Department of Business Administration
University of Global Village

Production and Operation Management

Course Code	**:**	**0413-622**	**Total Credit**	**:**	3 **(**Three**)**
			CIE Marks	**:**	90
Semester End Exam (SEE) Hours	**:**	03	SEE Marks	**:**	60

Course Learning Outcomes (CLOs): After completion of this course successfully, the students will be able to

CLO1	Understand Operations Management: Explain the core concepts, roles, and historical developments in Operations Management, including productivity measurement and improvement.
CLO2	Analyze Operational Processes: Identify and evaluate different processes, including core, support, service, and manufacturing, to improve operational efficiency and customer involvement.
CLO3	Develop Operations Strategies: Formulate and implement operations strategies aligned with corporate goals, competitive priorities, and global business approaches.
CLO4	Design Goods and Services: Apply principles of product design and development, manage product life cycles, and address challenges in transitioning from design to production.
CLO5	Ensure Quality Management: Implement quality management practices, including TQM, Six Sigma, and ethical considerations, to meet international standards and improve operational outcomes.
CLO6	Manage Capacity Efficiently: Measure, plan, and optimize capacity strategies using tools like simulations, waiting-line models, and decision trees to balance costs and output.

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Course plan specifying Topics, Teaching time, and CLOs

Sl. No.	Course Content	Hrs	CLOs
1	Operations and Productivity	**6**	CLO1
2	Designing And Managing Processes	**7**	CLO2
3	Operations Strategy as a Pattern of Decisions	**7**	CLO3
4	Design of Goods and Services	**8**	CLO4
5	Managing Quality	**8**	CLO5
6	Capacity and Capacity Management	**6**	CLO6

Course plan specifying content, CLOs, co-curricular activities (if any), teaching learning and assessment strategy matching with CLOs

Week	Course Content	Teaching-Learning Strategy	Assessment Strategy	CLOs
1 & 2	**Operations and Productivity** What is Operation management? Organizing to Produce Goods and Services; Why Study OM? What Operations Managers Do?; Ten Strategic Decisions; Where are the OM Jobs?; Significant Events in OM; Taylor's Principles; Productivity & Productivity Challenge; Measures of Productivity, Partial Productivity Measures; When does productivity increase?	• Lecture • Discussion • Assignment	• Question & Answer • (Oral) Class Test • Written Test	CLO1
3, 4 & 5	**Designing And Managing Processes:** A Process View; Types of Customers & Suppliers; Nested Processes; Types of Process in Operations Management;	• Lecture • Discussion • Assignment	• Question & Answer • (Oral) Class Test • Written Test	CLO2

	Differences Between Service and Manufacturing Processes; Similarities Between Service and Manufacturing Processes; Core Processes; Four Core Processes; Support Processes; Process Strategy Decisions; Nature of Service Processes; Process Structures; Process Structure in Manufacturing; Manufacturing Process Structuring; Process Choices; Customer Involvement; Customer Involvement: Advantages vs. Disadvantages; Strategies for Change			
6, 7 & 8	**Operations Strategy as a Pattern of Decisions** Different Strategies for Different Operations; Operations strategy; Corporate Strategy; Connection Between Corporate Strategy and Key Operation Decision; Global Strategies; Approaches of Global Strategies; Competitive Priorities and Capabilities; Order Winners and Qualifiers	• Lecture • Discussion • Assignment	• Question & Answer • (Oral) Class Test • Written Test	CLO3
9, 10 & 11	**Design of Goods and Services** Goods and Services Selection; Product Decision; Product Life Cycle; Product-by-Value Analysis; Product Development Stages; Quality Function Deployment; House of Quality; Organizing for Product Development; Issues for Product Design; Group Technology;	• Lecture • Discussion	• Question & Answer • (Oral) Class Test Written Test	CLO4

	Product Life-Cycle Management (PLM); Transition to Production			
12, 13 & 14	**Managing Quality:** Quality and Strategy; Different Views of Quality; Implications of Quality; International Quality Standards; Costs of Quality; Total quality management (TQM)**;** Plan-Do-Study-Act (PDSA) Cycle; Six Sigma; The Six Sigma Improvement Model; Implementing Six Sigma; Benchmarking**;** Ethics and Quality Management; Just-in-Time (JIT) Deming's Fourteen Points; Seven Concepts of TQM; Inspection; TQM In Services	• Lecture • Discussion • Assignment	• Question & Answer • (Oral) Class Test • Written Test	CLO5
15, 16 & 17	**Capacity and Capacity Management:** **Capacity;** Capacity Management; Measures of Capacity; Utilization; Economies of Scale**;** Four principal reasons drive cost reduction as output increases.; Diseconomies of Scale; Three dimensions of capacity strategy; Tools for Capacity Planning; Waiting-Line Model; Simulation ; Decision Trees.	• Lecture • Discussion • Assignment	• Question & Answer • (Oral) Class Test • Written Test	CLO6

TEXT BOOKS:

(1) Barry Render, Ralph M. Stair Jr. and Michael E. Hanna, Quantitative Analysis for Management, Pearson Education. (13th Edition)
(2) Richard B. Chase, F. Robert Jacobs, Nicholas J. Aquilano, Operations Management for Competitive Advantage, McGraw Hill Publication. (10th Edition)

(3) Lee J. Krajewski, Larry P. Ritzman, Manoj K. Malhotra, Operations Management, Pearson Education. (Eleventh Edition)

Assessment and Evaluation

1) Assessment Strategy: Group Discussion, Class tests, Case Study, Term Paper, Presentation.

2) Marks distribution:

a) Continuous Assessment:

- Class attendance is mandatory. Absent of 70% of classes; disqualify the student for final examination only authority recommendations will be accepted with highly reasonable causes.
- Late submission of assignments is not allowed. Late submission of assignments
- will be only taken with highly reasonable causes and a 20% mark will be deducted.
- To pass this course students will have to appear in mid-term and final examinations.

b) Summative:

CIE- Continuous Internal Evaluation (45 Marks)

Bloom's Category Marks (out of 45)	Tests (25)	Assignments (15)	Quizzes (05)	External Participation in Curricular/Co-Curricular Activities (5)
Remember			05	
Understand		05		
Apply	08			5
Analyze	09			
Evaluate	08	05		
Create		05		

SEE- Semester End Examination (50 Marks)

Bloom's Category	Tests
Remember	**10**
Understand	**10**

Apply	**20**
Analyze	**10**
Evaluate	**10**
Create	**----**

3) Make-up Procedures: Dates for exams will be strictly followed. No makeup exam (Normal case), for exceptional cases university rules and regulations should be followed.

Week-Based Content Distribution

Week	The slides are expected to cover
18.	1 to 30
19.	31 to 54
20.	55 to 67
21.	68 to 79
22.	80 to 97
23.	98 to 113
24.	114 to 128
25.	129 to 150
26.	151 to 167
27.	168 to 182
28.	183 to 195
29.	196 to 212
30.	213 to 223
31.	224 to 233
32.	234 to 244
33.	245 to 253
34.	254 to 263
Note: Follow the page number from the PDF starting from slide 1.	

Operations and Productivity

Outline

- Global Company Profile: Hard Rock Cafe
- What Is Operations Management?
- Organizing to Produce Goods and Services
- The Supply Chain
- Why Study OM?
- What Operations Managers Do

Outline - Continued

- The Heritage of Operations Management
- Operations for Goods and Services
- The Productivity Challenge
- Current Challenges in Operations Management
- Ethics, Social Responsibility, and Sustainability

Learning Objectives

When you complete this chapter you should be able to:

1.1 ***Define*** operations management

1.2 ***Explain*** the distinction between goods and services

1.3 ***Explain*** the difference between production and productivity

Learning Objectives

When you complete this chapter you should be able to:

1.4 ***Compute*** single-factor productivity

1.5 ***Compute*** multifactor productivity

1.6 ***Identify*** the critical variables in enhancing productivity

What Is Operations Management?

Production is the creation of goods and services

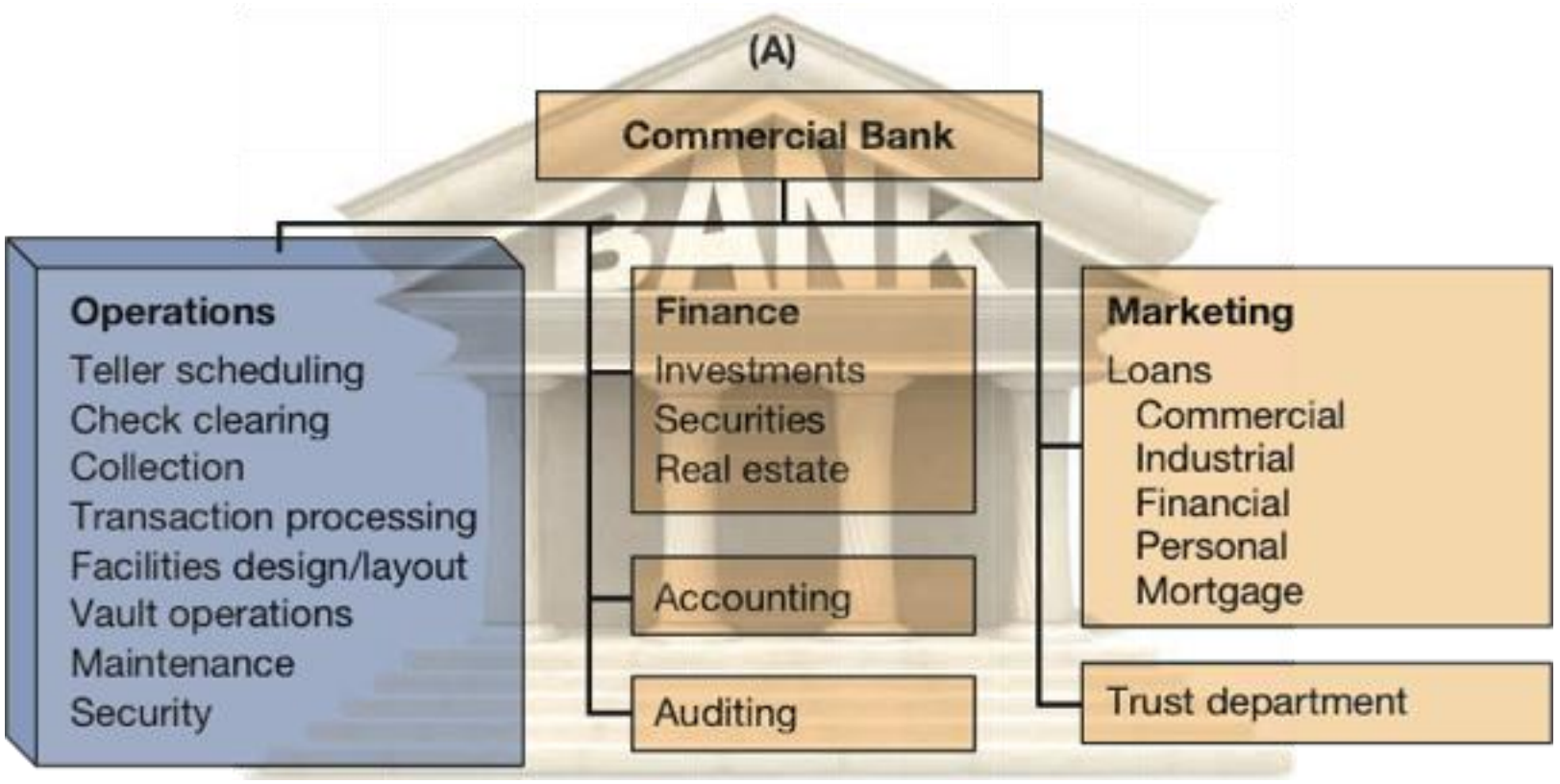
Operations management (OM) is the set of activities that create value in the form of goods and services by transforming inputs into outputs

Organizing to Produce Goods and Services

- Essential functions:
  1. ***Marketing*** – generates demand
  2. ***Production/operations*** – creates the product
  3. ***Finance/accounting*** – tracks how well the organization is doing, pays bills, collects the money

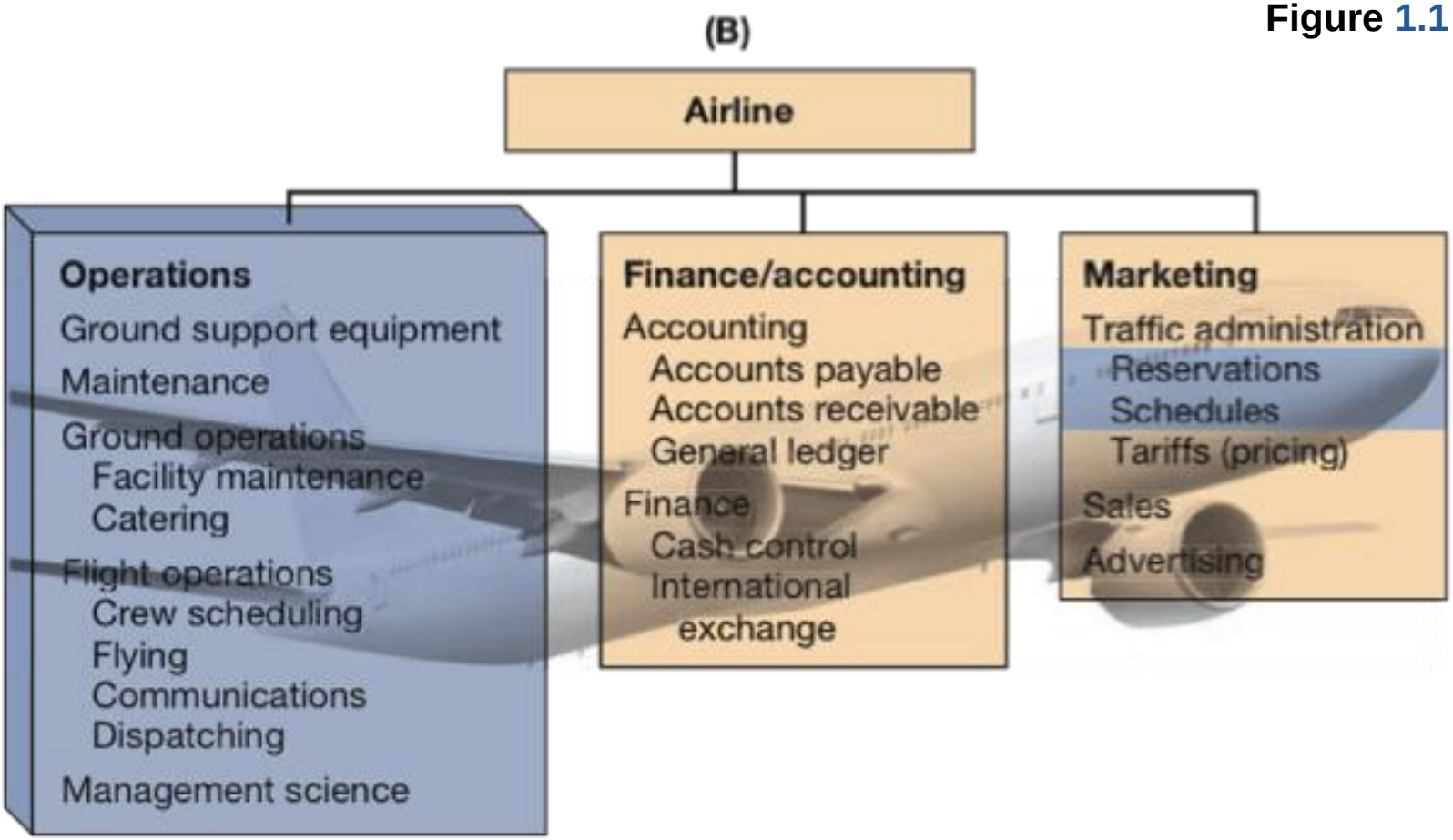
Organizational Charts

Figure 1.1



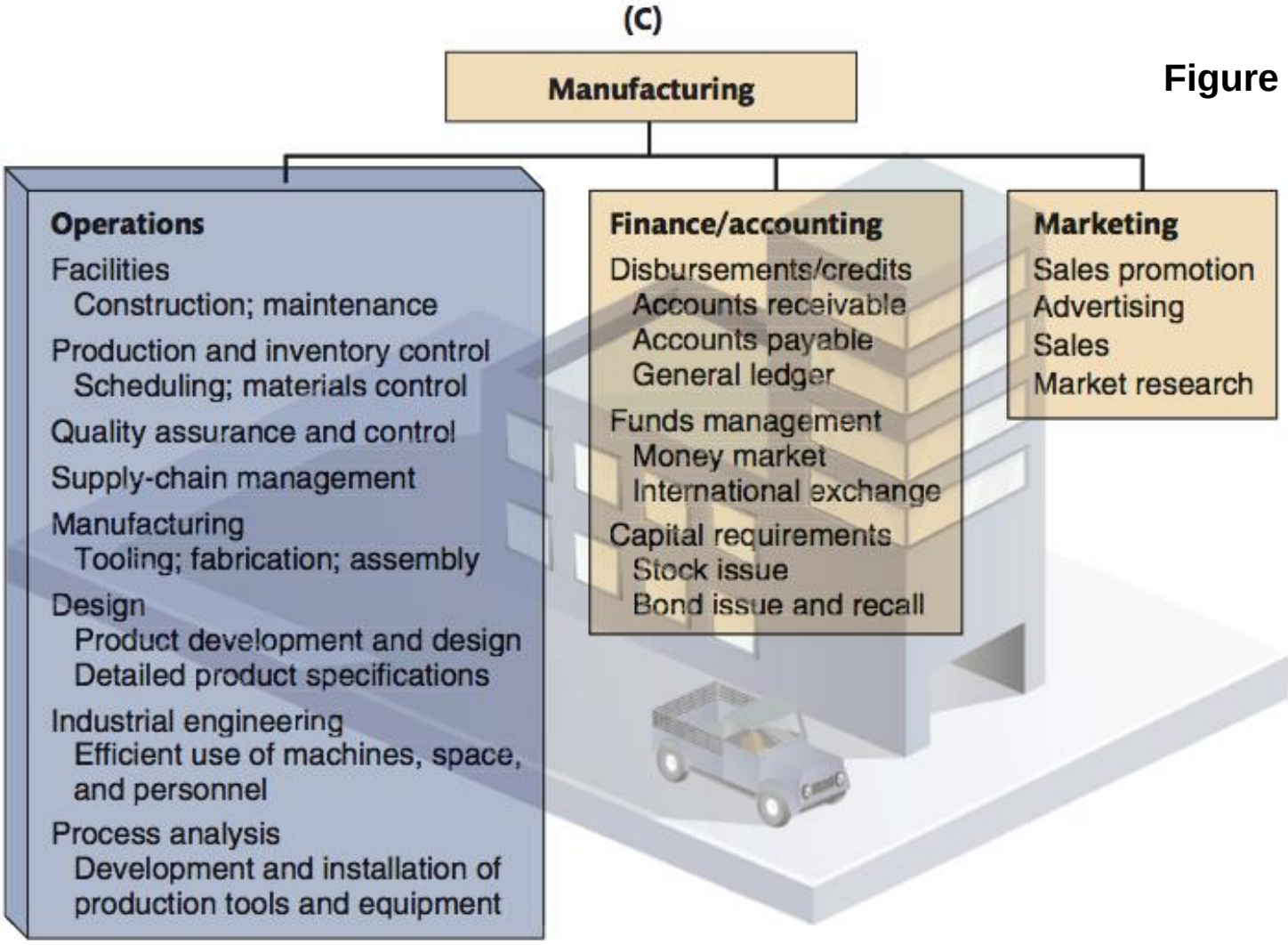
Organizational Charts

Figure 1.1



Organizational Charts

Figure 1.1



The Supply Chain

- A global network of organizations and activities that supply a firm with goods and services
- Members of the supply chain collaborate to achieve high levels of customer satisfaction, efficiency and competitive advantage

Figure 1.2

Why Study OM?

1. OM is one of three major functions of any organization; we want to study *how people organize themselves for productive enterprise*
2. We want (*and need*) to *know how goods and services are produced*
3. We want to understand *what operations managers do*
4. OM *is such a costly part of an organization*

Options for Increasing Contribution

TABLE 1.1

	CURRENT	MARKETING OPTION: INCREASE SALES REVENUE 50%	FINANCE/ ACCOUNTING OPTION: REDUCE FINANCE COSTS 50%	OM OPTION: REDUCE PRODUCTION COSTS 20%
Sales	$100,000	$150,000	$100,000	$100,000
Cost of goods	–80,000	–120,000	–80,000	–64,000
Gross margin	20,000	30,000	20,000	36,000
Finance costs	–6,000	–6,000	–3,000	–6,000
Subtotal	14,000	24,000	17,000	30,000
Taxes at 25%	–3,500	–6,000	–4,200	–7,500
Contribution	$ 10,500	$ 18,000	$ 12,750	$ 22,500

What Operations Managers Do

Basic Management Functions

- Planning
- Organizing
- Staffing
- Leading
- Controlling

Ten Strategic Decisions

TABLE 1.2

DECISION	CHAPTER(S)
1. *Design of goods and services*	5, Supplement 5
2. *Managing quality*	6, Supplement 6
3. *Process and capacity strategy*	7, Supplement 7
4. *Location strategy*	8
5. *Layout strategy*	9
6. *Human resources and job design*	10
7. *Supply-chain management*	11, Supplement 11
8. *Inventory management*	12, 14, 16
9. *Scheduling*	13, 15
10. *Maintenance*	17

The Strategic Decisions

1. Design of goods and services

- Defines what is required of operations
- Product design determines quality, sustainability and human resources

2. Managing quality

- Determine the customer's quality expectations
- Establish policies and procedures to identify and achieve that quality

Table 1.2 (cont.)

