JIT and Lean Operations + Maintenance

Chapter 15 and Chapter 15S

Introduction

The Toyota Approach

Muda: Waste and inefficiency. Perhaps the driving philosophy. Waste and inefficiency can be minimized by using the following tactics.

Kanban: A manual system used for controlling the movement of parts and materials that responds to *signals* of the need (i.e., demand) for delivery of parts or materials. This applies both to delivery to the factory and delivery to each workstation. The result is the delivery of a steady stream of containers of parts throughout the workday. Each container holds a small supply of parts or materials. New containers are delivered to replace empty containers.

Pull system: Replacing material or parts based on demand; produce only what is needed.

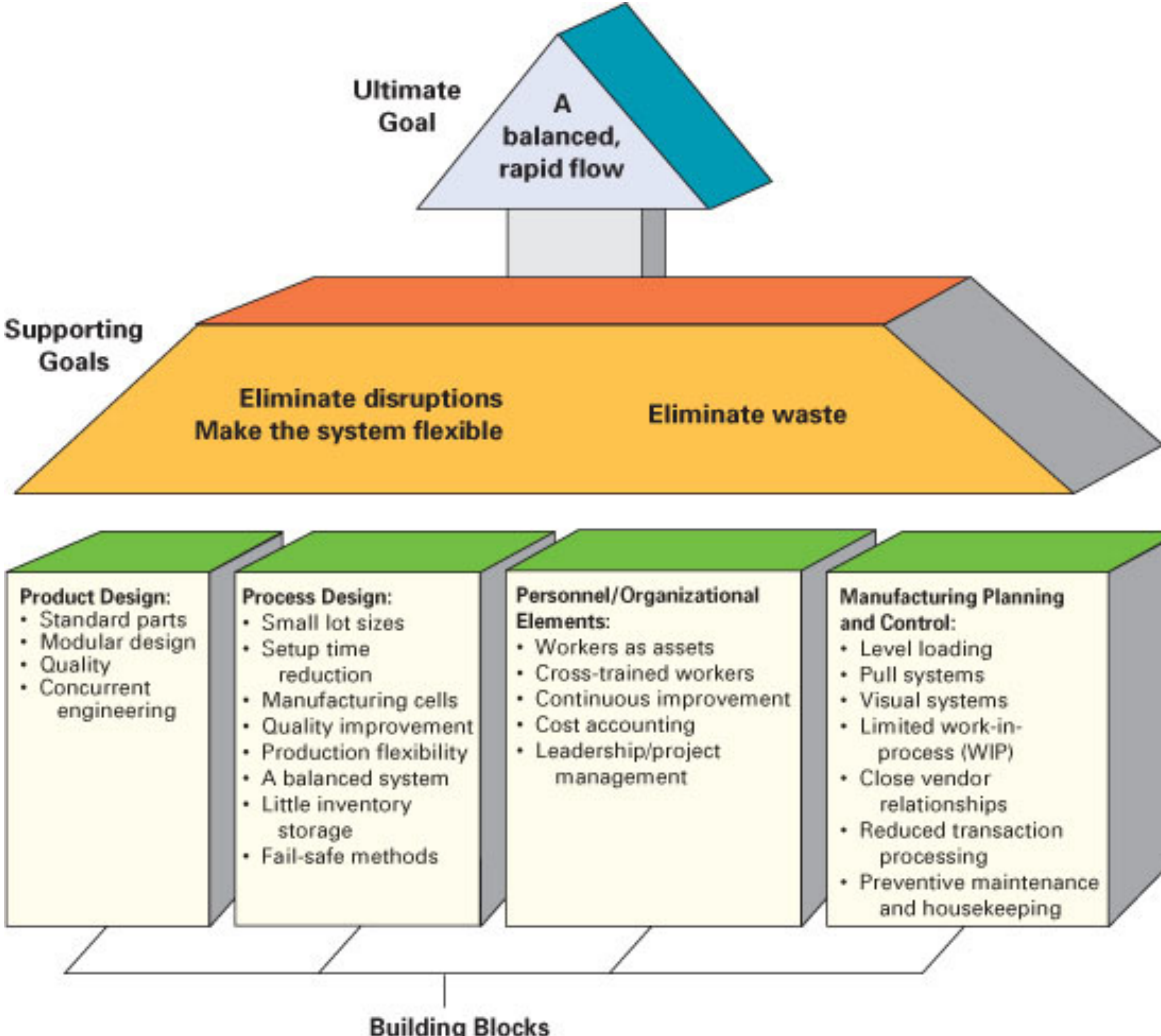
Heijunka: Variations in production volume lead to waste. The workload must be leveled; volume and variety must be averaged to achieve a steady flow of work.

