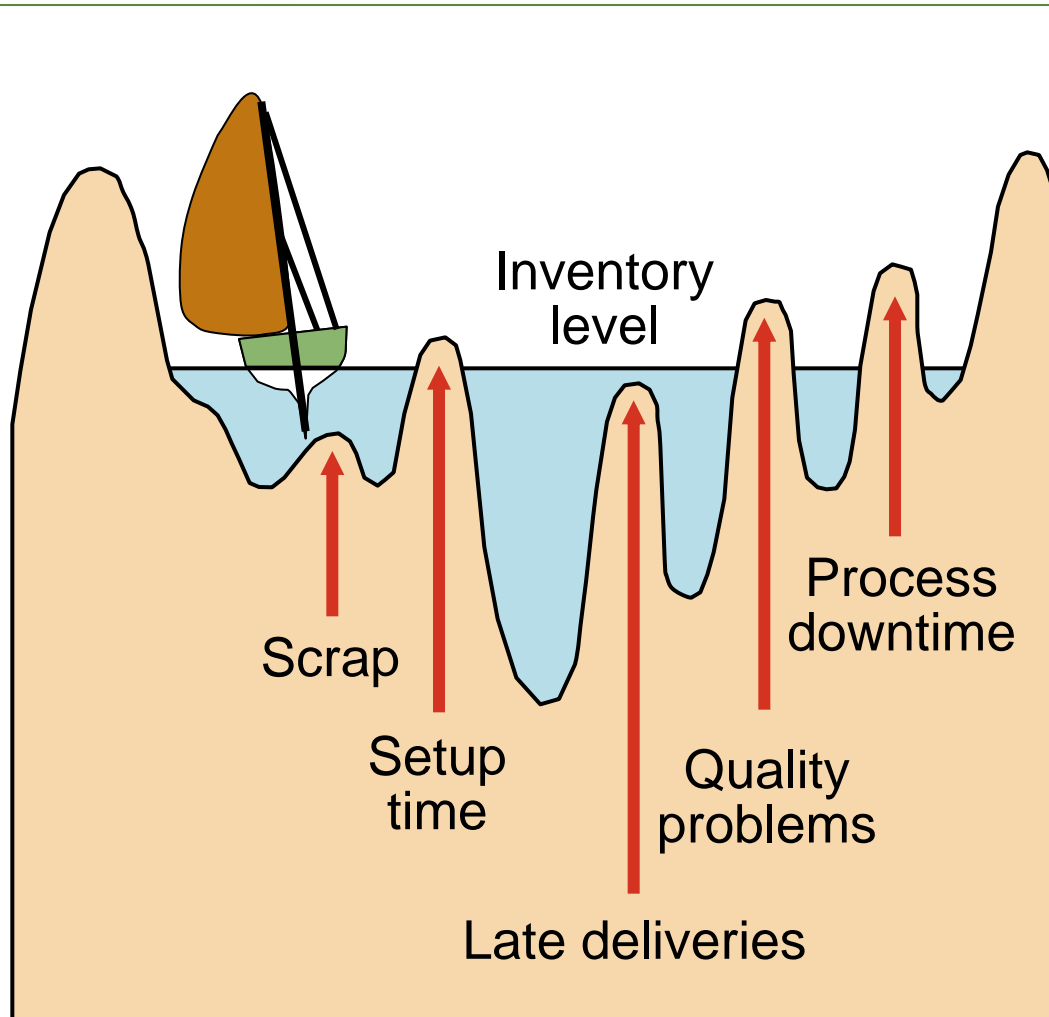
Reduce setup time

Use group technology

# Reduce Variability

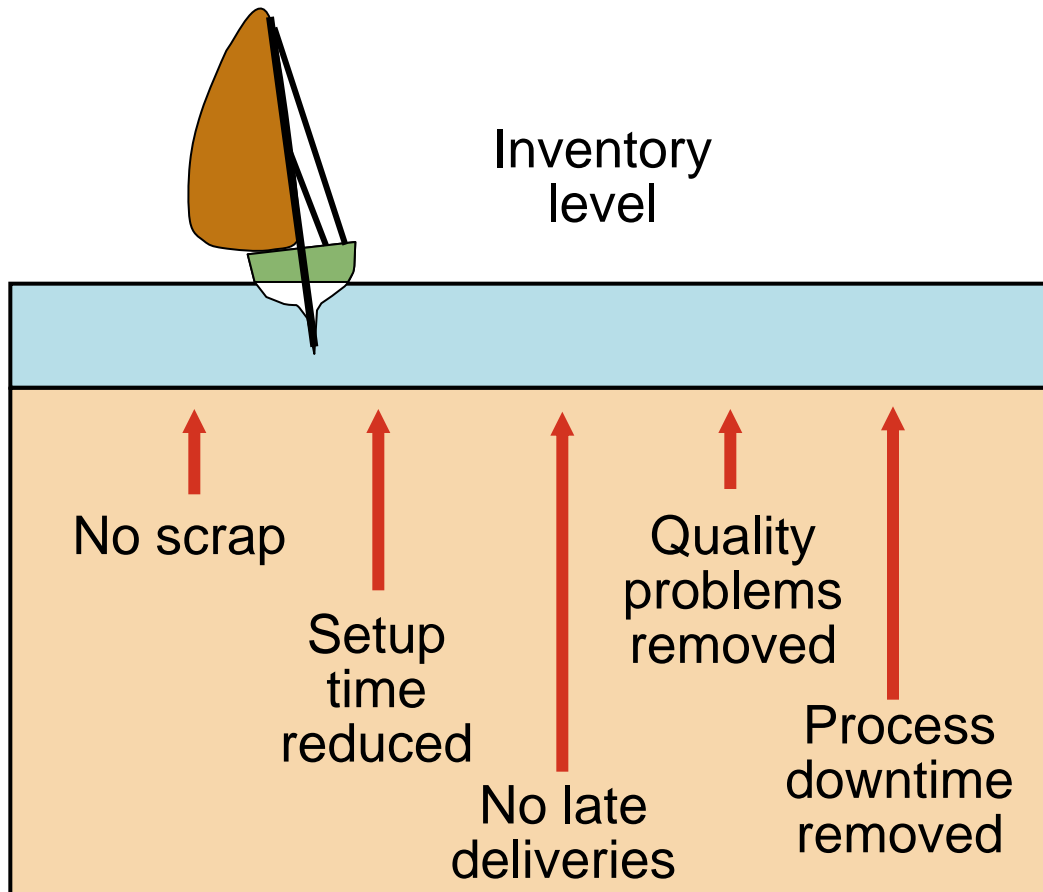


# Reduce Variability





# Reduce Variability