The Strategic Decisions

3. Process and capacity design

- How is a good or service produced?
- Commits management to specific technology, quality, resources, and investment

4. Location strategy

- Nearness to customers, suppliers, and talent
- Considering costs, infrastructure, logistics, and government

Table 1.2 (cont.)

The Strategic Decisions

5. Layout strategy

- Integrate capacity needs, personnel levels, technology, and inventory
- Determine the efficient flow of materials, people, and information

6. Human resources and job design

- Recruit, motivate, and retain personnel with the required talent and skills
- Integral and expensive part of the total system design

Table 1.2 (cont.)

The Strategic Decisions

7. Supply chain management

- Integrate supply chain into the firm's strategy
- Determine what is to be purchased, from whom, and under what conditions

8. Inventory management

- Inventory ordering and holding decisions
- Optimize considering customer satisfaction, supplier capability, and production schedules

Table 1.2 (cont.)

The Strategic Decisions

9. Scheduling

- Determine and implement intermediate- and short-term schedules
- Utilize personnel and facilities while meeting customer demands

10. Maintenance

- Consider facility capacity, production demands, and personnel
- Maintain a reliable and stable process

Table 1.2 (cont.)

Where are the OM Jobs?

- Technology/methods
- Facilities/space utilization
- Strategic issues
- Response time
- People/team development
- Customer service
- Quality
- Cost reduction
- Inventory reduction
- Productivity improvement

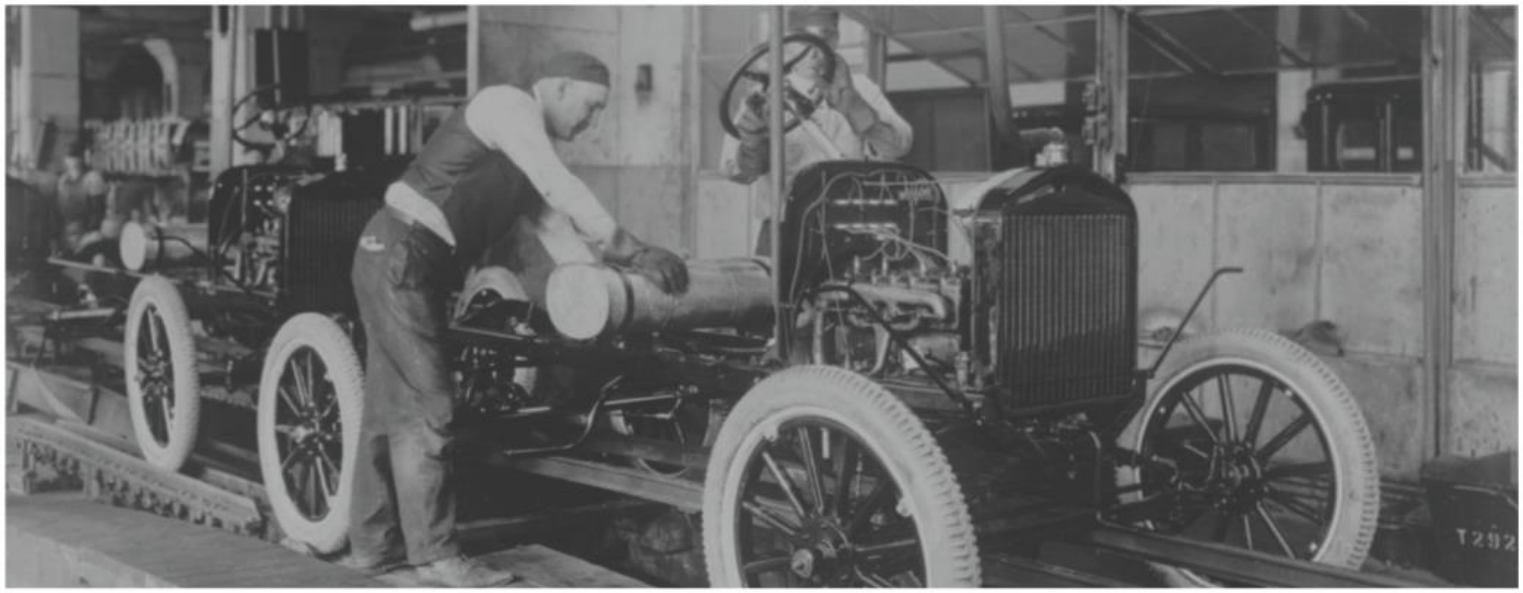
Opportunities

Figure 1.3

Certifications

- APICS, the Association for Operations Management
- American Society for Quality (ASQ)
- Institute for Supply Management (ISM)
- Project Management Institute (PMI)
- Council of Supply Chain Management Professionals
- Charter Institute of Procurement and Supply (CIPS)

Significant Events in OM



Everett Collection/Newscom

Cost Focus

Early Concepts
1776–1880
Labor Specialization (Smith, Babbage)
Standardized Parts (Whitney)

Scientific Management Era
1880–1910
Gantt Charts (Gantt)
Motion & Time Studies (Gilbreth)
Process Analysis (Taylor)
Queuing Theory (Erlang)

Mass Production Era
1910–1980
Moving Assembly Line (Ford/Sorensen)
Statistical Sampling (Shewhart)
Economic Order Quantity (Harris)
Linear Programming
PERT/CPM (DuPont)
Material Requirements Planning (MRP)

Quality Focus

Lean Production Era
1980–1995
Just-in-Time (JIT)
Computer-Aided Design (CAD)
Electronic Data Interchange (EDI)
Total Quality Management (TQM)
Baldrige Award
Empowerment
Kanbans

Customization Focus

Mass Customization Era
1995–2005
Internet/E-Commerce
Enterprise Resource Planning
International Quality Standards (ISO)
Finite Scheduling
Supply Chain Management
Mass Customization
Build-to-Order
Radio Frequency Identification (RFID)

Globalization Focus

Globalization Era
2005–2020
Global Supply Chains
Growth of Transnational Organizations
Instant Communications
Sustainability
Ethics in a Global Workforce
Logistics

Figure 1.4

The Heritage of OM

- Division of labor (Adam Smith 1776; Charles Babbage 1852)
- Standardized parts (Whitney 1800)
- Scientific Management (Taylor 1881)
- Coordinated assembly line (Ford/ Sorenson 1913)
- Gantt charts (Gantt 1916)
- Motion study (Frank and Lillian Gilbreth 1922)
- Quality control (Shewhart 1924; Deming 1950)

The Heritage of OM

- Computer (Atanasoff 1938)
- CPM/PERT (DuPont 1957, Navy 1958)
- Material requirements planning (Orlicky 1960)
- Computer aided design (CAD 1970)
- Flexible manufacturing system (FMS 1975)
- Baldrige Quality Awards (1980)
- Computer integrated manufacturing (1990)
- Globalization (1992)
- Internet (1995)

Taylor's Principles

Management Should Take More Responsibility for:

1. Matching employees to right job
2. Providing the proper training
3. Providing proper work methods and tools
4. Establishing legitimate incentives for work to be accomplished

Contributions From

- Industrial engineering
- Statistics
- Management
- Economics
- Physical sciences
- Information technology

Productivity Challenge

Productivity is the ratio of outputs (goods and services) divided by the inputs (resources such as labor and capital)

The objective is to improve productivity!

Important Note!
Production is a measure of output only and not a measure of efficiency

The Economic System

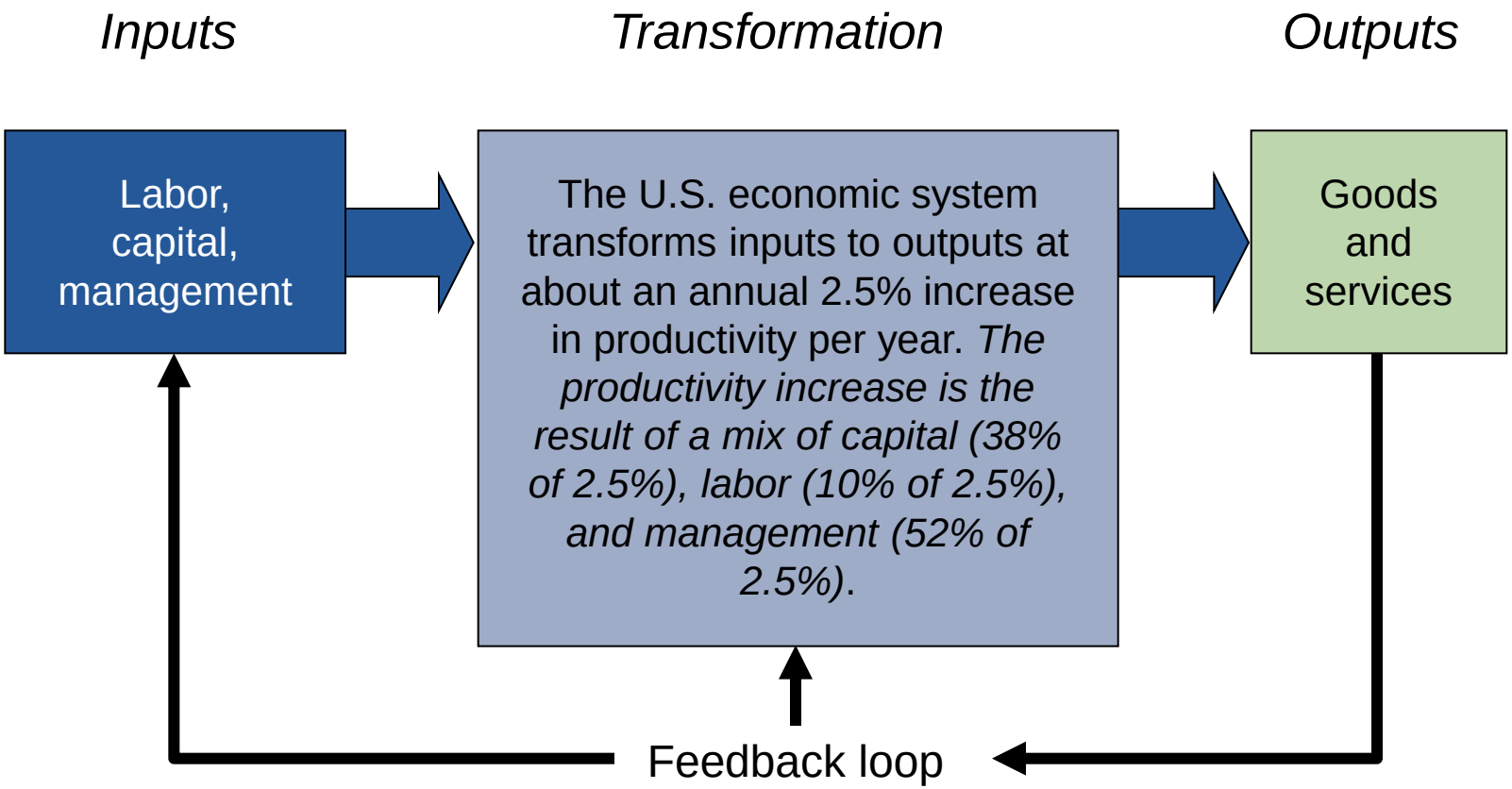


Figure 1.6

Improving Productivity at Starbucks

A team of 10 analysts continually look for ways to shave time. Some improvements:

Stop requiring signatures on credit card purchases under $25	➡	Saved 8 seconds per transaction
Change the size of the ice scoop	➡	Saved 14 seconds per drink
New espresso machines	➡	Saved 12 seconds per shot

Improving Productivity at Starbucks

A team of 10 analysts continually look for ways to shave ti… Some improveme…

Stop requirin… on credit card… under $25

Change the s… scoop

New espress… per shot

Operations improvements have helped Starbucks increase yearly revenue per outlet by $250,000 to $1,000,000.

Productivity has improved by 27%, or about 4.5% per year.

Productivity

$$\text{Productivity} = \frac{\text{Units produced}}{\text{Input used}}$$

- Measure of process improvement
- Represents output relative to input
- Only through productivity increases can our standard of living improve

Productivity Calculations

Labor Productivity

$$\text{Productivity} = \frac{\text{Units produced}}{\text{Labor-hours used}}$$

$$= \frac{1{,}000}{250} = 4 \text{ units/labor-hour}$$

One resource input ⇨ single-factor productivity

Multi-Factor Productivity

$$\text{Multifactor} = \frac{\text{Output}}{\text{Labor} + \text{Material} + \text{Energy} + \text{Capital} + \text{Miscellaneous}}$$

- Also known as total factor productivity
- Output and inputs are often expressed in dollars

Multiple resource inputs ⇨ multi-factor productivity

Collins Title Productivity

Old System:

Staff of 4 works 8 hrs/day
Payroll cost = $640/day

8 titles/day
Overhead = $400/day

$$\text{Old labor productivity} = \frac{8 \text{ titles/day}}{32 \text{ labor-hrs}} = .25 \text{ titles/labor-hr}$$

Collins Title Productivity

Old System:

Staff of 4 works 8 hrs/day — 8 titles/day

Payroll cost = $640/day — Overhead = $400/day

New System:

14 titles/day — Overhead = $800/day

$$\text{Old labor productivity} = \frac{8 \text{ titles/day}}{32 \text{ labor-hrs}} = .25 \text{ titles/labor-hr}$$

$$\text{New labor productivity} = \frac{14 \text{ titles/day}}{32 \text{ labor-hrs}} = .4375 \text{ titles/labor-hr}$$

Collins Title Productivity

Old System:

Staff of 4 works 8 hrs/day
Payroll cost = $640/day

8 titles/day
Overhead = $400/day

New System:

14 titles/day

Overhead = $800/day

$$\text{Old multifactor productivity} = \frac{8 \text{ titles/day}}{\$640 + 400} = .0077 \text{ titles/dollar}$$

Collins Title Productivity

Old System:

Staff of 4 works 8 hrs/day — 8 titles/day

Payroll cost = $640/day — Overhead = $400/day

New System:

14 titles/day — Overhead = $800/day

$$\text{Old multifactor productivity} = \frac{8 \text{ titles/day}}{\$640 + 400} = .0077 \text{ titles/dollar}$$

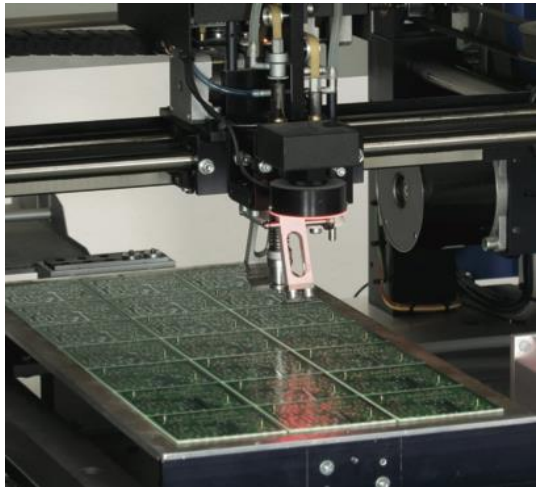
$$\text{New multifactor productivity} = \frac{14 \text{ titles/day}}{\$640 + 800} = .0097 \text{ titles/dollar}$$

Measurement Problems

1. ***Quality*** may change while the quantity of inputs and outputs remains constant
2. ***External elements*** may cause an increase or decrease in productivity
3. ***Precise units*** of measure may be lacking

Productivity Variables

1. ***Labor*** - contributes about 10% of the annual increase
2. ***Capital*** - contributes about 38% of the annual increase
3. ***Management*** - contributes about 52% of the annual increase

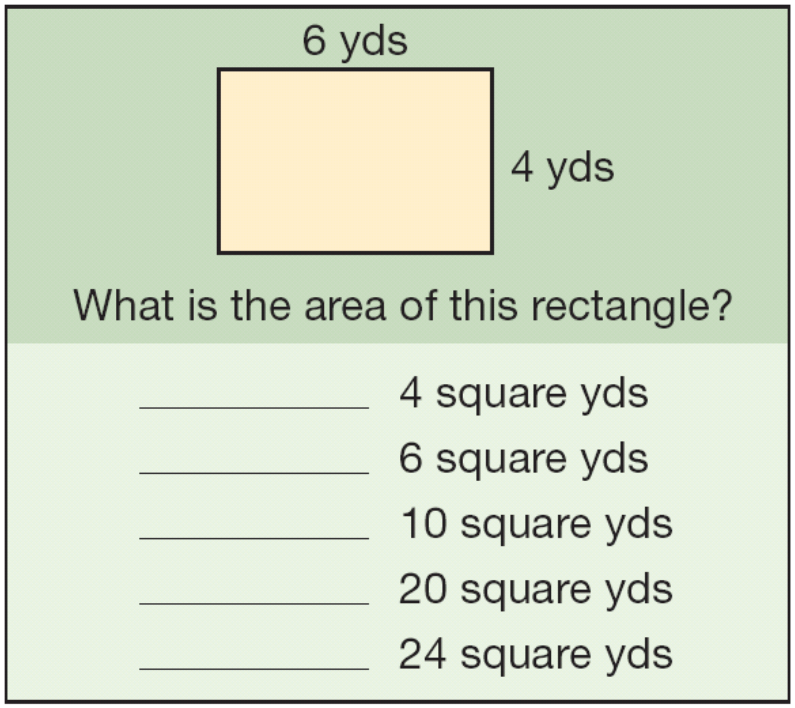


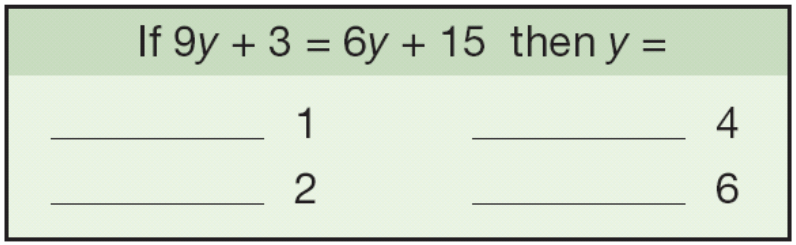
Key Variables for Improved Labor Productivity

1. Basic education appropriate for the labor force
2. Diet of the labor force
3. Social overhead that makes labor available
   - Challenge is in maintaining and enhancing skills in the midst of rapidly changing technology and knowledge

Labor Skills

About half of the 17-year-olds in the U.S. cannot correctly answer questions of this type





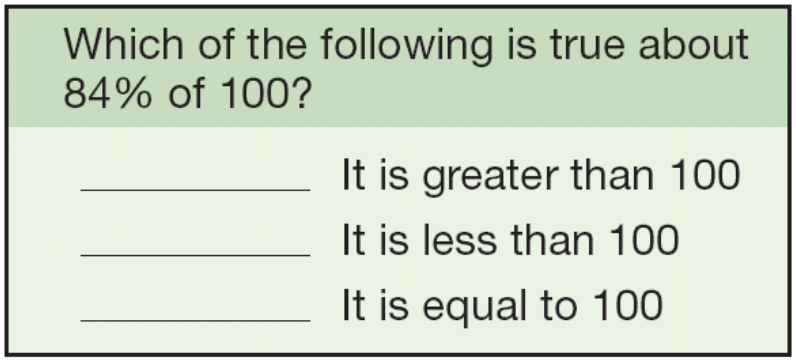
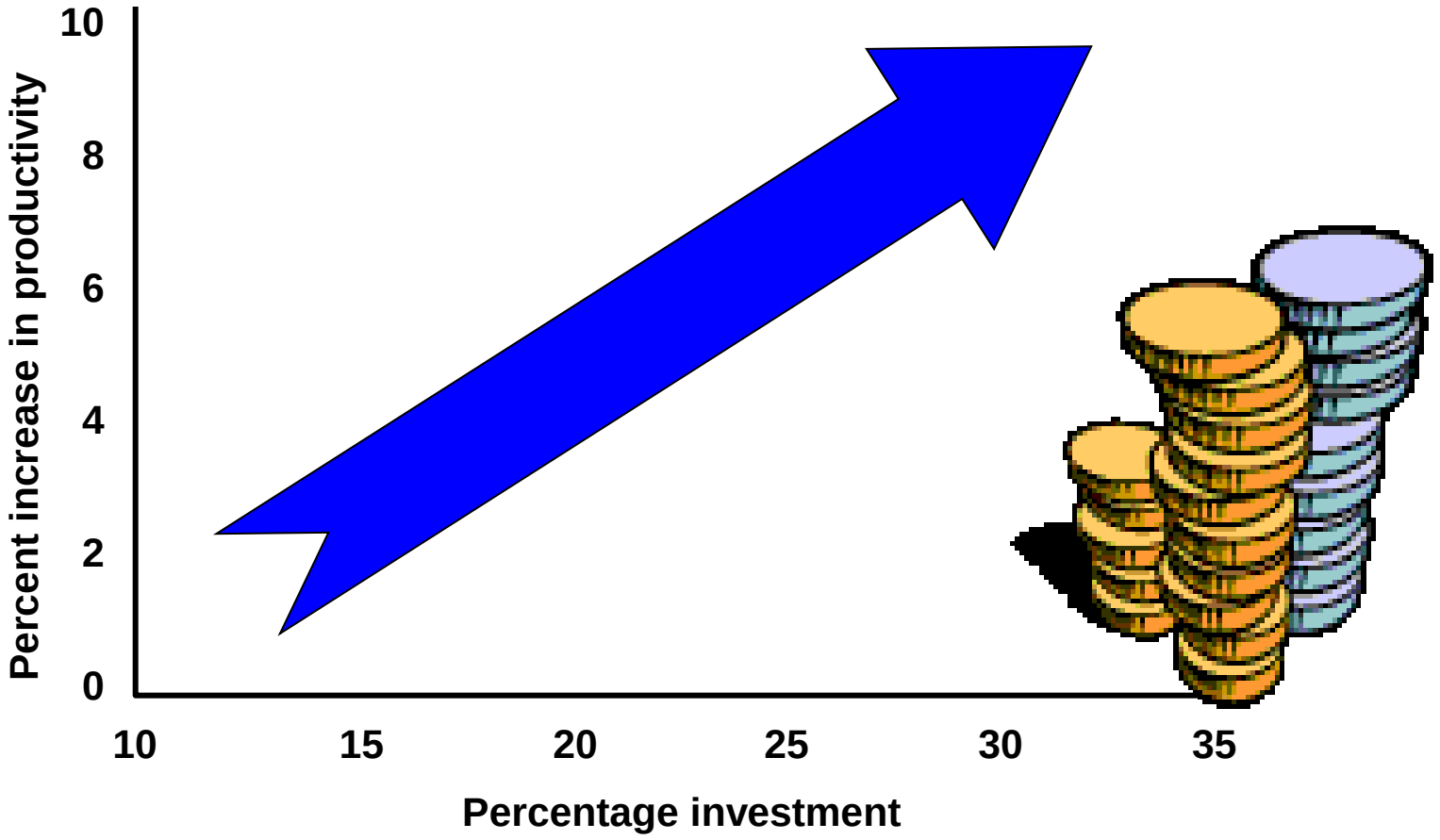