Kaizen: Continuous improvement of the system. There is always room for improvement, so this effort must be ongoing.

Jidoka: Quality at the source. Each worker is expected to perform ongoing quality assurance. The objective is to avoid passing defective products to following work stations, and to make workers aware of quality.

Poka-yoke: Safeguards built into a process to reduce the possibility of committing an error.

Team concept: Use small teams of workers for process improvement.


Ultimate Goal
A balanced, rapid flow
Supporting Goals
Eliminate disruptions
Make the system flexible
Eliminate waste
Product Design:
• Standard parts
• Modular design
• Quality
• Concurrent engineering
Process Design:
• Small lot sizes
• Setup time reduction
• Manufacturing cells
• Quality improvement
• Production flexibility
• A balanced system
• Little inventory storage
• Fail-safe methods
Personnel/Organizational Elements:
• Workers as assets
• Cross-trained workers
• Continuous improvement
• Cost accounting
• Leadership/project management
Manufacturing Planning and Control:
• Level loading
• Pull systems
• Visual systems
• Limited work-in-process (WIP)
• Close vendor relationships
• Reduced transaction processing
• Preventive maintenance and housekeeping
Building Blocks

Supporting Goals

- Eliminate disruptions.
- Make the system flexible.
- Eliminate waste, especially excess inventory.

Wastes According to JIT

Overproduction —involves excessive use of manufacturing resources.

Waiting time —requires space, adds no value.

Unnecessary transporting —increases handling, increases work-in-process inventory.

Processing waste —makes unnecessary production steps, scrap.

Inefficient work methods —reduce productivity, increase scrap, increase work-in-process inventory.

Product defects —require rework costs and possible lost sales due to customer dissatisfaction.

The Kaizen Philosophy

- Waste is the enemy, and to eliminate waste it is necessary to get the hands dirty.
- Improvement should be done gradually and continuously; the goal is not big improvements done intermittently.
- Everyone should be involved: top managers, middle managers, and workers.
- *Kaizen* is built on a cheap strategy, and it does not require spending great sums on technology or consultants.
- It can be applied anywhere.
- It is supported by a visual system: a total transparency of procedures, processes, and values, making problems and wastes visible to all.
- It focuses attention where value is created.
- It is process oriented.
- It stresses that the main effort of improvement should come from new thinking and a new work style.
- The essence of organizational learning is to learn while doing.

Building Blocks

- Product design.
- Process design.
- Personnel/organizational elements.
- Manufacturing planning and control.

Product Design

Standard parts.

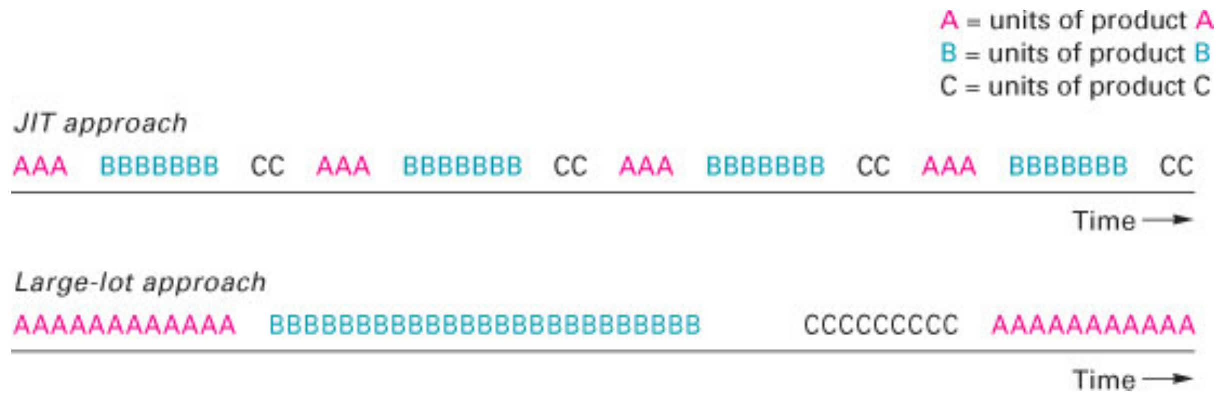
Modular design.