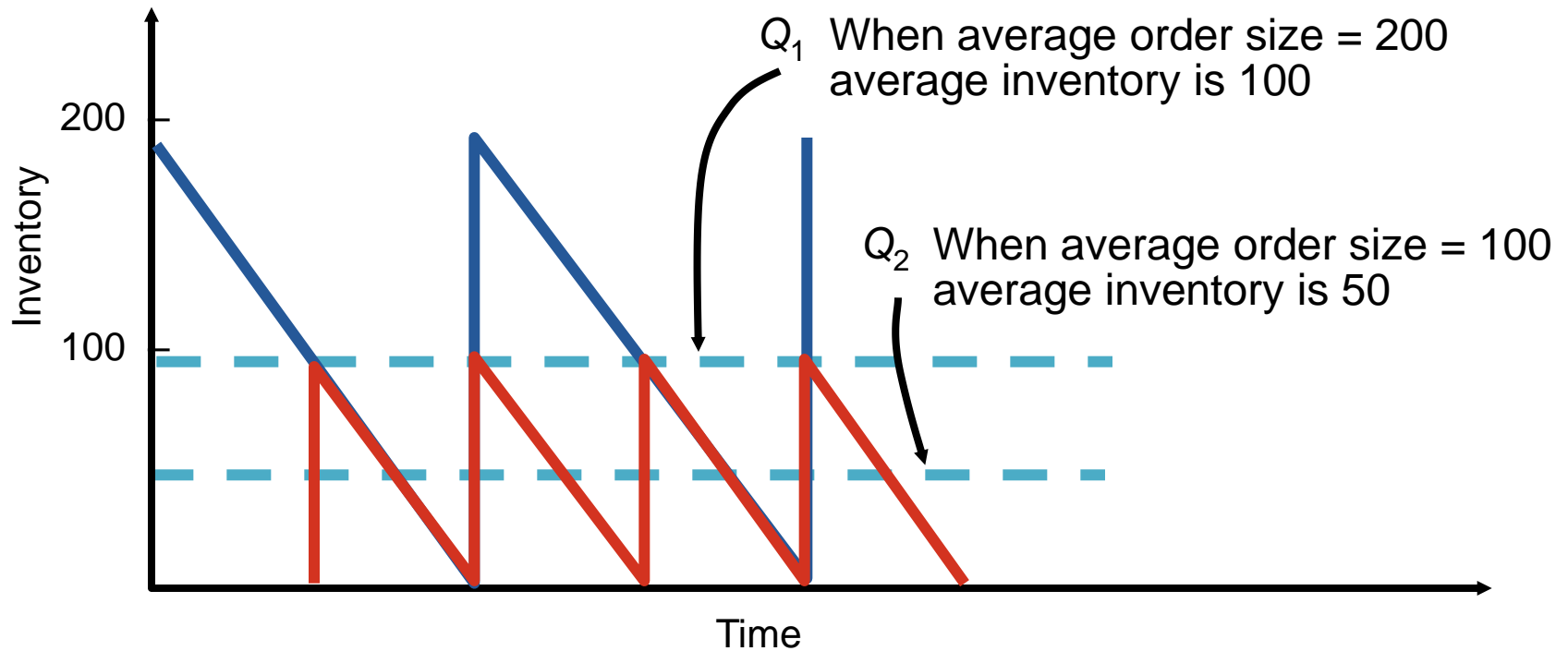


# Reduce Inventory

- 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



# Reduce Lot Sizes

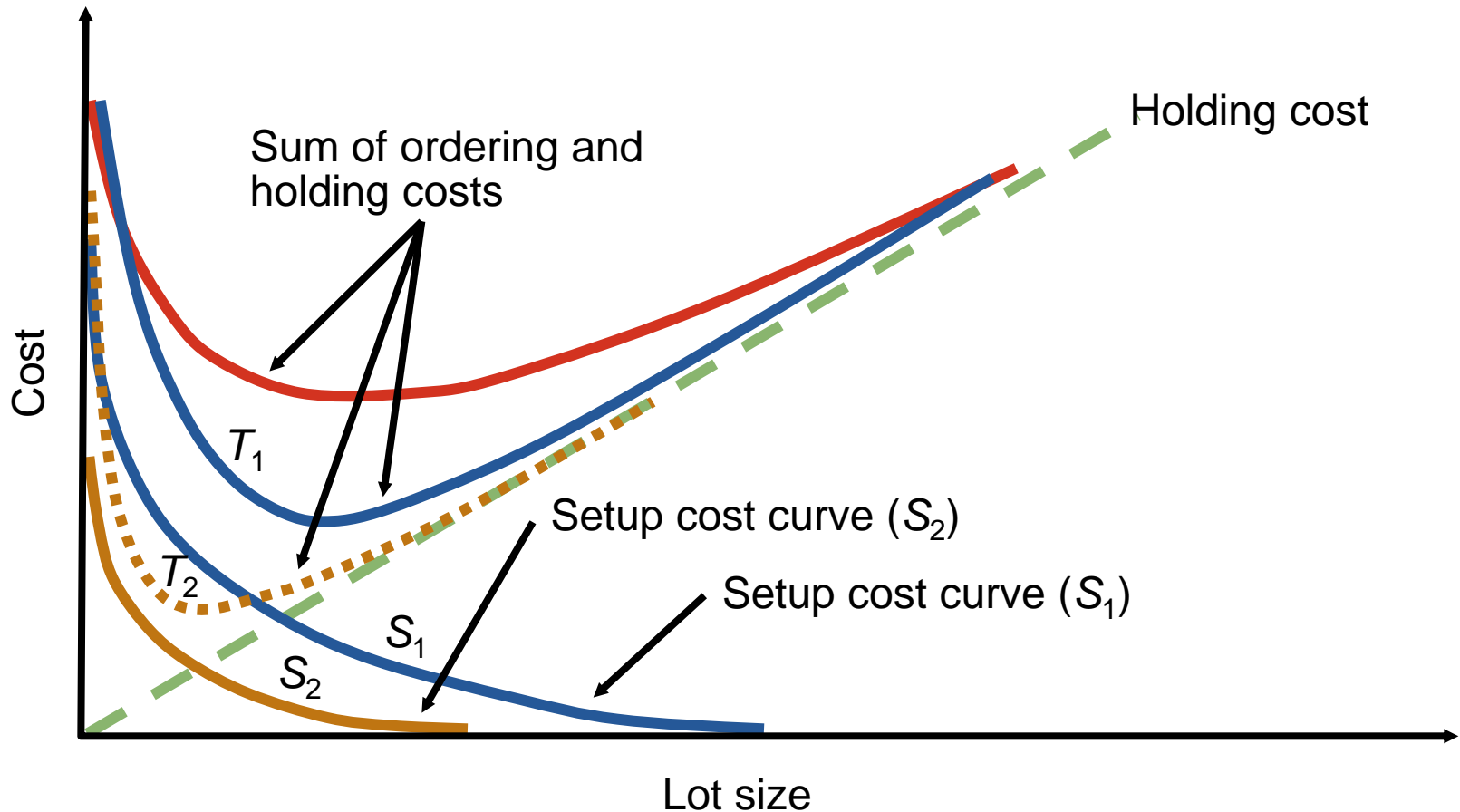
- Ideal situation is to have lot sizes of one pulled from one process to the next
- Often not feasible
- Can use EOQ analysis to calculate desired setup time
- Two key changes necessary
  - Improve material handling
  - Reduce setup time