Figure 1.7

Capital



Management

- Ensures labor and capital are effectively used to increase productivity
  - Use of knowledge
  - Application of technologies
- Knowledge societies
  - Labor has migrated from manual work to technical and information-processing tasks
- More effective use of technology, knowledge, and capital

Productivity in the Service Sector

- Productivity improvement in services is difficult because:

1. Typically labor intensive
2. Frequently focused on unique individual attributes or desires
3. Often an intellectual task performed by professionals
4. Often difficult to mechanize and automate
5. Often difficult to evaluate for quality

Productivity at Uber

Improvements:

- Mobility-as-a-service
- Low costs and ease of use
- Peer-to-peer transport services
- Generates employment
- Decrease in fuel emission

Results:

- Preparation time cut to 8 seconds
- Management span of control increased from 5 to 30
- In-store labor cut by 15 hours/day
- Floor space reduced by more than 50%
- Stores average 164 seconds/customer from drive-up to pull-out
- Water- and energy-savings grills conserve 300 million gallons of water and 200 million KwH of electricity each year
- Green-inspired cooking method saves 5,800 restaurants $17 million per year

Current Challenges in OM

- Globalization
- Supply-chain partnering
- Sustainability
- Rapid product development
- Mass customization
- Lean operations

Ethics, Social Responsibility, and Sustainability

Challenges facing operations managers:

- Develop and produce safe, high-quality green products
- Train, retrain, and motivate employees in a safe workplace
- Honor stakeholder commitments

Ethics, Social Responsibility, and Sustainability

Challenges facing operations managers:

- Develop and produce safe, high-quality green products
- Train, retrain, and motivate employees in a safe workplace
- Honor stakeholder commitments

Problem: 1

Natalie Attire makes fashionable garments. During a particular week, employees worked 360 hours to produce a batch of 132 garments, of which 52 were "seconds" (meaning that they were flawed). Seconds are sold for $90 each at Attire's Factory Outlet Store. The remaining 80 garments are sold to retail distribution at $200 each. What is the *labor* productivity ratio of this manufacturing process?

SOLUTION

$$\text{Value of output} = (52 \text{ defective} \times 90/\text{defective}) + (80 \text{ garments} \times 200/\text{garment})$$

$$= \$20{,}680$$

$$\text{Labor hours of input} = 360 \text{ hours}$$

$$\text{Labor productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\$20{,}680}{360 \text{ hours}}$$

$$= \$57.44 \text{ in sales per hour}$$

Problem: 2

Student tuition at Boehring University is $150 per semester credit hour. The state supplements school revenue by $100 per semester credit hour. Average class size for a typical 3-credit course is 50 students. Labor costs are $4,000 per class, materials costs are $20 per student per class, and overhead costs are $25,000 per class.

a. What is the *multifactor* productivity ratio for this course process?

b. If instructors work an average of 14 hours per week for 16 weeks for each 3-credit class of 50 students, what is the *labor* productivity ratio?

SOLUTION

a. Multifactor productivity is the ratio of the value of output to the value of input resources.

$$\text{Value of output} = \left(\frac{50 \text{ students}}{\text{class}}\right)\left(\frac{3 \text{ credit hours}}{\text{students}}\right)\left(\frac{\$150 \text{ tuition} + \$100 \text{ state support}}{\text{credit hour}}\right)$$

$$= \$37{,}500/\text{class}$$

$$\text{Value of inputs} = \text{Labor} + \text{Materials} + \text{Overhead}$$

$$= \$4{,}000 + (\$20/\text{student} \times 50 \text{ students/class}) + \$25{,}000$$

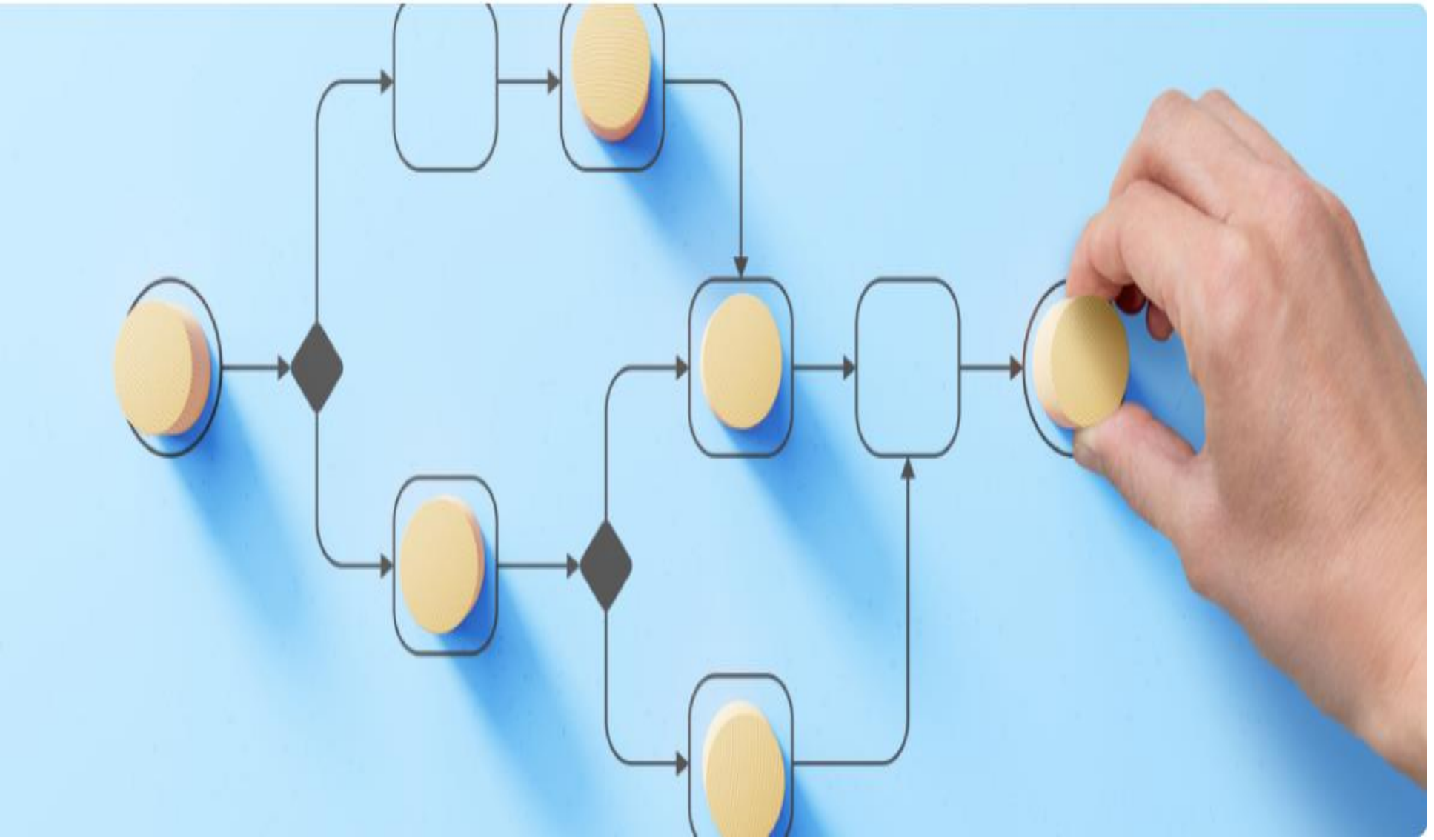
$$= \$30{,}000/\text{class}$$

$$\text{Multifactor productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\$37{,}500/\text{class}}{\$30{,}000/\text{class}} = 1.25$$

b. Labor productivity is the ratio of the value of output to labor hours. The value of output is the same as in part (a), or \$37,500/class, so

$$\text{Labor hours of input} = \left(\frac{14 \text{ hours}}{\text{week}}\right)\left(\frac{16 \text{ weeks}}{\text{class}}\right) = 224 \text{ hours/class}$$

$$\text{Labor productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\$37{,}500/\text{class}}{224 \text{ hours/class}} = \$167.41/\text{hour}$$



A Process View

A process is any activity or group of activities that takes one or more inputs, transforms them, and provides one or more outputs for its customers.

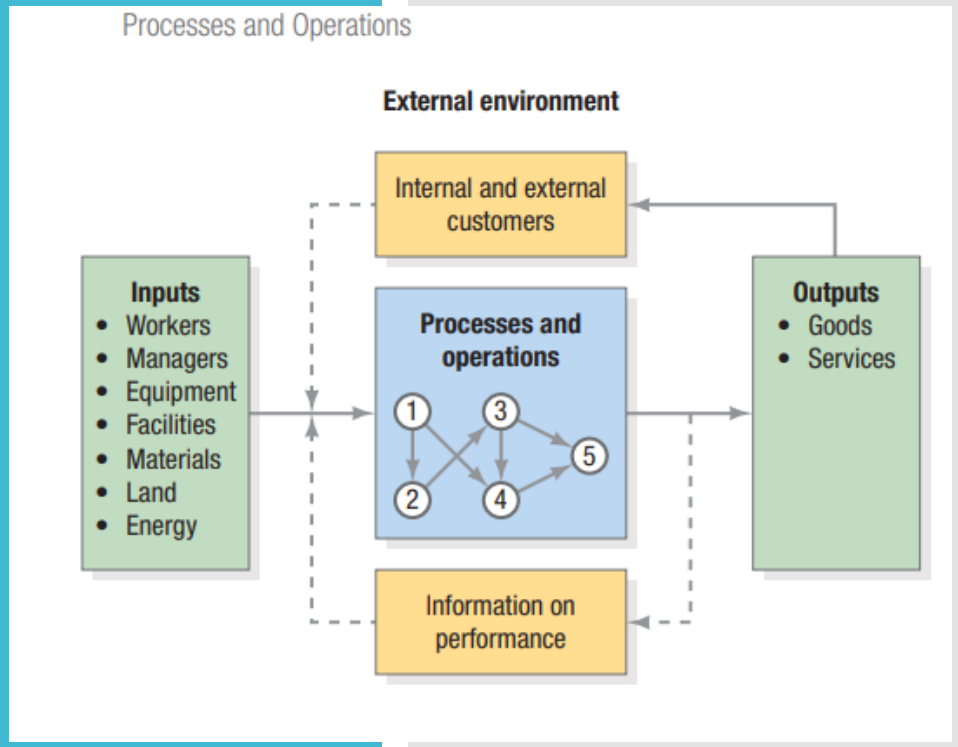
For organizational purposes, processes tend to be clustered together into **operations**. An operation is a group of resources performing all or part of one or more **processes**.

Processes can be linked together to form a **supply chain**, which is the interrelated series of processes within a firm and across different firms that produce a service or product to the satisfaction of customers. A firm can have multiple supply chains, which vary by the product or service provided.

A Process View

A Process View

Every process involves inputs and outputs:
Inputs: Workers, managers, equipment, materials, facilities, land, and energy.
Process flow: Arrows represent the flow of products or services through different stages, which may vary based on customer needs.
Outputs: Goods or services delivered to customers (internal or external).



External Customers: End users or intermediaries (e.g., retailers) who purchase the firm's products. A bookstore buys books from a publisher to sell to customers.
Internal Customers: Employees or processes within the company who rely on outputs from other internal processes. The marketing team uses product designs developed by the design department.
External Suppliers: Businesses or individuals providing materials or services needed by the firm. A textile supplier providing fabric to a clothing manufacturer.
Internal Suppliers: Internal employees or processes that supply materials or information for other processes. The accounting department providing budget reports to the operations team.

Types of Customers & Suppliers

A nested process is a hierarchical structure where a main process is divided into smaller subprocesses, which can themselves be further divided into even smaller processes.

Nested processes are essential for improving the efficiency and effectiveness of complex systems.

- **Modularity:** They break down complex tasks into manageable parts, making it easier to understand, develop, and maintain the overall process.
- **Reusability:** Subprocesses can be reused in different contexts, promoting efficiency and reducing redundancy.
- **Clarity and Focus:** Nesting allows teams to concentrate on specific aspects without feeling overwhelmed, leading to better communication and collaboration.
- **Scalability:** Nested structures can easily accommodate growth by adding new subprocesses without disrupting existing workflows.

Nested Processes

- **Error Isolation:** Issues can be traced back to specific subprocesses, facilitating quicker diagnosis and resolution.
- **Easier Testing:** Subprocesses can be tested individually, ensuring each part functions correctly before integration.
- **Enhanced Control:** Better tracking of progress and performance is possible, as each subprocess can be monitored for efficiency and effectiveness.

Service and Manufacturing Processes Two major types of processes are (1) service and (2) manufacturing.

1. **Service Processes:** Service processes involve the delivery of intangible goods or services to customers. These processes typically emphasize customer interaction, experience, and satisfaction. Services cannot be stored or owned; they are experienced at the moment of delivery. Examples include healthcare, education, hospitality, and consulting.
2. **Manufacturing Processes:** Manufacturing processes involve the production of tangible goods through a series of physical and chemical transformations. These processes focus on creating products that can be produced, stored, and transported. Manufacturing often involves significant capital investment in machinery and facilities. Examples include automobile production, electronics assembly, and food processing.

Types of Process in Operations Management

Differences between service and manufacturing processes

1. Nature of Output

Manufacturing Processes:

•**Tangible Products**: The output is a physical good that can be produced, stored, and transported. A car manufacturing plant produces vehicles. The cars are tangible items that can be measured, counted, and stored in inventory.

Service Processes:

•**Intangible Products**: The output is a service that cannot be physically touched or stored. A hair salon provides haircuts. The service is delivered in real-time and cannot be stored or transported; it's experienced at the moment of delivery.

2. Degree of Customer Contact

Manufacturing Processes:

•**Low Customer Contact**: Typically, customers are not directly involved in the production process. Interaction is minimal, focusing instead on efficiency and volume. In a factory producing smartphones, customers may have input through surveys or feedback, but they do not participate in the actual assembly process.

Service Processes:

•**High Customer Contact**: Customers often play an active role in the delivery of the service, influencing the experience and outcome. In a restaurant, customers interact with waitstaff, influence service speed, and provide immediate feedback on their meals, which can affect the overall service experience.

Differences between service and manufacturing processes

3. Response Times: Manufacturing processes often have longer response times due to the complexity of production cycles and supply chains, whereas services can often be delivered immediately.

4. Capital Intensity: Manufacturing is typically more capital-intensive, requiring significant investment in machinery and facilities. In contrast, service processes may rely more on human resources and less on heavy equipment.

5. Quality Measurement: Quality in manufacturing can often be measured through quantifiable metrics (e.g., defect rates, adherence to specifications), while service quality is often more subjective (e.g., customer satisfaction, experience).

- Physical, durable output
- Output can be inventoried
- Low customer contact
- Long response time
- Capital intensive
- Quality easily measured

- Intangible, perishable output
- Output cannot be inventoried
- High customer contact
- Short response time
- Labor intensive
- Quality not easily measured

Similarities Between Service and Manufacturing Processes

Combined Expectations: Customers expect both quality service and good products (e.g., a restaurant should provide good food and service; a computer purchase involves good products and warranties).

Inventory Management:

- Service Providers: Maintain inventories of inputs, like hospitals keeping medical supplies.
- Manufacturers: Sometimes don’t inventory outputs, especially for low-volume or perishable products (e.g., tailored suits, daily newspapers).

Process Clarity: At the process level, it’s clearer whether a task is service-based or manufacturing-based.

Similarities Between Service and Manufacturing Processes

However, classifying entire companies can be confusing since many perform both types of processes.

Example of McDonald’s: Cooking a hamburger and assembling it are considered manufacturing processes because they change the food’s physical properties.

Other processes at McDonald's are service-oriented (e.g., taking orders, customer service).This creates debate on whether to classify McDonald’s as a service provider or manufacturer, while process classifications are more straightforward.

Core Processes

A core process is a set of activities that delivers value to external customers. Managers of these processes and their employees interact with external customers and build relationships with them, develop new services and products, interact with external suppliers, and produce the service or product for the external customer.

Examples include a hotel's reservation handling, a new car design for an auto manufacturer, or Web-based purchasing for an online retailer like Amazon.com. Of course, each of the core processes has nested processes within it.

Four core processes:

1. **Supplier Relationship Process.** Employees in the supplier relationship process select the suppliers of services, materials, and information and facilitate the timely and efficient flow of these items into the firm. Working effectively with suppliers can add significant value to the services or products of the firm. For example, negotiating fair prices, scheduling on-time deliveries, and gaining ideas and insights from critical suppliers are just a few of the ways to create value.

2. **New Service/Product Development Process.** Employees in the new service/product development process design and develop new services or products. The services or products may be developed to external customer specifications or conceived from inputs received from the market in general.

Four core processes:

3. Order Fulfillment Process. The order fulfilment process includes the activities required to produce and deliver the service or product to the external customer.

4. Customer Relationship Process, sometimes referred to as customer relationship management. Employees involved in the customer relationship process identify, attract, and build relationships with external customers, and facilitate the placement of orders by customers. Traditional functions, such as marketing and sales, maybe a part of this process.

Support Processes

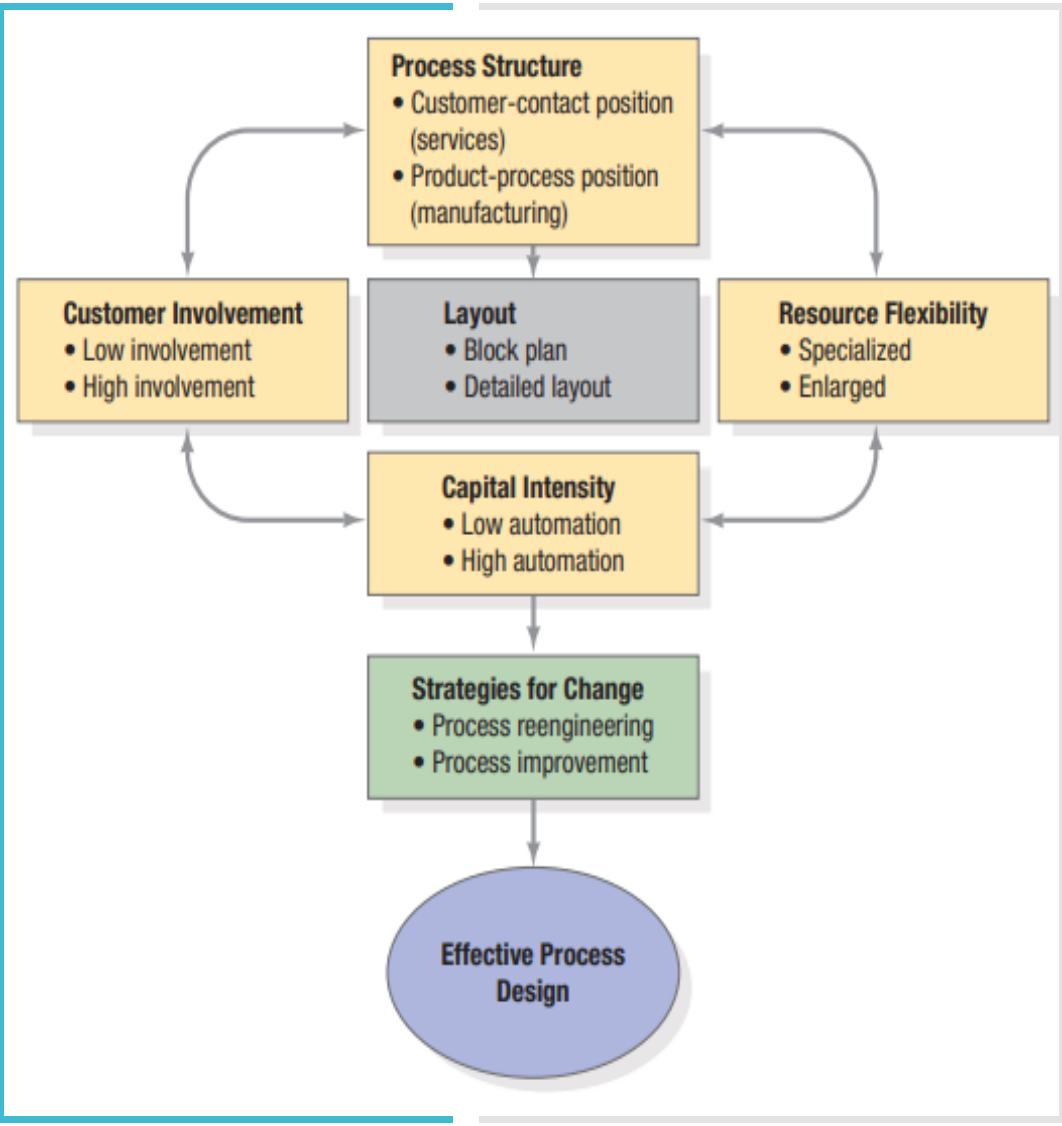
A support process provides vital resources and inputs to the core processes and is essential to the management of the business. Firms have many support processes.