Highly capable production systems with quality built in.

Concurrent engineering.

Process Design

Small lot sizes.



Benefits of small lot sizes
Reduced inventory, lower carrying costs
Less space required to store inventory
Less rework if defects occur
Less inventory to "work off" before implementing product improvements
Increased visibility of problems
Increased production flexibility
Increase ease of balancing operations

Setup time reduction.

Manufacturing cells.

Guidelines for increasing production flexibility

Reduce downtime due to changeovers by reducing changeover time.

Use preventive maintenance on key equipment to reduce breakdowns and downtime.

Cross-train workers so they can help when bottlenecks occur or other workers are absent.

Use many small units of capacity

Use off-line buffers.

Reserve capacity for important customers.

Quality improvement.

Production flexibility.

Autonomation = Jidoka

A balanced system.

Little inventory storage.

Fail-safe methods (Poka-yoke).

Personel/Organization Elements

Workers as assets.

Cross-trained workers.

Continuous improvement.

Cost accounting.

Leadership/project management.

Andon

Activity-based Costing

Manufacturing Planning and Control

Level loading

Pull systems

Model	Daily Quantity
A	7
B	16
C	5

Cycle	1	2	3	4	5
Pattern	A B(3) C	A(2) B(3) C	A B(4) C	A(2) B(3) C	A B(3) C
Extra unit(s)		A	B	A	

Visual systems

$$N = \frac{DT(1 + X)}{C}$$

N = Total number of containers (1 card per container)

D = Planned usage rate of using work center

T = Average waiting time for replenishment of parts plus average production time for a container of parts

X = Policy variable set by management that reflects possible inefficiency in the system (the closer to 0, the more efficient the system)

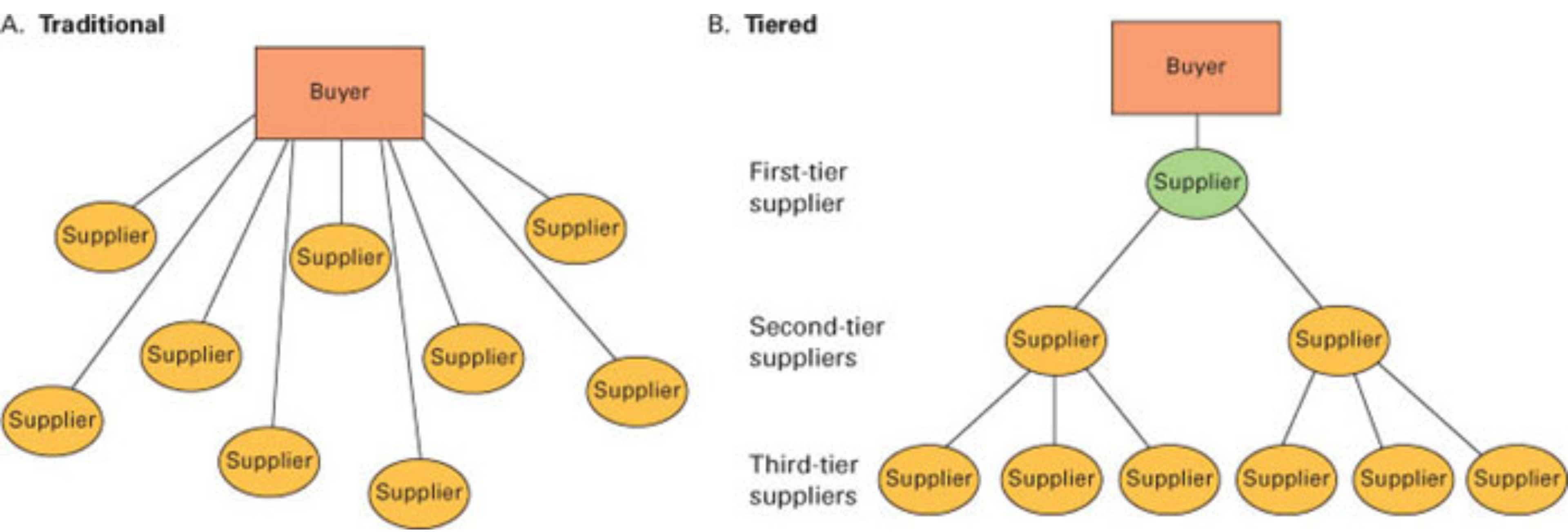
C = Capacity of a standard container (should be no more than 10 percent of daily usage of the part)

Production kanban (p-kanban): signals the need to produce parts.
Conveyance kanban (c-kanban): signals the need to deliver parts to the next work center.