$$Q_p^* = \sqrt{\frac{2DS}{H\left(1 - \frac{d}{p}\right)}}$$

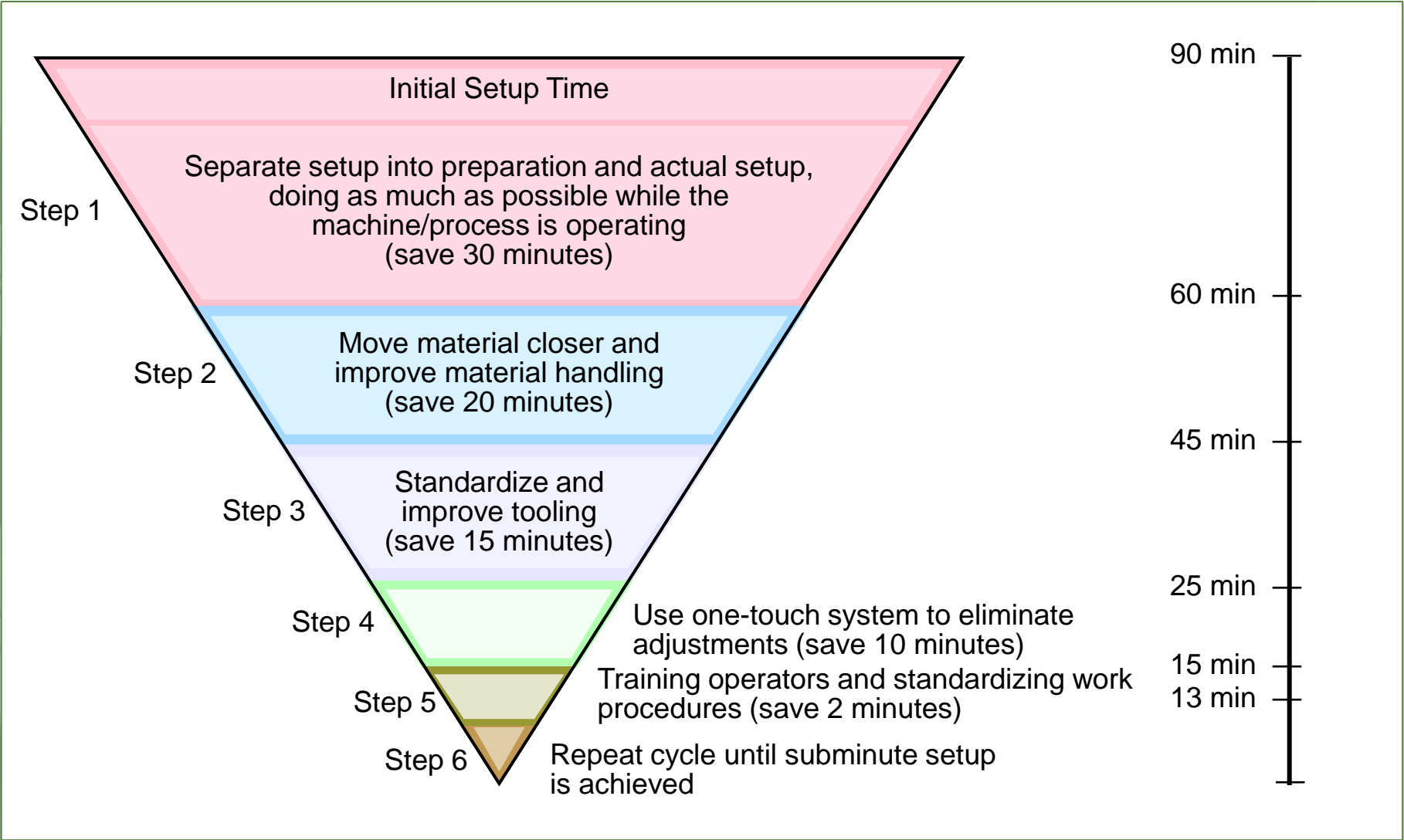
# Reduce Setup Costs

- 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



# Reduce Setup Costs



# 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

TABLE

## JIT SCHEDULING TACTICS

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
- Freezing the schedule closest to the due dates can improve performance