Examples include budgeting, recruiting, and scheduling. Support processes provide key resources, capabilities, or other inputs that allow the core processes to function.

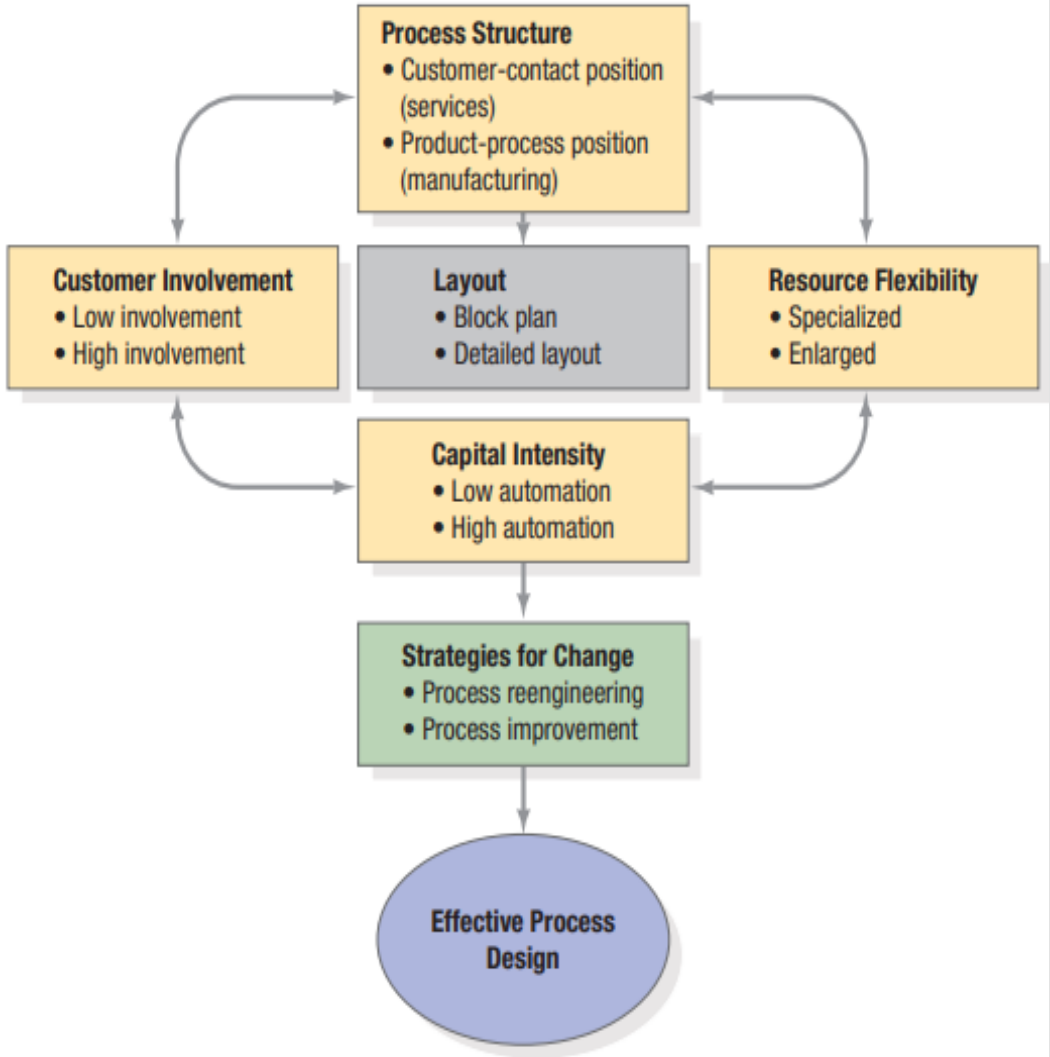
The Human Resources function in an organization provides many support processes such as recruiting and hiring workers who are needed at different levels of the organization, training the workers for skills and knowledge needed to properly execute their assigned responsibilities, and establishing incentive and compensation plans that reward employees for their performance. The legal department puts in place support processes that ensure that the firm complies with the rules and regulations under which the business operates.

- # Process Strategy Decisions

- Process decisions directly affect the process itself and indirectly the services and the products that it provides. Whether dealing with processes for offices, service providers, or manufacturers, operations managers must consider four common process decisions. Figure 3.1 shows that they are all important steps toward an effective process design.
- These four decisions are best understood at the process or sub-process level, rather than at the firm level



- Process structure determines the process type relative to the kinds of resources needed, how resources are partitioned tween them, and their key characteristics. A layout, which is the physical arrangement of operations created from the various processes, puts these decisions into tangible form.
- Customer involvement reflects the ways in which customers become part of the process and the extent of their participation.
- Resource flexibility is the ease with which employees and equipment can handle a wide variety of products, output levels, duties, and functions.
- Capital intensity is the mix of equipment and human skills in a process. The greater the relative cost of equipment, the greater the capital intensity



Nature of Service Processes: Customer Contact

Customer-Contact Matrix

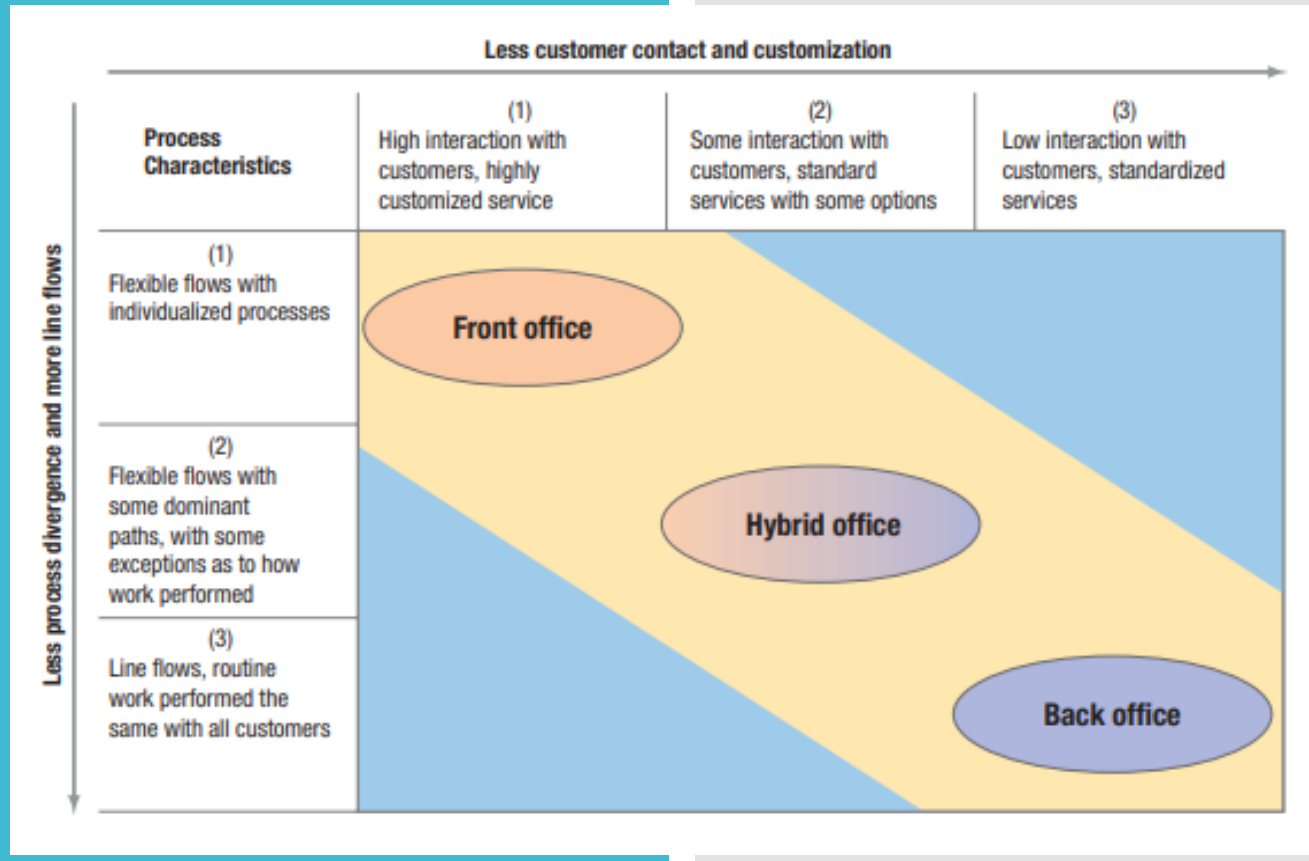
The customer-contact matrix, shown in Figure, brings together three elements:

(1) the degree of customer contact,
(2) customization, and
(3) process characteristics.

The matrix is the starting point for evaluating and improving a process.

The manager has three process structures, which form a continuum, to choose from:

(1) front office,
(2) hybrid offices, and
(3) back office.



Process Structures:

1.Front Office

1. High customer contact with direct interaction.
2. Customized services with flexible workflows.
3. Example: Tailored consultations.

2.Hybrid Office

1. Moderate customer contact with some customization.
2. Standardized services offering limited options.
3. Example: Bank teller services.

3.Back Office

1. Low customer contact and minimal customization.
2. Standardized, routine tasks with linear workflows.
3. Example: Financial report preparation.

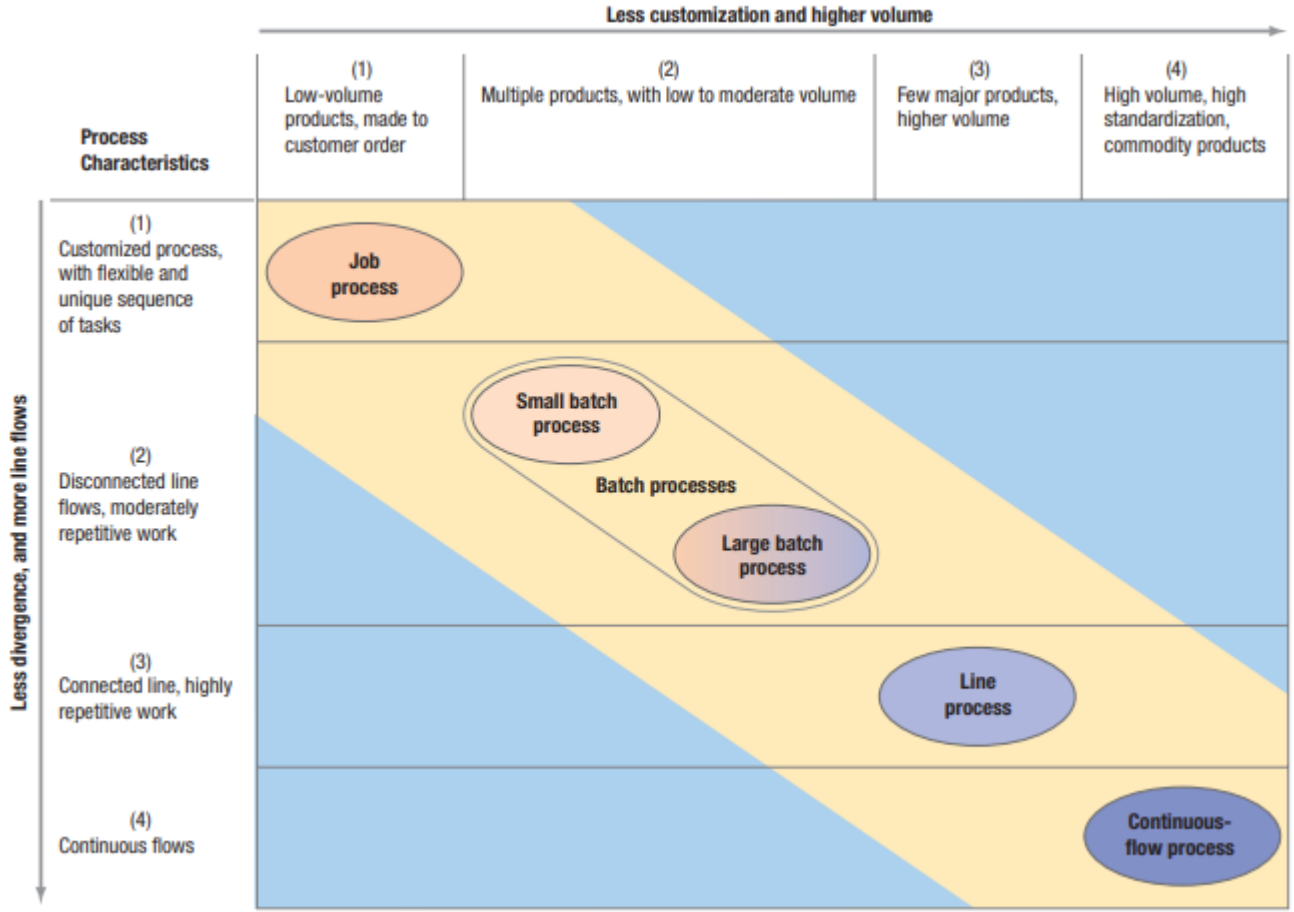
Process Structure in Manufacturing

The product-process matrix, shown in Figure, brings together three elements:

(1) Volume,

(2) Product Customization,

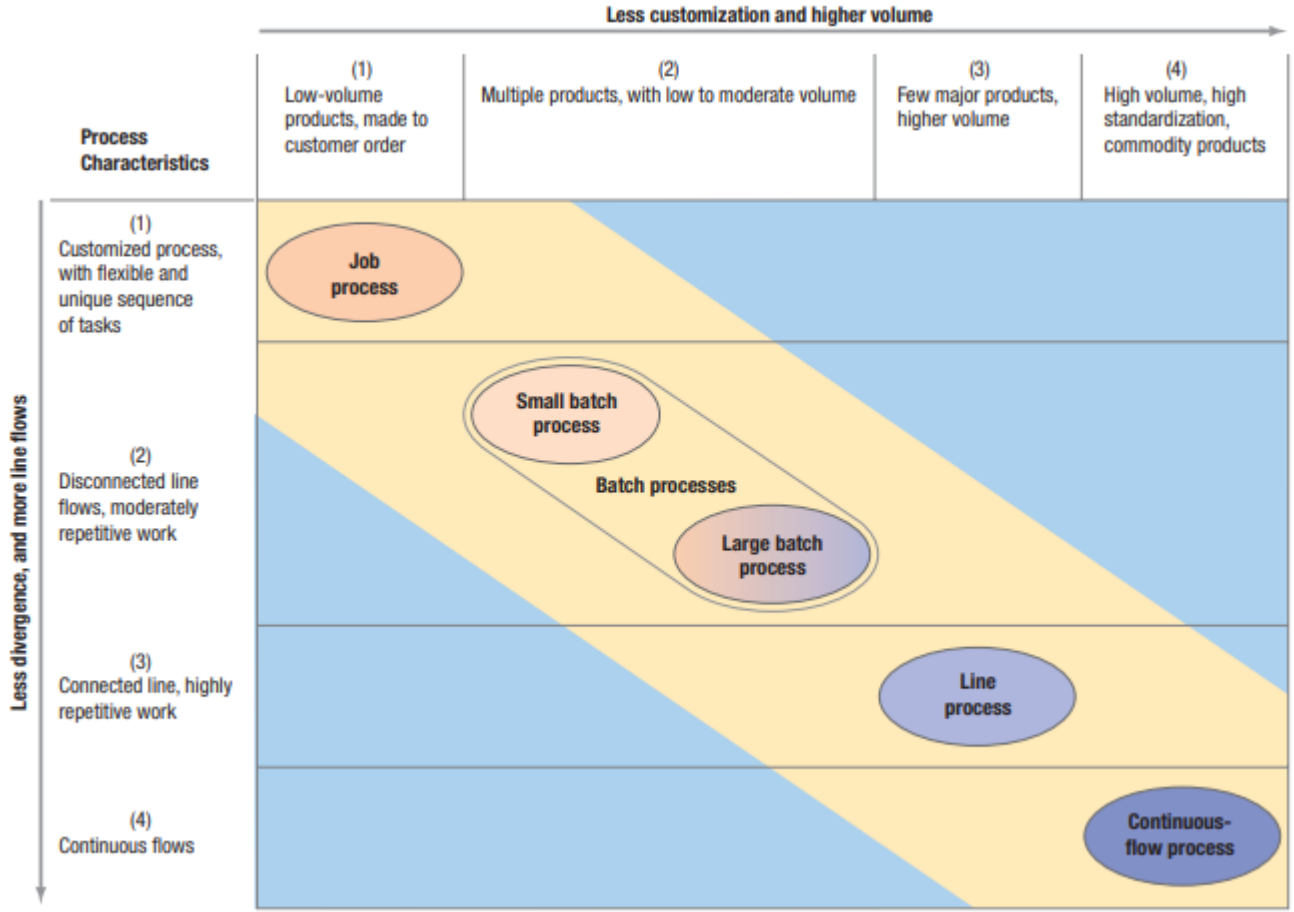
(3) Process Characteristics.



Manufacturing Process Structuring

The figure shows several desirable positions (often called process choices) in the product process matrix that effectively connect the manufactured product with the process. Process choice is the way of structuring the process by organizing resources around the process or organizing them around the products.

The manager has four process choices, which form a continuum, to choose from:
(1) Job Process,
(2) Batch Process,
(3) Line Process,
(4) Continuous-flow Process.



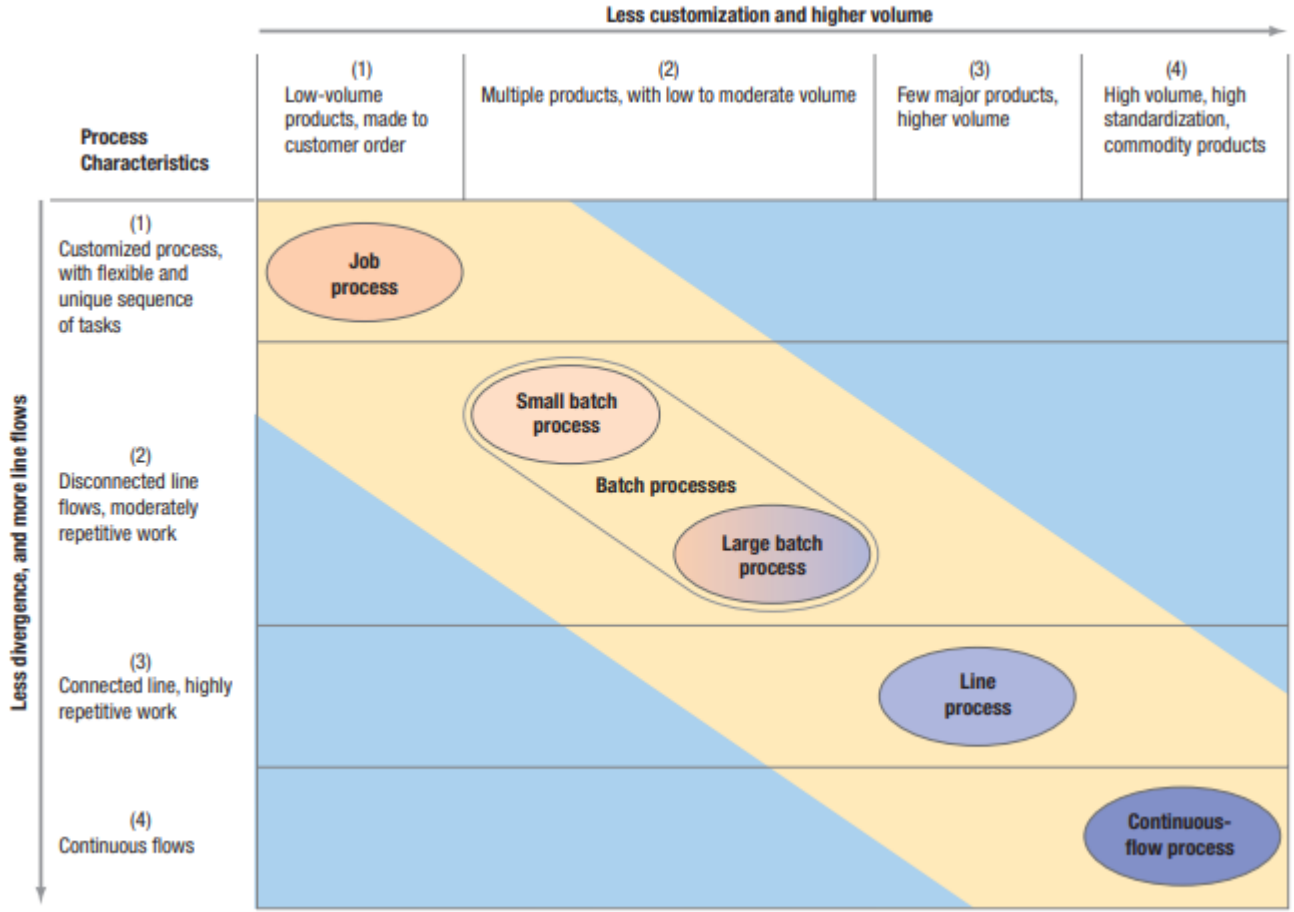
Process Choices:

1.Job Process: A job process creates the flexibility needed to produce a wide variety of products in significant quantities, with considerable divergence in the steps performed.