Limited work-in-process (WIP)

$$\text{WIP} = \text{Cycle time} \times \text{Arrival rate}$$

Close vendor relationships



Reduced transaction processing

Logistical transactions include ordering, execution, and confirmation of materials transported from one location to another. Related costs cover shipping and receiving personnel, expediting orders, data entry, and data processing.

Balancing transactions include forecasting, production planning, production control, procurement, scheduling, and order processing. Associated costs relate to the personnel involved in these and supporting activities.

Quality transactions include determining and communicating specifications, monitoring, recording, and followup activities. Costs relate to appraisal, prevention, internal failures (e.g., scrap, rework, retesting, delays, administration activities) and external failures (e.g., warranty costs, product liability, returns, potential loss of future business).

Change transactions primarily involve engineering changes and the ensuing changes generated in specifications, bills of material, scheduling, processing instructions, and so on. Engineering changes are among the most costly of all transactions.

Preventive maintenance and housekeeping

Sort. Decide which items are needed to accomplish the work, and keep only those items.
Straighten. Organize the workplace so that the needed items can be accessed quickly and easily.
Sweep. Keep the workplace clean and ready for work. Perform equipment maintenance regularly.
Standardize. Use standard instructions and procedures for all work.
Self-discipline. Make sure that employees understand the need for an uncluttered workplace.

Factor	Traditional	JIT
Inventory	Much, to offset forecast errors, late deliveries	Minimal necessary to operate
Deliveries	Few, large	Many, small
Lot sizes	Large	Small
Setups, runs	Few, long runs	Many, short runs
Vendors	Long-term relationships are unusual	Partners
Workers	Necessary to do the work	Assets