# 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

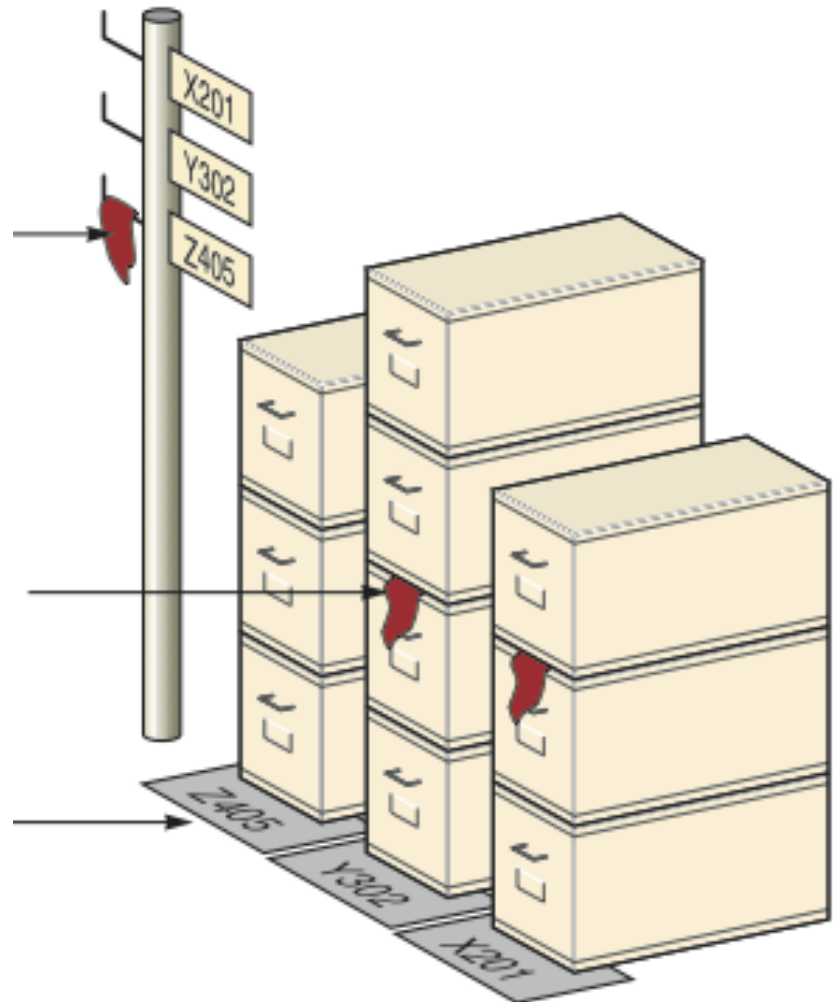


# Kanban

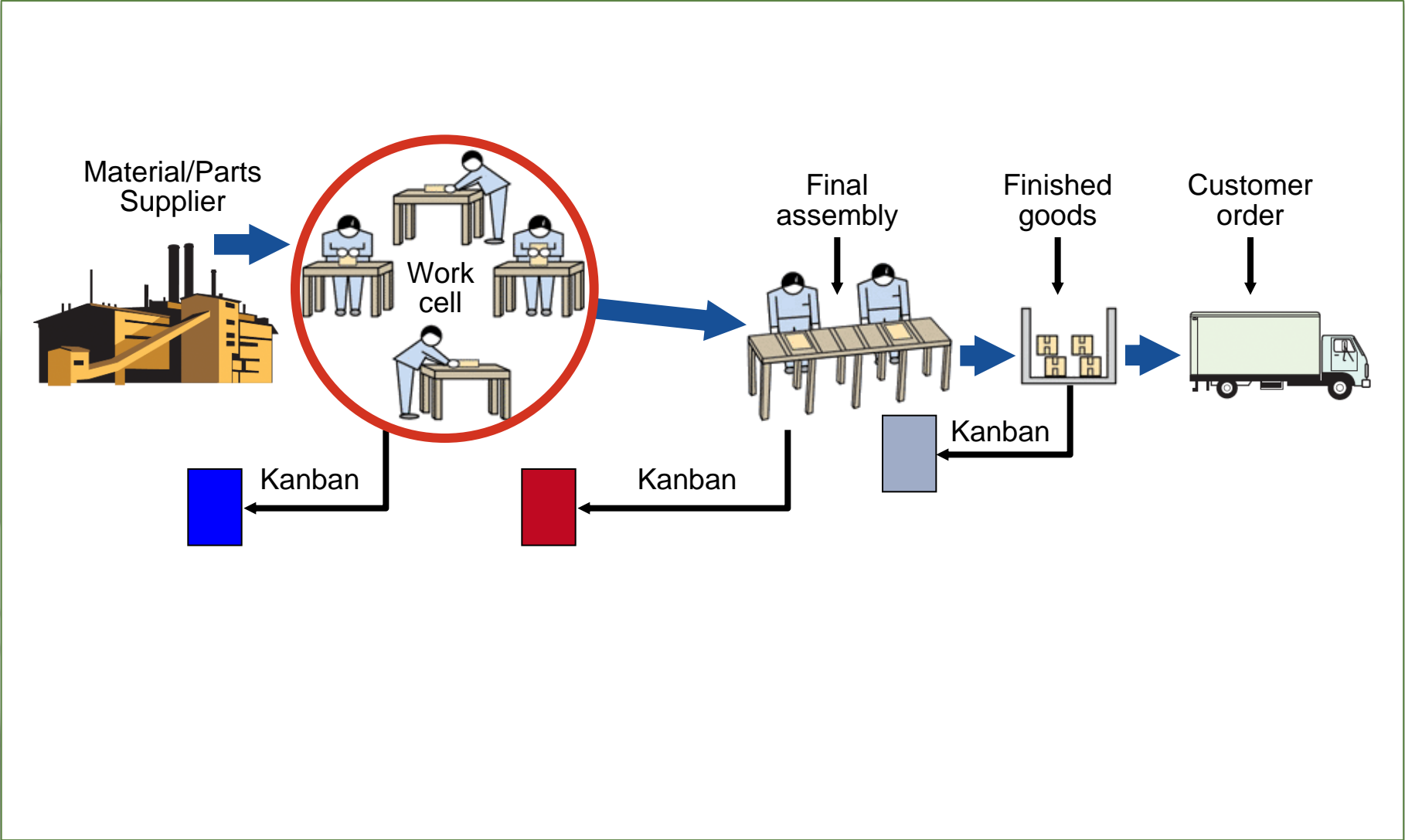
Signal marker hanging on post for part Z405 shows that production should start for that part. The post is located so that workers in normal locations can easily see it.

Signal marker on stack of boxes

Part numbers mark location of specific part



# Kanban



# More Kanban

- When the producer and user are not in visual contact, a card can be used; otherwise, a light or flag or empty spot on the floor may be adequate
- Usually each card controls a specific quantity or parts although multiple card systems may be used if there are several components or if the lot size is different from the move size

# More Kanban

- Kanban cards provide a direct control and limit on the amount of work-in-process between cells
- If there is an intermediate 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 producing area

# Advantages of Kanban

- Small containers require tight schedules, smooth operations, little variability
- Shortages create an immediate impact
- Places emphasis on meeting schedules, reducing lead time and setups, and economic material handling
- Standardized containers reduce weight, disposal costs, wasted space, and labor



# 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

TABLE

## 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

# Toyota Production System

- ▶ Continuous improvement
  - ▶ Build an organizational culture and value system that stresses improvement of all processes, **kaizen**
  - ▶ 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

- ▶ Broader than 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

- Lean systems tend to have the following attributes
  - Develop partnerships with suppliers
  - Educate suppliers
  - Eliminate all but value-added activities
  - Develop employees
  - Make jobs challenging
  - Build worker flexibility

# Lean Sustainability

- Two sides of the same coin
- Maximize resource use and economic efficiency
- Focus on issues outside the immediate firm
- Driving out waste is the common ground



# Lean Operations in Services

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