- High customization, low volume.
- Flexible workflows for unique tasks.
- Example: Custom cabinets, metal casting.

2.Batch Process: The batch process is by far the most common process choice found in practice, leading to terms such as small batch or large batch to further distinguish one process choice from another. A batch process differs from the job process with respect to volume, variety, and quantity.

- Moderate customization, medium volume.
- Flexible flow with dominant paths.
- Example: Standard components for assembly lines.



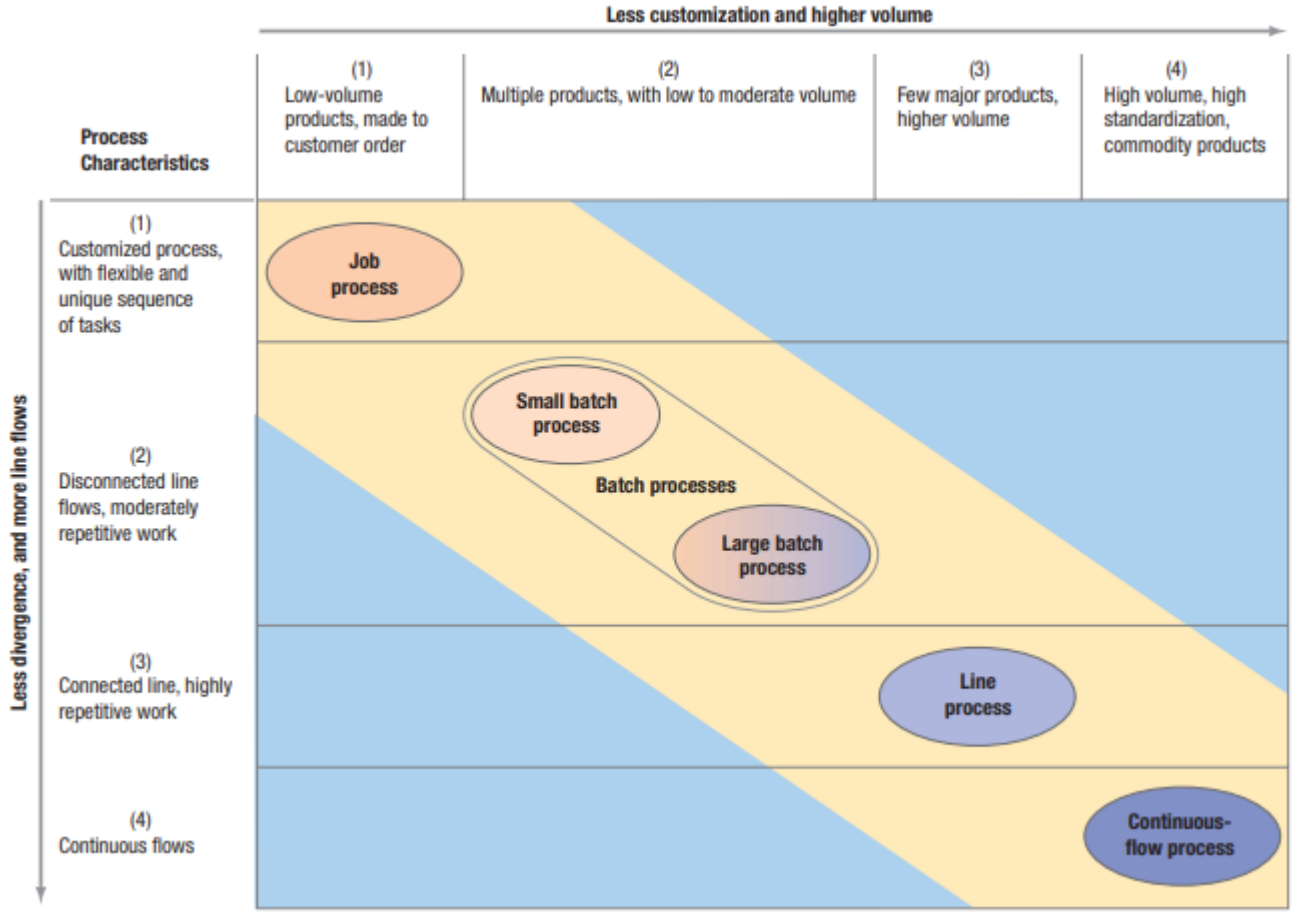
Process Choices:

3. Line Process: A-line process lies between the batch and continuous processes on the continuum; volumes are high and products are standardized, which allows resources to be organized around particular products.

- Low customization, high volume.
- Repetitive workflows with minimal variability.
- Example: Automobiles, appliances.

4. Continuous Flow Process: A continuous flow process is the extreme end of high-volume standardized production, with rigid line flows. Process divergence is negligible. Its name derives from the way materials move through the process.

- No customization, very high volume.
- Rigid line flows with uninterrupted production.
- Example: Petroleum refining, steel manufacturing.



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Key Features:

1.Clustering Processes:

1. Operations group human and capital resources performing related tasks.
2. Examples: Customer service desks, production lines, or marketing departments.

2.Cross-Departmental Flows:

1. Flows of information, services, or products often span departmental boundaries.
2. **Challenge**: Processes like job or batch workflows create complex inter-departmental flows.

Steps for Layout Design:

1.Gather Information: Identify relationships and interactions between departments.

2.Develop a Block Plan: Define approximate locations for departments based on their interactions.

3.Design a Detailed Layout: Specify exact placements and optimize spatial arrangements.

Layout

The layout is the physical arrangement of operations (or departments) within a facility, grouping processes into tangible organizational structures.

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Customer Involvement

- The extent and ways customers participate in and influence a process.
- Especially relevant in high customer-contact service processes.

Examples:

1.eBay: Customers manage auction variability.

2.Starbucks:

1. Customizable beverages with multiple options.
2. Uses ordering protocols and “ordering guides” to streamline customer involvement.

Customer Involvement: Advantages vs. Disadvantages

Advantages	Disadvantages
Better quality, faster delivery, and greater flexibility.	Increased variability and inefficiencies in processes.
Lower costs through self-service and customer assembly.	Higher operational costs (e.g., training and facility changes).
Enhanced customer satisfaction and engagement.	Disruption in timing and demand management.
Coordination across the supply chain.	Quality risks from exposing facilities and processes.
Savings in price and time for customers.	Need for decentralized facilities near customers.

Key Decision: Managers must evaluate trade-offs to meet competitive priorities and maximize customer satisfaction.

Strategies for Change

Approach	Key Features
Process Reengineering	- Radical redesign for dramatic improvements in **cost, quality, service, speed**.
	- Emphasis on **core business processes**.
	- Requires **strong leadership** and **cross-functional teams**.
	- **Information technology** as a primary enabler.
	- Adopts a **clean-slate philosophy** focused on customer objectives.
	- **Process analysis** ensures understanding of current operations.
Process Improvement	- Incremental, systematic approach for **continuous improvement**.
	- Aims to streamline tasks, eliminate inefficiencies, and enhance customer satisfaction.
	- Focuses on reducing costs, delays, and improving safety.

Operations Strategy as a Pattern of Decisions

Operations strategy

Operations strategy defines how a company uses its operations to support its overall corporate strategy and create a customer-focused business.

- It connects long-term and short-term decisions to improve competitiveness.
- It links long-term and short-term operations decisions to corporate strategy and develops the capabilities the firm needs to be competitive.
- It is at the heart of managing processes and supply chains. A firm's internal processes are only building blocks: They need to be organized to ultimately be effective in a competitive environment.

Operations strategy is the linchpin that brings these processes together to form supply chains that extend beyond the walls of the firm, encompassing suppliers as well as customers. Since customers constantly desire change, the firm's operations strategy must be driven by the needs of its customers.

Corporate Strategy:

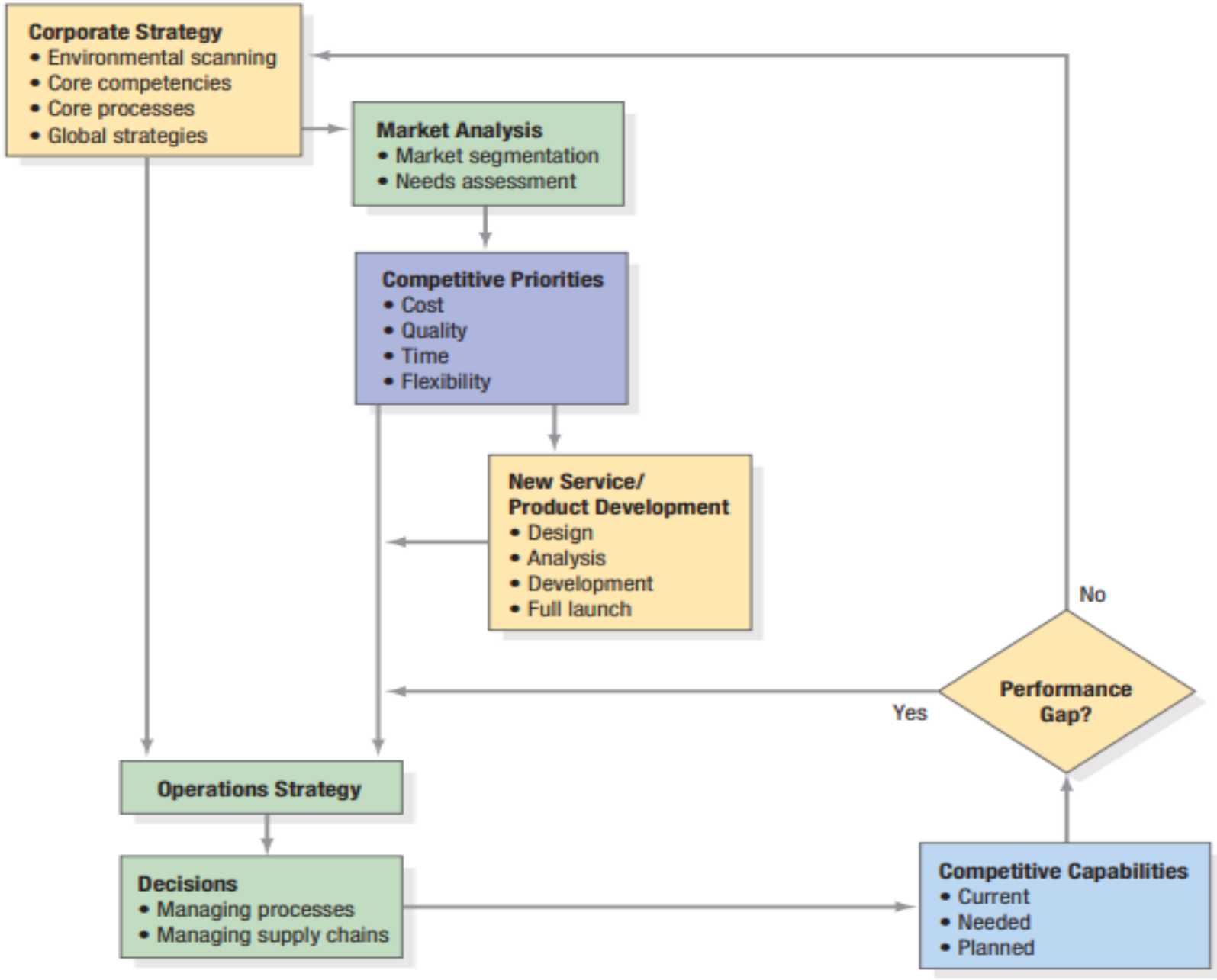
- Corporate strategy provides an overall direction that serves as the framework for carrying out all the organization's functions. It specifies the business or businesses the company will pursue, isolates new opportunities and threats in the environment, and identifies growth objectives.

Key Considerations for the Development of Corporate Strategy:

- *Environmental Scanning*
- *Core Competencies*
- *Core Processes*
- *Global Strategies*

FIGURE

Connection Between Corporate Strategy and Key Operations Management Decisions



Environmental Scanning: Monitor changes in the business environment to identify opportunities and threats. Environmental Scanning.

Importance: Adaptation to continual changes in the external environment (industry trends, economic conditions, technological shifts, etc.) is crucial for staying competitive. Example: Car manufacturers developing alternative fuel vehicles in response to dwindling oil reserves.

Core Competencies: Recognize and develop unique strengths that differentiate the firm. Unique strengths that provide a competitive edge, reflecting the organization's collective learning.

Workforce: A skilled, flexible workforce responsive to market needs.

Facilities: Well-located and adaptable facilities that support various services/products.

Market and Financial Know-How: Ability to attract capital and effectively market services/products.

Systems and Technology: Expertise in data-intensive systems and new technologies.

Core Processes: Core processes should align with core competencies, allowing firms to focus on strengths for competitive advantage.
Examples: Companies may specialize in customer acquisition, service innovation, or managing order fulfilment processes.
Global Strategies: Establish essential processes such as customer relationships, new product development, order fulfilment, and supplier relationships. Identifying international opportunities and threats is vital for growth.

Approaches of Global Strategies:

- *Strategic Alliances:* Collaborate with other firms for shared benefits (e.g., buyer-supplier relationships).
- *Joint Ventures:* Partner with other firms to produce services/products, gaining access to new markets (e.g., GM and VW in China).
- *Technology Licensing:* License services or production methods to enter foreign markets.
- *Location Considerations:* Understand that strategies successful in the home market may not be effective abroad due to differing economic, political, and cultural contexts (e.g., Jollibee's success in the Philippines).

Market Analysis

To develop a customer-driven operations strategy in both the service and manufacturing sectors, it's essential to understand customer needs and how to fulfil them. Market analysis is a two-part process: ***market segmentation*** *and* ***needs assessment****.*

1. Market Segmentation

Market segmentation identifies groups of customers with similar characteristics, allowing the firm to design specific products or services for each group. By defining these segments, companies can develop effective marketing and operational strategies.

•*Example*: The Gap, Inc. targets teenagers and young adults with its primary brand, while GapKids focuses on products for children (infants to 12-year-olds), aiming at parents or guardians.

•*Importance*: Segmenting customers helps companies understand that even similar products may be used differently by different customers, allowing for tailored approaches that meet each group’s unique needs.

2. Needs Assessment

The next step is to assess the specific needs within each segment and evaluate how well these needs are being met, especially compared to competitors. Needs assessments help companies identify both tangible and intangible product or service attributes that customers value. Needs can be grouped into four main areas:

- **Service or Product Needs**: Includes attributes like price, quality, and level of customization.
- **Delivery System Needs**: Focuses on the systems and processes required to deliver the service or product, including availability, convenience, reliability, speed, and dependability.
- **Volume Needs**: Relates to demand levels, such as high or low demand volume, demand variability, and predictability.
- **Other Needs**: Includes factors like the company's reputation, years in business, after-sale support, financial investment capabilities, and legal expertise.

Conducting thorough market segmentation and needs assessment is key to devising a customer-driven strategy that supports long-term success by aligning operations with what customers truly want.

Competitive Priorities and Capabilities

A customer-driven operations strategy requires coordination across all areas of a firm to understand and meet the needs of both external and internal customers. Effective strategies must identify the **competitive priorities** that help the firm deliver value to customers and the **competitive capabilities** that allow it to meet these priorities.

Competitive Priorities

Competitive priorities are the essential operational dimensions—like cost, quality, time, and flexibility—that processes and supply chains must meet to satisfy customer demands and build or maintain market share. Management identifies the most critical priorities for each process to help the company stay competitive.

Competitive Capabilities

Competitive capabilities refer to the actual performance dimensions that a company's processes or supply chains can currently achieve, such as speed, accuracy, or cost-efficiency. If there's a gap between desired priorities and current capabilities, management must either improve the capability or adjust the priority.

Competitive Priorities Grouped by Capability

The four main groups of competitive priorities are:

Cost: Emphasizing cost-efficiency to provide low-cost products or services.

Quality: Ensuring high quality and consistency in products or services.

Time: Focusing on delivery speed and development speed (time to market).

Flexibility: Adapting to changing demands, including volume flexibility and customization.

Time-Based Competition

Some companies combine priorities, such as focusing on delivery speed and development speed. This approach, known as **time-based competition**, involves critically analyzing each production step to reduce time without compromising quality.

Evolving Competitive Priorities

Competitive priorities can shift over time based on market changes. For example:

- *Early Stages*: When color ink-jet printers first entered the mass market, the focus was on consistent quality, quick delivery, and flexibility in production volume.
- *High-Demand Periods*: As demand increased, priorities shifted to low-cost operations, maintaining quality, and ensuring on-time delivery.

Order Winners and Order Qualifiers

To compete effectively, firms need to understand **order winners** and **order qualifiers**, two key criteria that affect customer purchasing decisions.

1. Order Winners: Order winners are criteria that help customers differentiate a firm's product or service from competitors, driving the decision to choose one product over another. These can include operational factors (like price, quality, and delivery speed) and non-operational factors (like after-sale support, technical assistance, and company reputation).

Example: In the auto industry, order winners may include a vehicle's price and reliability, with successful models like the Toyota Corolla and Honda Civic using competitive pricing as an order winners to capture market share.

2. Order Qualifiers: Order qualifiers are the basic standards that a product or service must meet to even be considered by customers. Meeting these minimum requirements alone will not ensure a sale but will position a firm to compete in the market.

Example: Consistent quality is an order qualifier in the auto industry. For instance, the Yugo subcompact car, known for its low price, ultimately failed in the U.S. market because it couldn’t meet the minimum quality standards expected by customers, leading to its exit despite its low price.

Strategic Importance of Order Winners and Qualifiers

From an operations perspective, understanding which priorities are order winners and which are qualifiers is critical:

- **Order Qualifiers**: Ensuring a firm meets minimum thresholds (like quality standards) to stay in the competition.
- **Order Winners**: Investing in factors that help a firm stand out, like pricing or customer support, to attract greater sales.

In competitive bidding, for instance, a supplier may need to demonstrate consistent quality (order qualifier) to be considered. Once qualified, the final selection might be based on low price and a strong reputation (order winners).

In summary, **order qualifiers** set the foundation for competition, while **order winners** drive customer choice and market share.

Design of Goods and Services

Learning Objectives

When you complete this chapter you should be able to :

- **5.1** ***Define*** product life cycle
- **5.2** ***Describe*** a product development system
- **5.3** ***Build*** a house of quality
- **5.4** ***Explain*** how time-based competition is implemented by OM

Learning Objectives

When you complete this chapter you should be able to :

- **5.5** ***Describe*** how goods and services are defined by OM
- **5.6** ***Describe*** the documents needed for production
- **5.7** ***Explain*** how the customer participates in the design and delivery of services

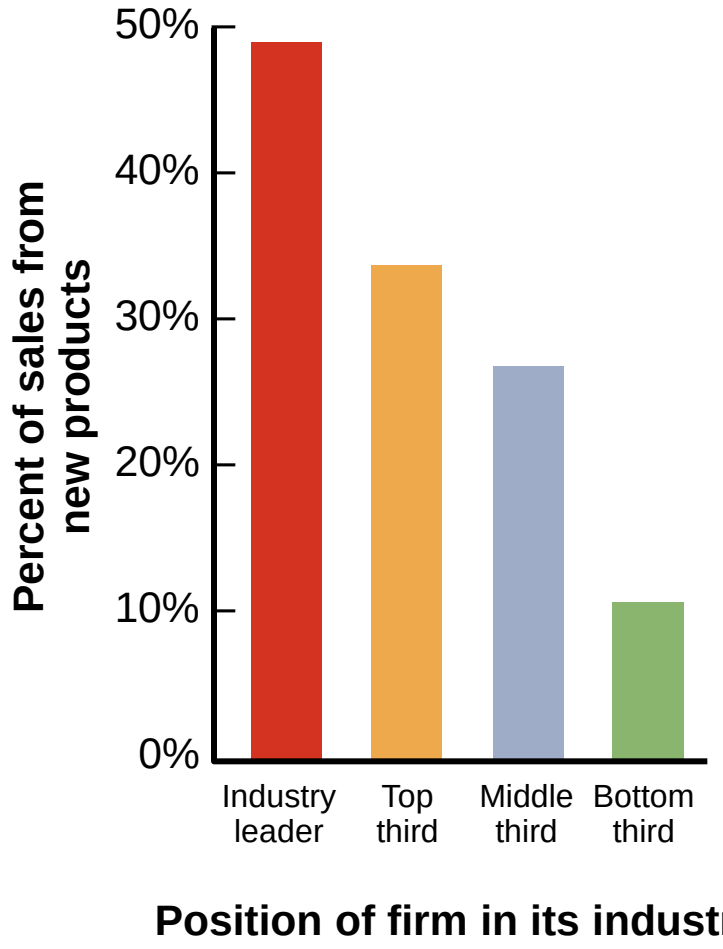
Goods and Services Selection

- Organizations exist to provide goods or services to society
- Great products are the key to success
- Top organizations typically focus on core products
- Customers buy satisfaction, not just a physical good or particular service
- Fundamental to an organization's strategy with implications throughout the operations function

Goods and Services Selection

- Limited and predicable life cycles requires constantly looking for, designing, and developing new products
- Utilize strong communication among customer, product, processes, and suppliers
- New products generate substantial revenue

Goods and Services Selection



The higher the percentage of sales from the last 5 years, the more likely the firm is to be a leader.