Transitioning to a JIT System

Planning a Successful Conversion

Obstacles to Conversion

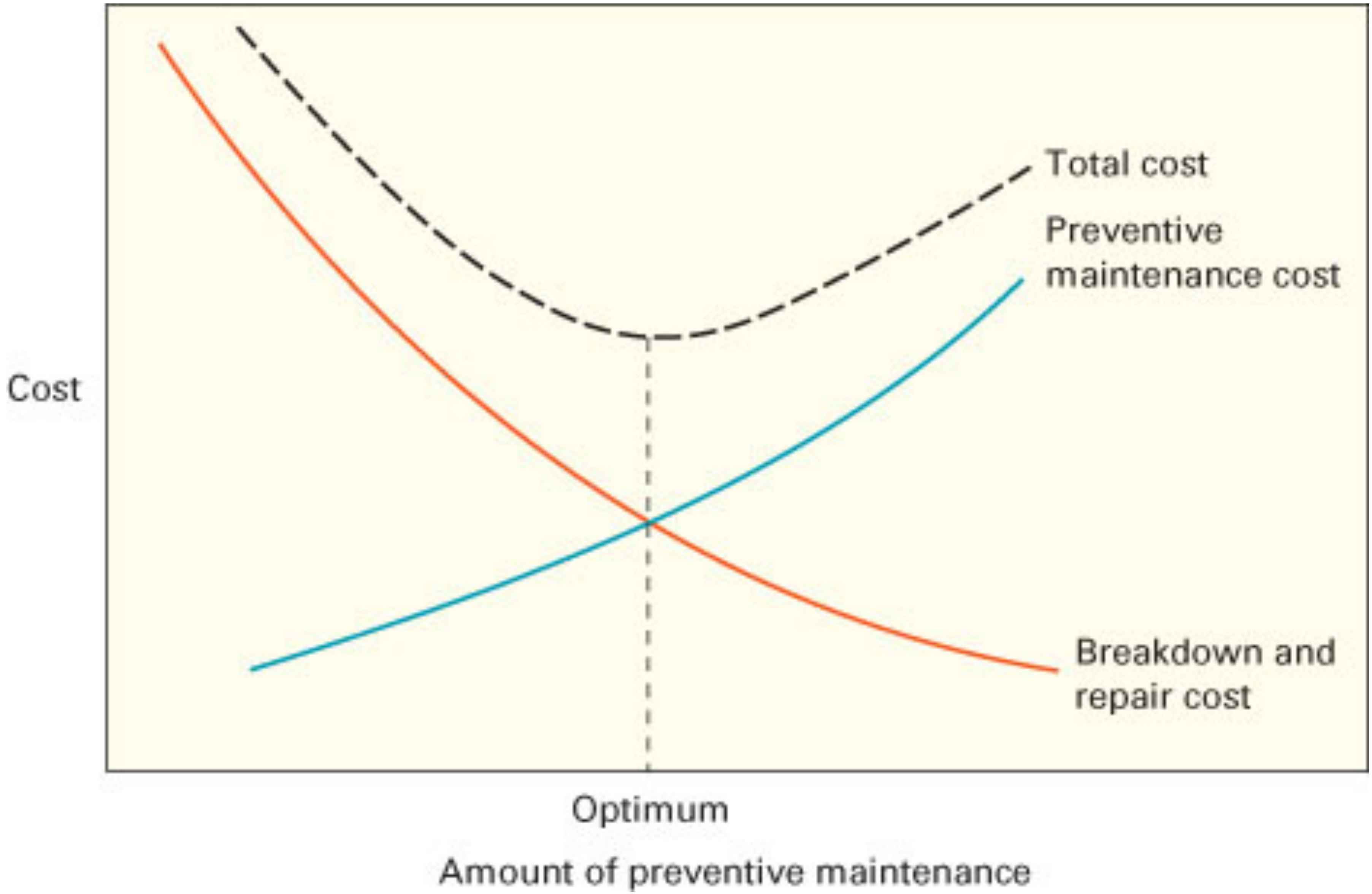
A Cooperative Spirit

The Downside of Conversion to a JIT System

Maintenance

Avoid production or service disruptions.
Not add to production or service costs.
Maintain high quality.
Avoid missed delivery dates.

Operations capacity is reduced, and orders are delayed.
There is no output, but overhead continues, increasing the cost per unit.
There are quality issues; output may be damaged.
There are safety issues; employees or customers may be injured.



Total cost
Preventive maintenance cost
Cost
Breakdown and repair cost
Optimum
Amount of preventive maintenance

Preventive Maintenance

The result of planned inspections that reveal a need for maintenance.

According to the calendar (passage of time).

After a predetermined number of operating hours.

Example

The frequency of breakdown of a machine per month is shown in the table. The cost of a breakdown is $1,000 and the cost of preventive maintenance is $1,250 per month. If preventive maintenance is performed, the probability of a machine breakdown is negligible. Should the manager use preventive maintenance, or would it be cheaper to repair the machine when it breaks down?

Number of breakdowns	0	1	2	3
Frequency of occurrence	.20	.30	.40	.10

Number of Breakdowns	×	Frequency of Occurrence	=	Expected Number of Breakdowns
0		.20		0
1		.30		.30
2		.40		.80
3		.10		.30
		1.00		1.40

Expected cost using repair policy is 1.40 breakdowns/month × $1,000/breakdown = $1,400. Preventive maintenance would cost $1,250.

Therefore, preventive maintenance would yield a savings of $150/month.

Example

Another approach that might be used relates to the time before a breakdown occurs. Suppose that the average time before breakdown is normally distributed and has a mean of 3 weeks and a standard deviation of .60 week. If breakdown cost averages $1,000 and preventive maintenance costs $250, what is the optimal maintenance interval?

$$\frac{\text{Preventive cost}}{\text{Breakdown cost}} = \frac{\$250}{\$1{,}000} = .20$$

Find the number of standard deviations from the mean represented by an area under the normal curve equal to .20 using Appendix B, Table B. It is -0.67. Use this value of z to compute the maintenance interval:

Mean + z standard deviations = 3 – .67(.60) = 2.598 (round to 2.6 weeks)

Breakdown Programs

Among the major approaches used to deal with breakdowns are the following:

Standby or backup equipment that can be quickly pressed into service.

Inventories of spare parts that can be installed as needed, thereby avoiding lead times involved in ordering parts, and *buffer inventories*, so that other equipment will be less likely to be affected by short-term downtime of a particular piece of equipment.

Operators who are able to perform at least minor repairs on their equipment.

Repair people who are well trained and readily available to diagnose and correct problems with equipment.

Replacement