Figure 5.1

Product Decision

The objective of the* product decision *is to develop and implement a product strategy that meets the demands of the marketplace with a competitive advantage

Product Strategy Options

- Differentiation
  - Shouldice Hospital
- Low cost
  - Taco Bell
- Rapid response
  - Toyota

Product Life Cycles

- May be any length from a few days to decades
- The operations function must be able to introduce new products successfully

Product Life Cycle

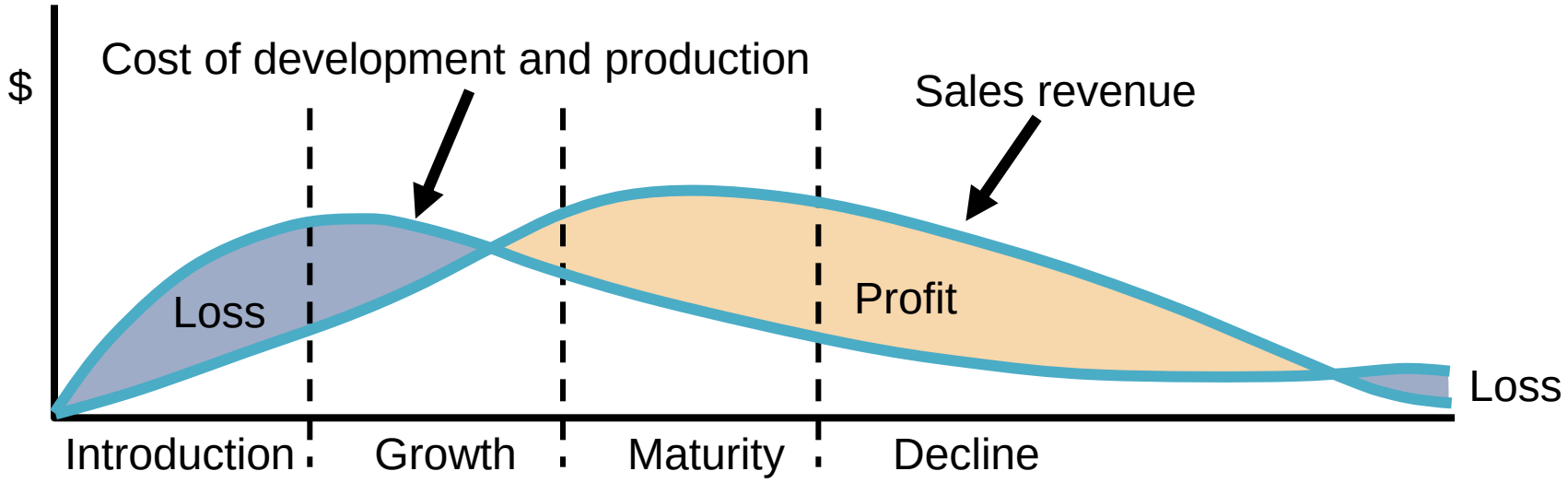


Figure 5.2

Life Cycle and Strategy

Introductory Phase

- Fine tuning may warrant unusual expenses for
  1) Research
  2) Product development
  3) Process modification and enhancement
  4) Supplier development

Product Life Cycle

Growth Phase

- Product design begins to stabilize
- Effective forecasting of capacity becomes necessary
- Adding or enhancing capacity may be necessary

Product Life Cycle

Maturity Phase

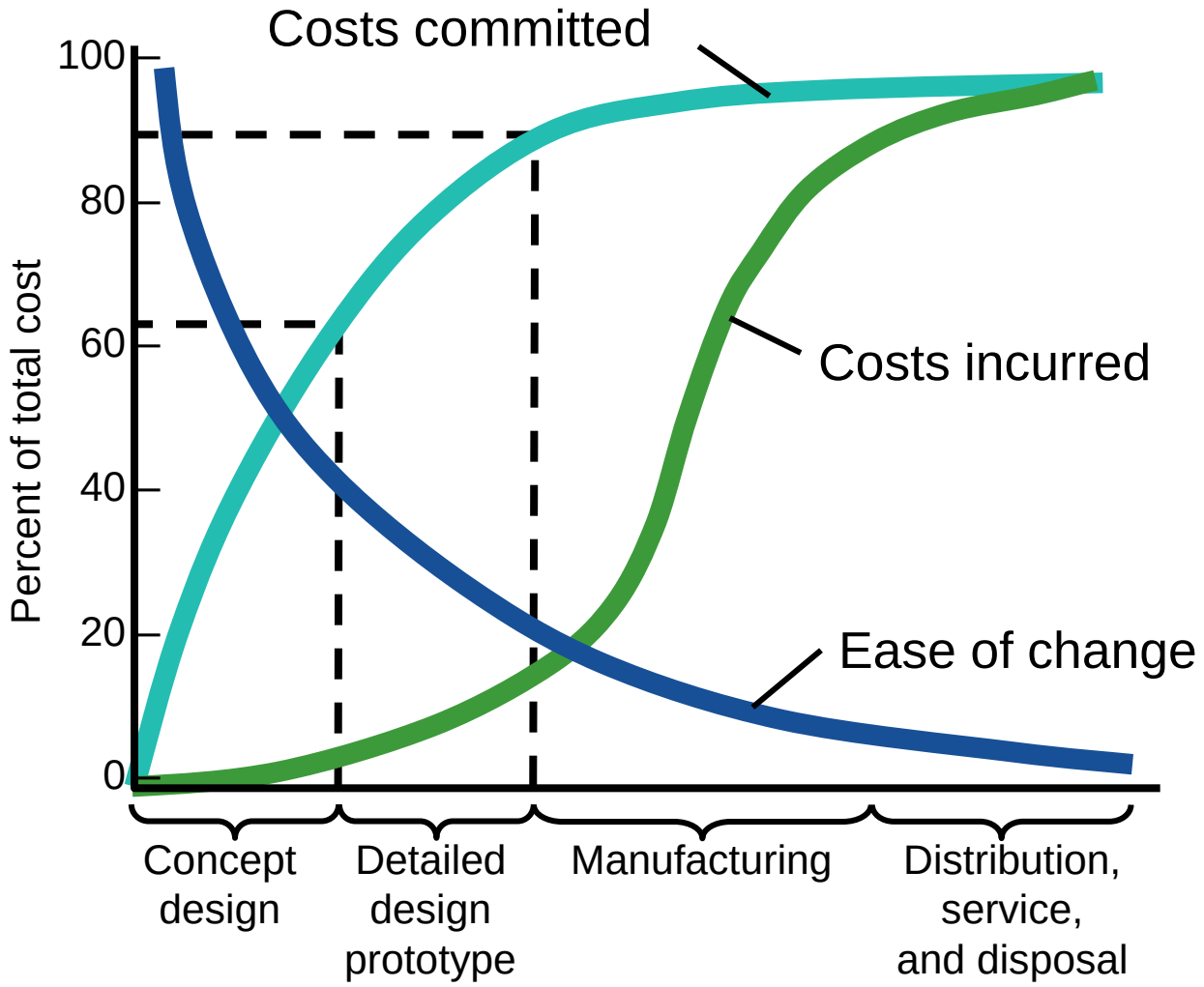
- Competitors now established
- High volume, innovative production may be needed
- Improved cost control, reduction in options, paring down of product line

Product Life Cycle

Decline Phase

- Unless product makes a special contribution to the organization, must plan to terminate offering

Product Life Cycle Costs



Product-by-Value Analysis

- Lists products in descending order of their individual dollar contribution to the firm
- Lists the total annual dollar contribution of the product
- Helps management evaluate alternative strategies

Generating New Products

1. Understanding the customer
2. Economic change
3. Sociological and demographic change
4. Technological change
5. Political and legal change
6. Market practice, professional standards, suppliers, distributors

Product Development Stages

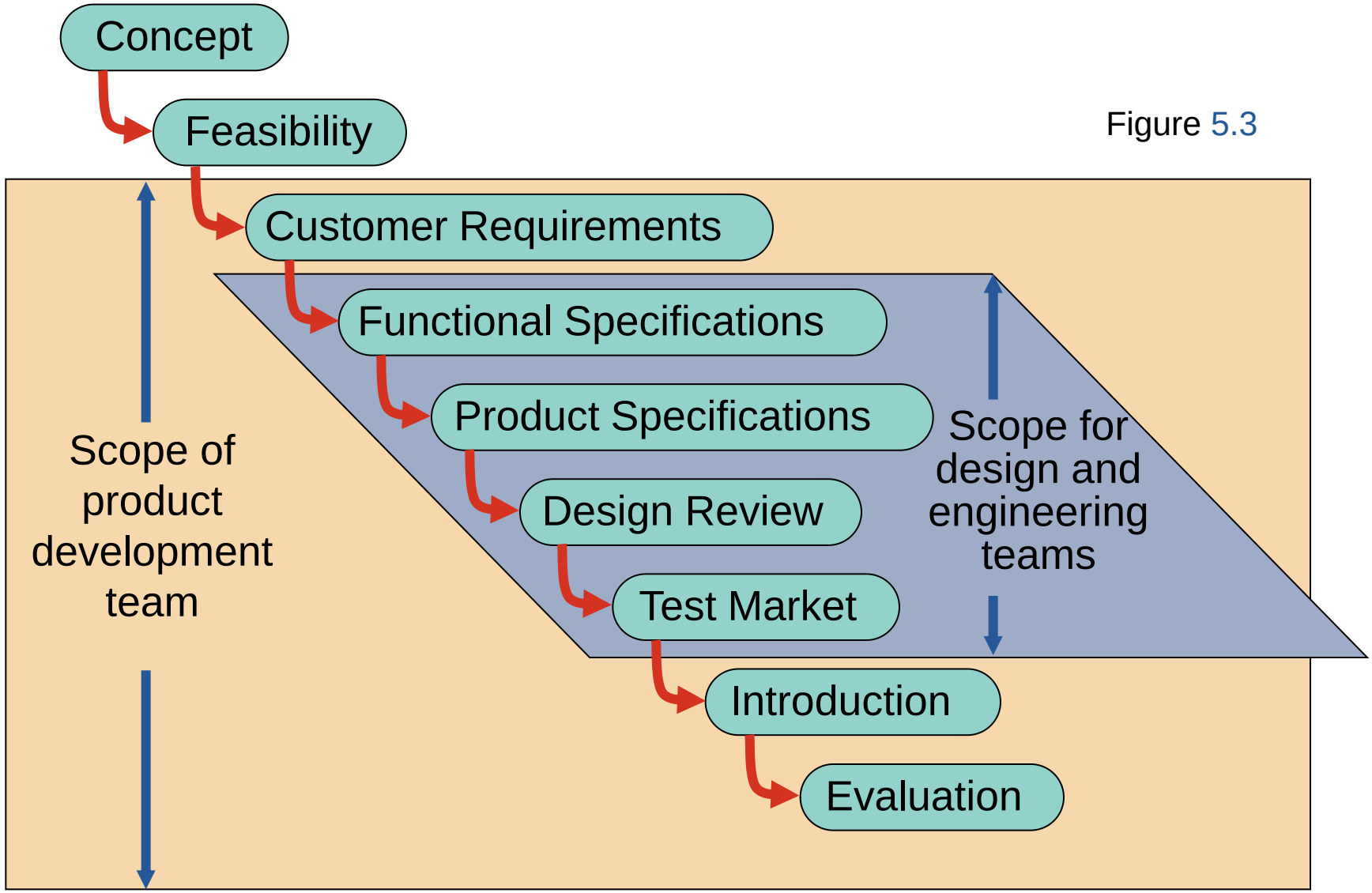


Figure 5.3

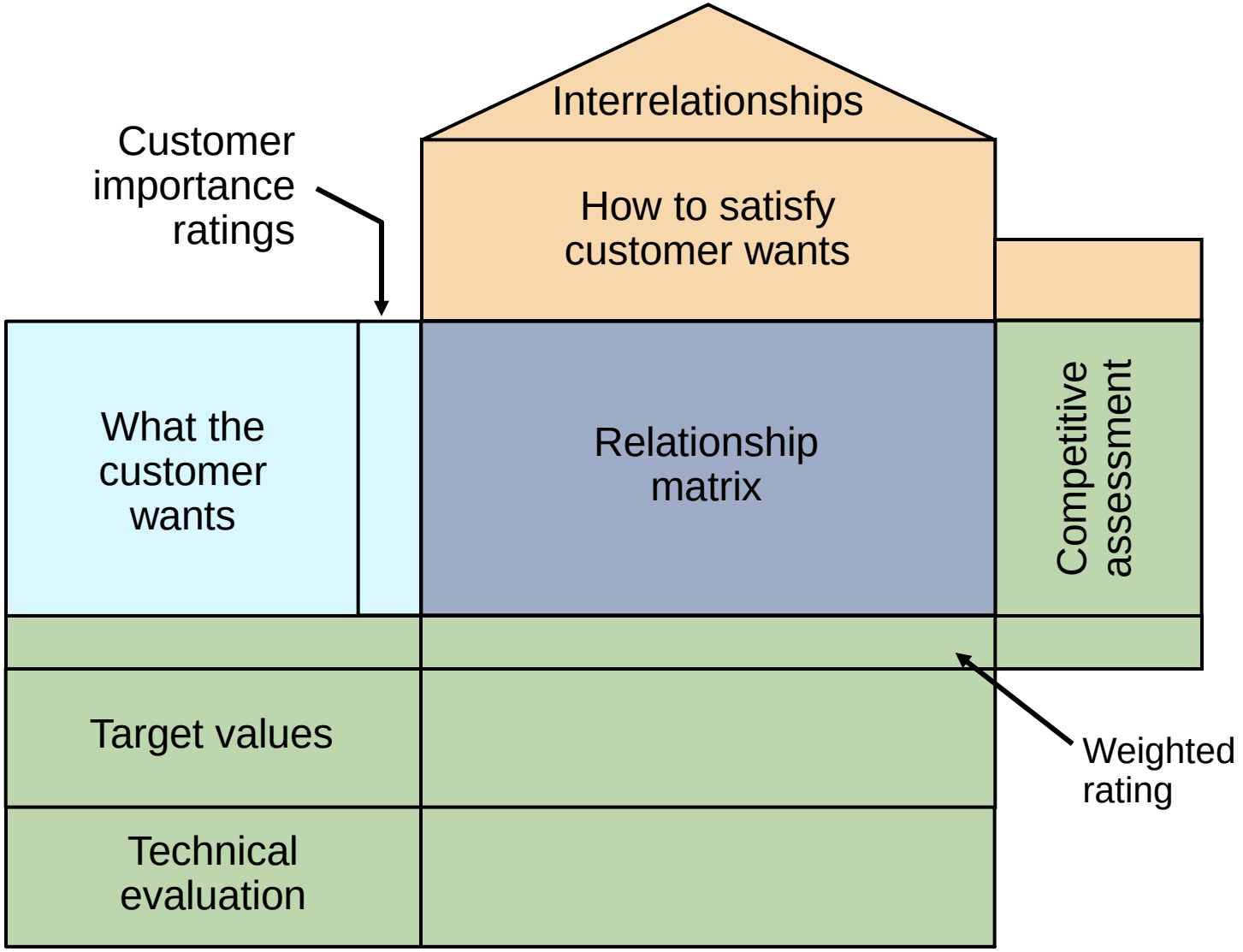
Quality Function Deployment

- **Quality function deployment (QFD)**
  - Determine what will satisfy the customer
  - Translate those customer desires into the target design
- **House of quality**
  - Utilize a planning matrix to relate customer *wants* to *how* the firm is going to meet those *wants*

Quality Function Deployment

1. Identify customer *wants*
2. Identify *how* the good/service will satisfy customer wants
3. Relate customer wants to product *hows*
4. Identify relationships between the firm's *hows*
5. Develop *our* importance ratings
6. Evaluate competing products
7. Compare performance to desirable technical attributes

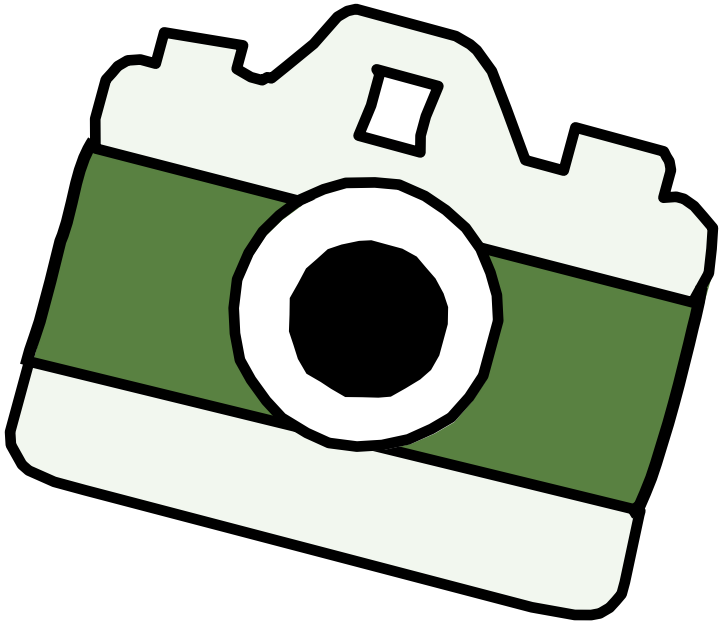
QFD House of Quality



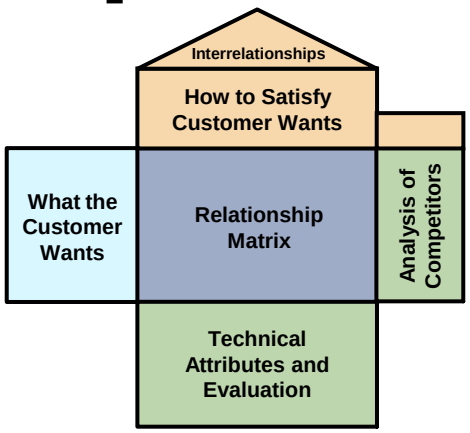
House of Quality Example

Your team has been charged with designing a new camera for Great Cameras, Inc.

The first action is to construct a House of Quality



House of Quality Example

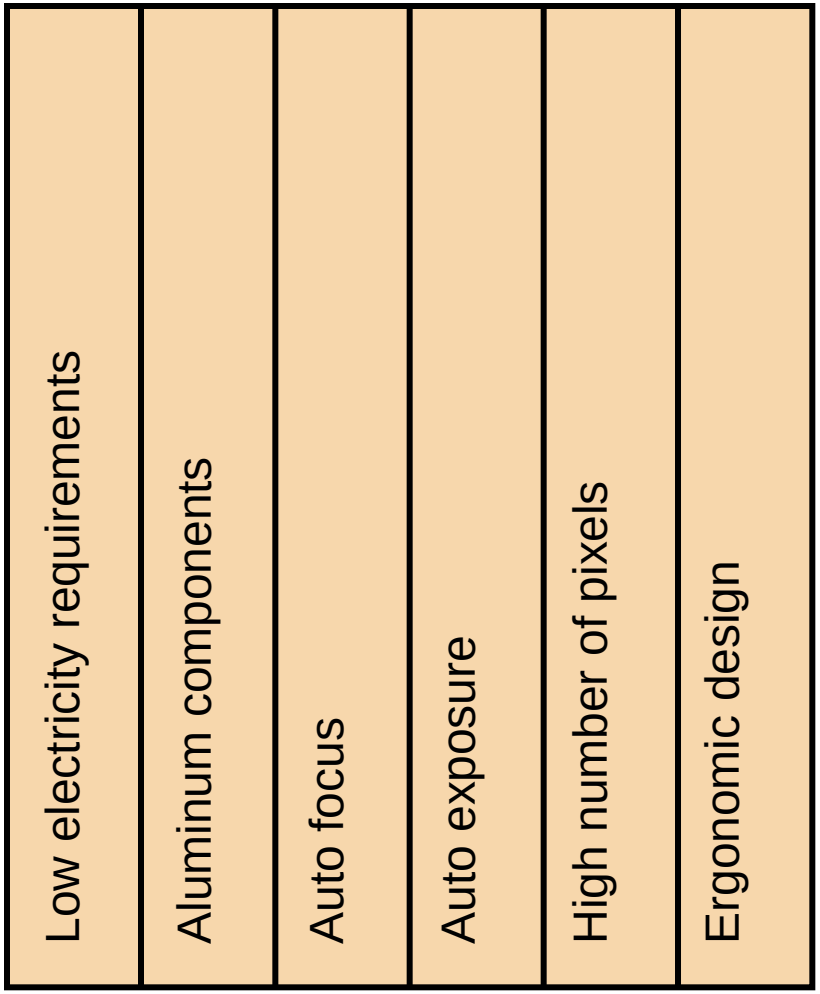


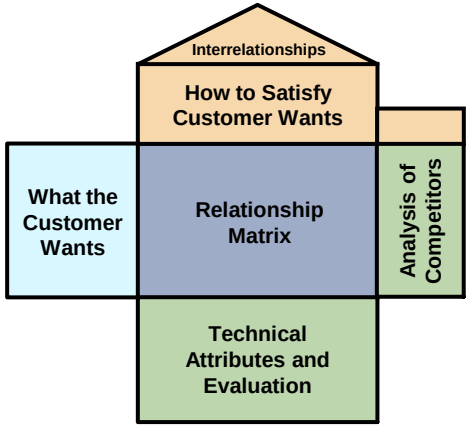
What the customer wants

Customer importance rating (5 = highest)

Lightweight	3
Easy to use	4
Reliable	5
Easy to hold steady	2
High resolution	1

House of Quality Example





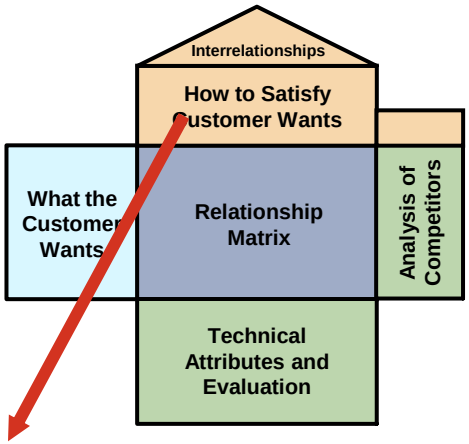
How to Satisfy Customer Wants

House of Quality Example

High relationship

Medium relationship

Low relationship

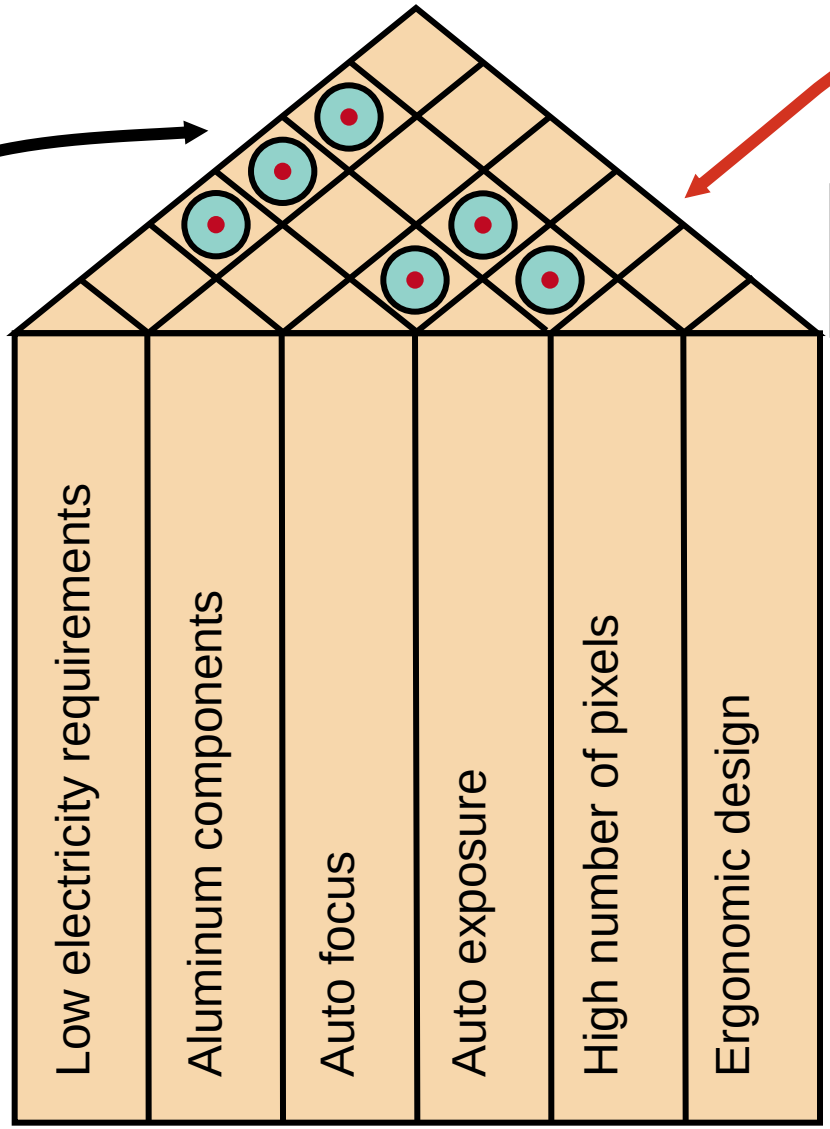


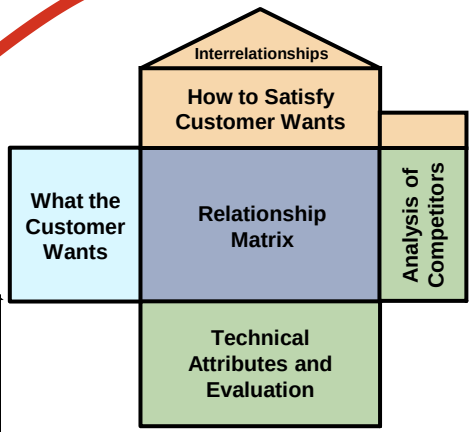
Lightweight	3	●	○				●
Easy to use	4	●		○	○	○	○
Reliable	5	○		○	○	○	
Easy to hold steady	2						◉
High resolution	1					◉	

Relationship matrix

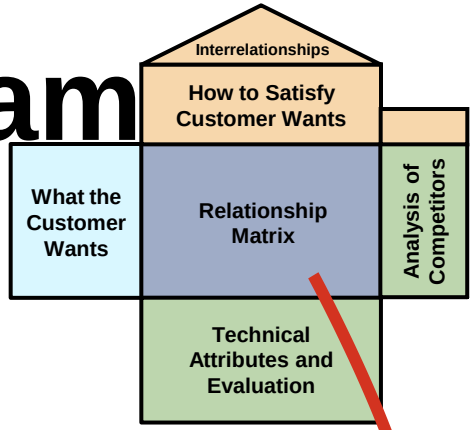
House of Quality Example

Relationships between the things we can do





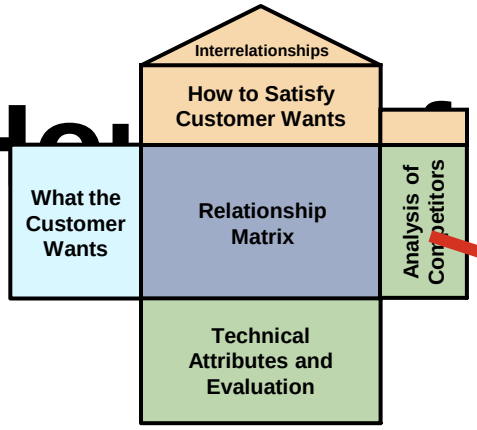
House of Quality Exam



Lightweight	3	●	◯				●
Easy to use	4	●		◯	◯	◯	◯
Reliable	5	◯		◯	◯	◯	
Easy to hold steady	2						◎
High resolution	1					◎	
Our importance ratings		22	9	27	27	32	25

Weighted rating

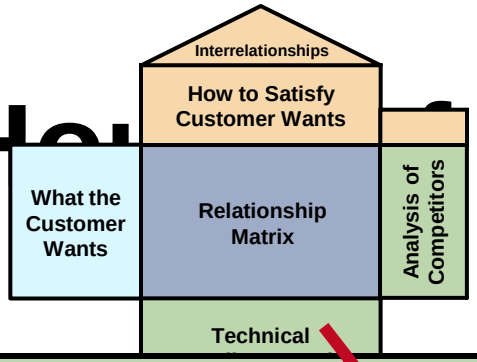
House of Quality Example



How well do competing products meet customer wants

				Company A	Company B
Lightweight	3	●	●	G	P
Easy to use	4	●	○	G	P
Reliable	5	○		F	G
Easy to hold steady	2			G	P
High resolution	1			P	P
Our importance ratings		22	5		

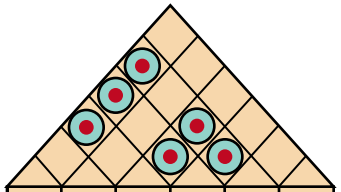
House of Quality Example



Target values (Technical attributes)		0.5 A	75%	2' to ∞	2 circuits	Failure 1 per 10,000	Panel ranking
Technical evaluation	Company A	0.7	60%	yes	1	ok	G
	Company B	0.6	50%	yes	2	ok	F
	Us	0.5	75%	yes	2	ok	G

House of Quality Example

Completed House of Quality



		Low electricity requirements	Aluminum components	Auto focus	Auto exposure	High number of pixels	Ergonomic design	Company A	Company B
Lightweight	3	•	◯				•	G	P
Easy to use	4	•		◯	◯	◯	◯	G	P
Reliable	5	◯		◯	◯	◯		F	G
Easy to hold steady	2						◉	G	P
High resolution	1					◉		P	P
Our importance ratings		22	9	27	27	32	25		
Target values (Technical attributes)		0.5 A	75%	2' to ∞	2 circuits	Failure 1 per 10,000	Panel ranking		
Technical evaluation	Company A	0.7	60%	yes	1	ok	G		
	Company B	0.6	50%	yes	2	ok	F		
	Us	0.5	75%	yes	2	ok	G		

House of Quality Sequence

Deploying resources through the organization in response to customer requirements

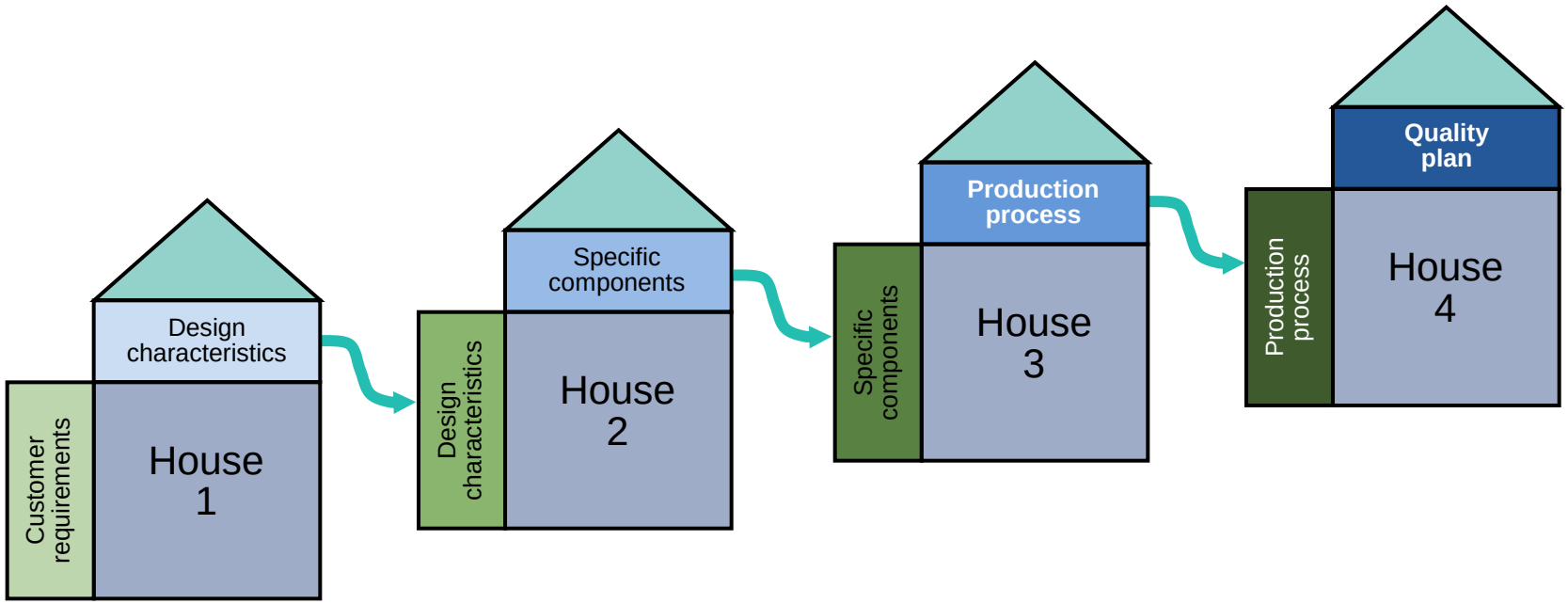


Figure 5.4

Organizing for Product Development

- Traditionally – distinct departments
  - Duties and responsibilities are defined
  - Difficult to foster forward thinking
- A Champion
  - Product manager drives the product through the product development system and related organizations

Organizing for Product Development

- Team approach
  - Cross functional – representatives from all disciplines or functions
  - Product development teams, design for manufacturability teams, value engineering teams
- Japanese “whole organization” approach
  - No organizational divisions

Organizing for Product Development

- Product development teams
  - Market requirements to product success
  - Cross functional teams often involving vendors
  - Open, highly participative environment
- Concurrent engineering
  - Simultaneous performance of product development stages

Manufacturability and Value Engineering

- Benefits:
  1. Reduced complexity of the product
  2. Reduction of environmental impact
  3. Additional standardization of components
  4. Improvement of functional aspects of the product
  5. Improved job design and job safety
  6. Improved maintainability (serviceability) of the product
  7. Robust design

Cost Reduction of a Bracket via Value Engineering

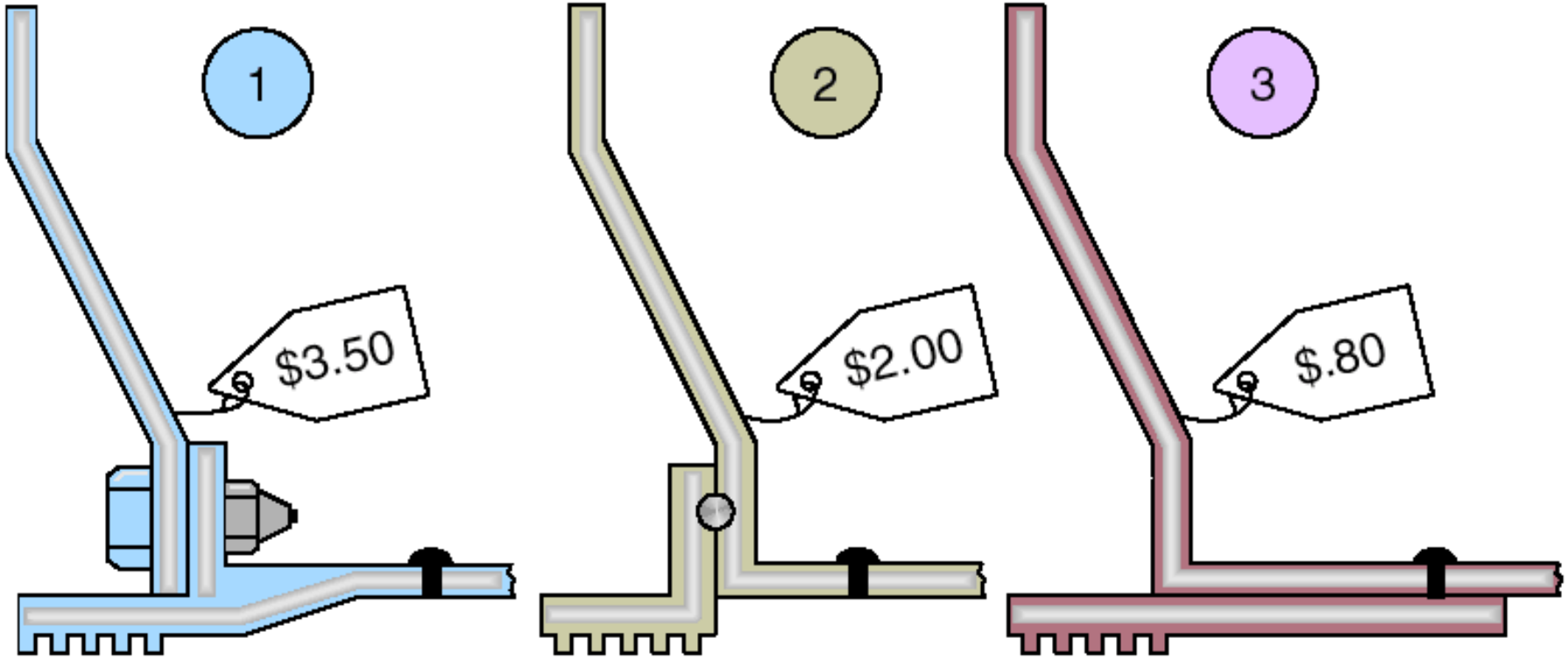


Figure 5.5

Issues for Product Design

- Robust design
- Modular design
- Computer-aided design (CAD)
- Computer-aided manufacturing (CAM)
- Virtual reality technology
- Value analysis
- Sustainability and Life Cycle Assessment (LCA)

Robust Design

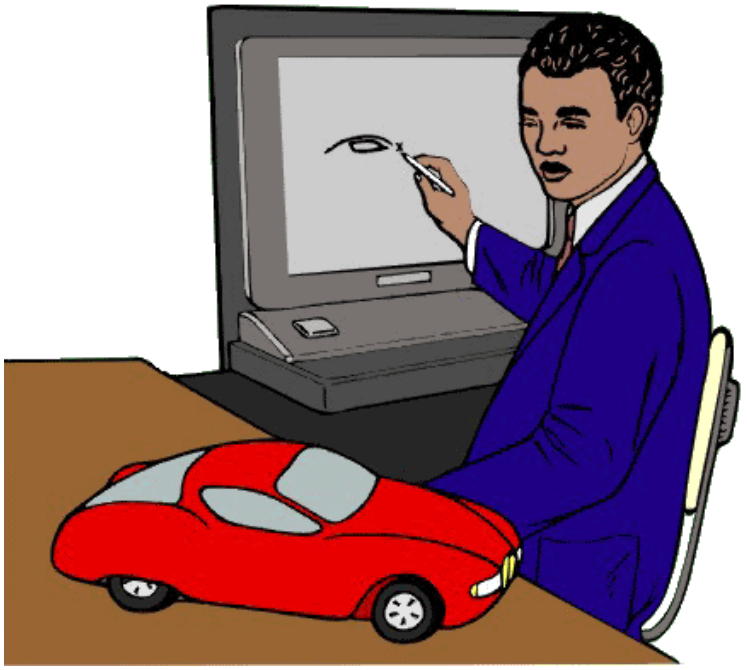
- Product is designed so that small variations in production or assembly do not adversely affect the product
- Typically results in lower cost and higher quality

Modular Design

- Products designed in easily segmented components
- Adds flexibility to both production and marketing
- Improved ability to satisfy customer requirements

Computer Aided Design (CAD)

- Using computers to design products and prepare engineering documentation
- Shorter development cycles, improved accuracy, lower cost
- Information and designs can be deployed worldwide



Extensions of CAD

- 3-D Object Modeling
  - Small prototype development
- Design for Manufacturing and Assembly (DFMA)
  - Solve manufacturing problems during the design stage
- CAD through the internet
  - International data exchange through STEP
- 3-D printing

Computer-Aided Manufacturing (CAM)

- Utilizing specialized computers and program to control manufacturing equipment
- Often driven by the CAD system (CAD/CAM)

Benefits of CAD/CAM

1. Product quality
2. Shorter design time
3. Production cost reductions
4. Database availability
5. New range of capabilities

Virtual Reality Technology

- Computer technology used to develop an interactive, 3-D model of a product from the basic CAD data
- Allows people to ‘see’ the finished design before a physical model is built
- Very effective in large-scale designs such as plant layout

Value Analysis

- Focuses on design improvement during production
- Seeks improvements leading either to a better product or a product which can be produced more economically with less environmental impact

Sustainability and Life Cycle Assessment (LCA)

- *Sustainability* means meeting the needs of the present without compromising the ability of future generations to meet their needs
- LCA is a formal evaluation of the environmental impact of a product

Product Development Continuum

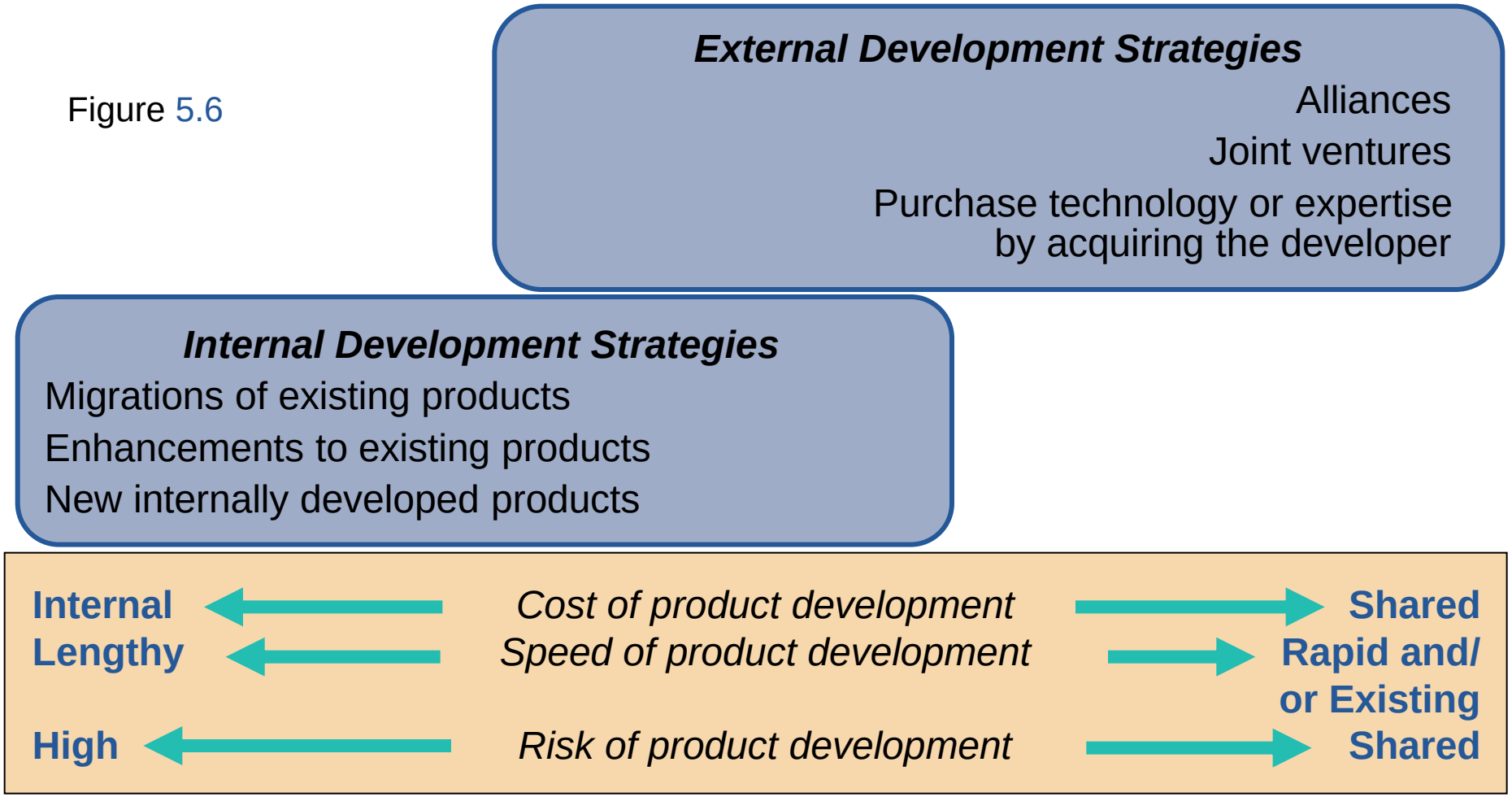
- Product life cycles are becoming shorter and the rate of technological change is increasing
- Developing new products faster can result in a competitive advantage
- **Time-based competition**

Product Development Continuum

- Alliances
  - Cooperative agreements between independent organizations
  - Useful when technology is developing
  - Reduces risks

Product Development Continuum

Figure 5.6



Product Development Continuum

- Purchasing technology by acquiring a firm
  - Speeds development
  - Issues concern the fit between the acquired organization and product and the host
- Joint Ventures
  - Both organizations learn
  - Risks are shared

Defining a Product

- First definition is in terms of *functions*
- Rigorous specifications are developed during the design phase
- Manufactured products will have an **engineering drawing**
- **Bill of material (BOM)** lists the components of a product

Product Documents

- Engineering drawing
  - Shows dimensions, tolerances, and materials
  - Shows codes for Group Technology
- Bill of Material
  - Lists components, quantities and where used
  - Shows product structure

Make-or-Buy Decisions

- Produce components themselves or buy from an outside source
- Variations in
  - Quality
  - Cost
  - Delivery schedules
- Critical to product definition

Group Technology

- Parts grouped into families with similar characteristics
- Coding system describes processing and physical characteristics
- Part families can be produced in dedicated manufacturing cells

Group Technology Benefits

1. Improved design
2. Reduced raw material and purchases
3. Simplified production planning and control
4. Improved layout, routing, and machine loading
5. Reduced tooling setup time, work-in-process, and production time

Documents for Production

- Assembly drawing
- Assembly chart
- Route sheet
- Work order
- Engineering change notices (ECNs)

Configuration Management

- The need to manage ECNs has led to the development of configuration management systems
- A product's planned and changing components are accurately identified
- Control and accountability for change are identified and maintained

Product Life-Cycle Management (PLM)

- Integrated software that brings together most, if not all, elements of product design and manufacture
  - Product design
  - CAD/CAM
  - DFMA
  - Product routing
  - Materials
  - Layout
  - Assembly
  - Maintenance
  - Environmental

Service Design

- Service typically includes direct interaction with the customer
- **Process – chain – network (PCN)** analysis focuses on the ways in which processes can be designed to optimize interaction between firms and their customers

Process-Chain-Network (PCN) Analysis

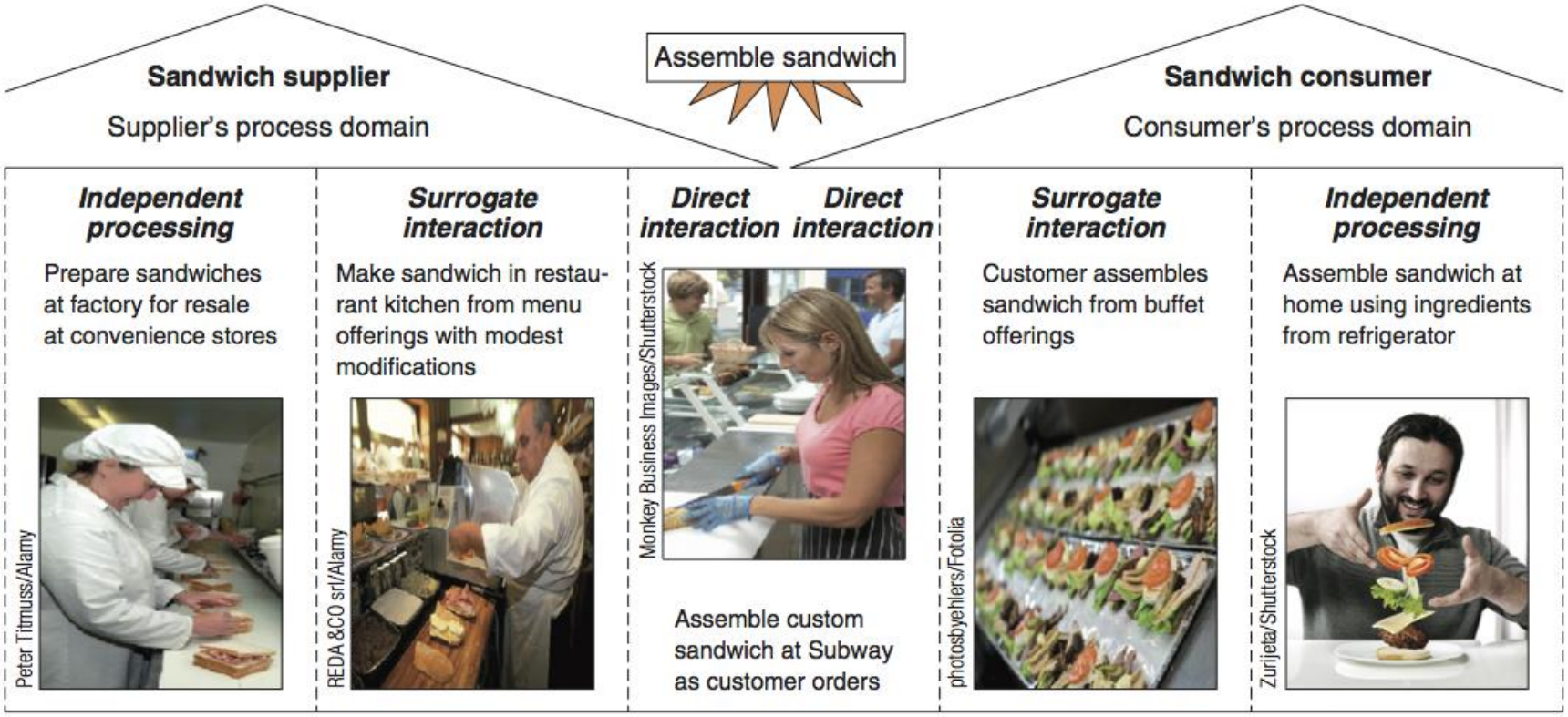


Figure 5.12

Process-Chain-Network (PCN) Analysis

1. *Direct interaction* region includes process steps that involve interaction between participants
2. The *surrogate (substitute) interaction* region includes process steps in which one participant is acting on another participant's resources
3. The *independent processing* region includes steps in which the supplier and/or the customer is acting on resources where each has maximum control

Process-Chain-Network (PCN) Analysis

- All three regions have similar operating issues but the appropriate way of handling the issues differs across regions – service operations exist only within the area of *direct* and *surrogate interaction*
- PCN analysis provides insight to aid in positioning and designing processes that can achieve strategic objectives

Adding Service Efficiency

- Service productivity is notoriously low partially because of customer involvement in the *design* or *delivery* of the service, or both
- Complicates product design

Adding Service Efficiency

- Limit the options
  - Improves efficiency and ability to meet customer expectations
- Delay customization
- Modularization
  - Eases customization of a service

Adding Service Efficiency

- Automation
  - Reduces cost, increases customer service
- Moment of truth
  - Critical moments between the customer and the organization that determine customer satisfaction

Documents for Services

- High levels of customer interaction necessitates different documentation
- Often explicit job instructions
- Scripts and storyboards are other techniques

Transition to Production

- Know when to move to production
  - Product development can be viewed as evolutionary and never complete
  - Product must move from design to production in a timely manner
- Most products have a trial production period to insure producibility
  - Develop tooling, quality control, training
  - Ensures successful production

Transition to Production

- Responsibility must also transition as the product moves through its life cycle
  - Line management takes over from design
- Three common approaches to managing transition
  - Project managers
  - Product development teams
  - Integrate product development and manufacturing organizations

Outline

- Global Company Profile: Regal Marine
- Goods and Services Selection
- Generating New Products
- Product Development
- Issues for Product Design
- Product Development Continuum

Outline - Continued

- Defining a Product
- Documents for Production
- Service Design
- Transition to Production

Managing Quality

Outline

- **Global Company Profile:** Arnold Palmer Hospital
- Quality and Strategy
- Defining Quality
- Total Quality Management
- Tools of TQM
- The Role of Inspection
- TQM in Services

Managing Quality Provides a Competitive Advantage

Arnold Palmer Hospital

- Delivers over 12,000 babies annually
- Virtually every type of quality tool is employed
  - Continuous improvement
  - Employee empowerment
  - Benchmarking
  - Just-in-time
  - Quality tools

Learning Objectives

When you complete this chapter you should be able to:

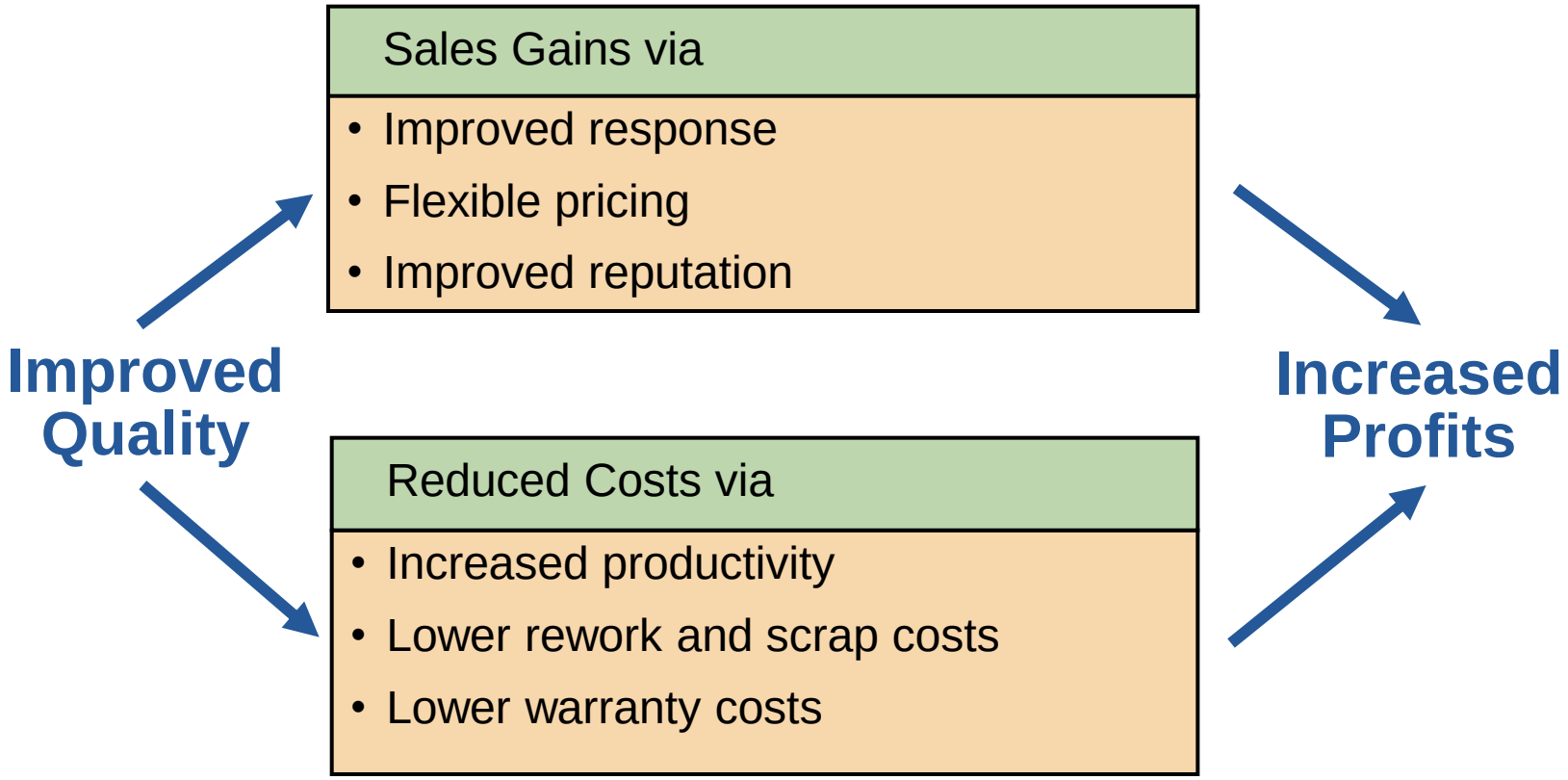
- **6.1** ***Define*** quality and TQM
- **6.2** ***Describe*** the ISO international quality standards
- **6.3** ***Explain*** Six Sigma
- **6.4** ***Explain*** how benchmarking is used in TQM
- **6.5** ***Explain*** quality robust products and Taguchi concepts
- **6.6** ***Use*** the seven tools of TQM

Quality and Strategy

- Managing quality supports *differentiation*, *low cost*, and *response* strategies
- Quality helps firms increase sales and reduce costs
- *Building* a quality organization is a demanding task

Two Ways Quality Improves Profitability

Figure 6.1



The Flow of Activities

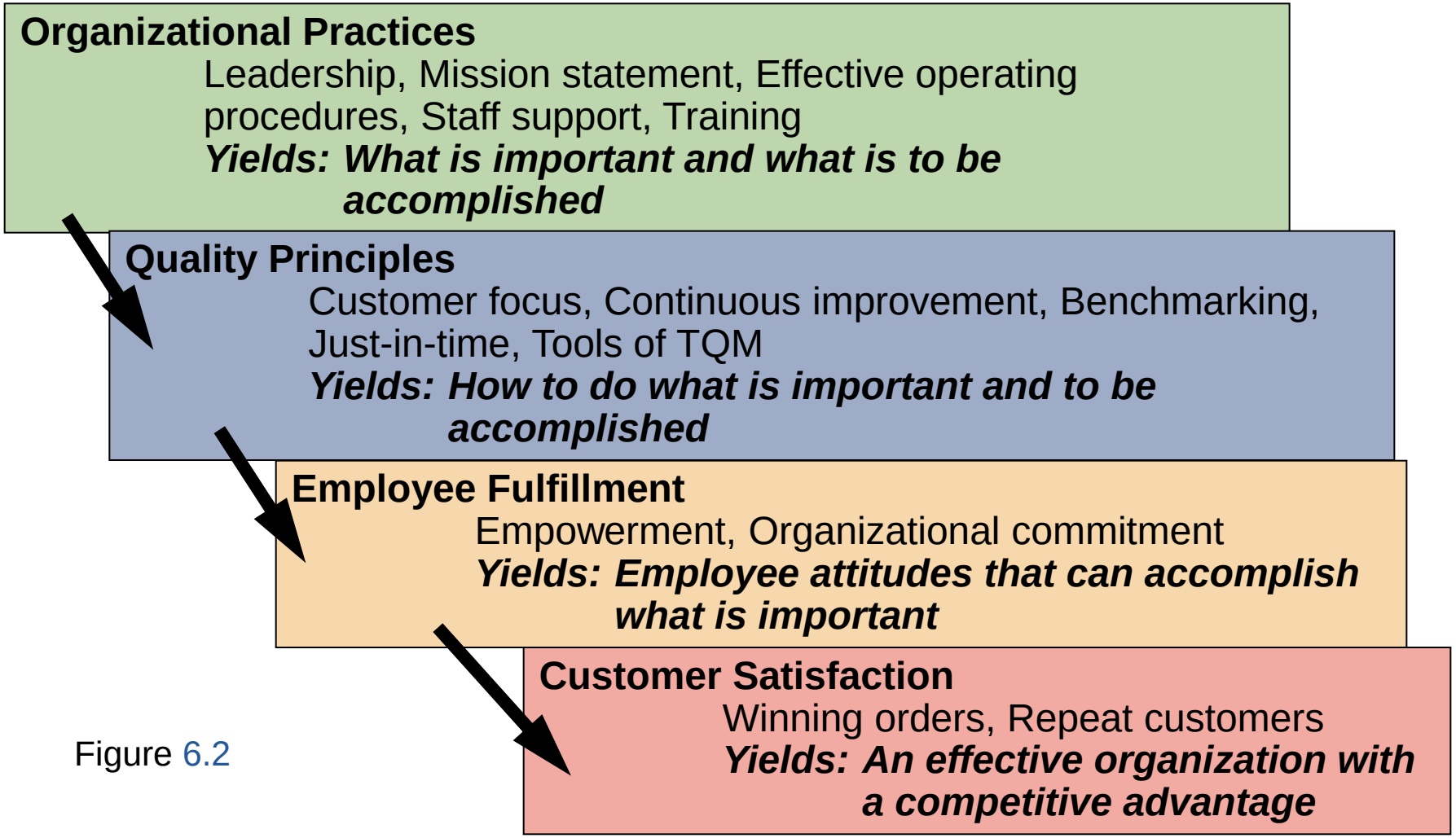


Figure 6.2

Defining Quality

An operations manager's objective is to build a total quality management system that identifies and satisfies customer needs

Defining Quality

The totality of features and characteristics of a product or service that bears on its ability to satisfy stated or implied needs

American Society for Quality

Different Views

- *User based*: better performance, more features
- *Manufacturing based*: conformance to standards, making it right the first time
- *Product based*: specific and measurable attributes of the product

Implications of Quality

1. Company reputation
   - Perception of new products
   - Employment practices
   - Supplier relations
2. Product liability
   - Reduce risk
3. Global implications
   - Improved ability to compete

Malcolm Baldrige National Quality Award

- Established in 1988 by the U.S. government
- Designed to promote TQM practices
- Recent winners include

  MidwayUSA, Charter School of San Diego, Mid-America Transplant Services, Hill Country Memorial, PricewaterhouseCoopers Public Sector Practice, Elevations Credit Union, Lockheed Martin Missiles and Fire Control, MESA Products Inc.

Baldrige Criteria

Applicants are evaluated on:

CATEGORIES	POINTS
Leadership	120
Strategic Planning	85
Customer Focus	85
Measurement, Analysis, and Knowledge Management	90
Workforce Focus	85
Operations Focus	85
Results	450

ISO 9000 International Quality Standards

- International recognition
- Encourages quality management procedures, detailed documentation, work instructions, and recordkeeping
- 2015 revision gives greater emphasis to *risk-based thinking*
- Over one million certifications in 206 countries
- Critical for global business

ISO 9000 International Quality Standards

- Management principles
  1) Top management leadership
  2) Customer satisfaction
  3) Continual improvement
  4) Involvement of people
  5) Process analysis
  6) Use of data-driven decision making
  7) A systems approach to management
  8) Mutually beneficial supplier relationships

Costs of Quality

Costs of Quality refer to the expenses associated with ensuring that processes meet customer expectations and the losses incurred when they do not. A defect occurs when a process fails to satisfy a customer, leading to dissatisfaction and potential harm to the business

(1)Prevention Cost
(2)Appraisal Cost
(3)Internal Failure Cost
(4)External Failure Cost

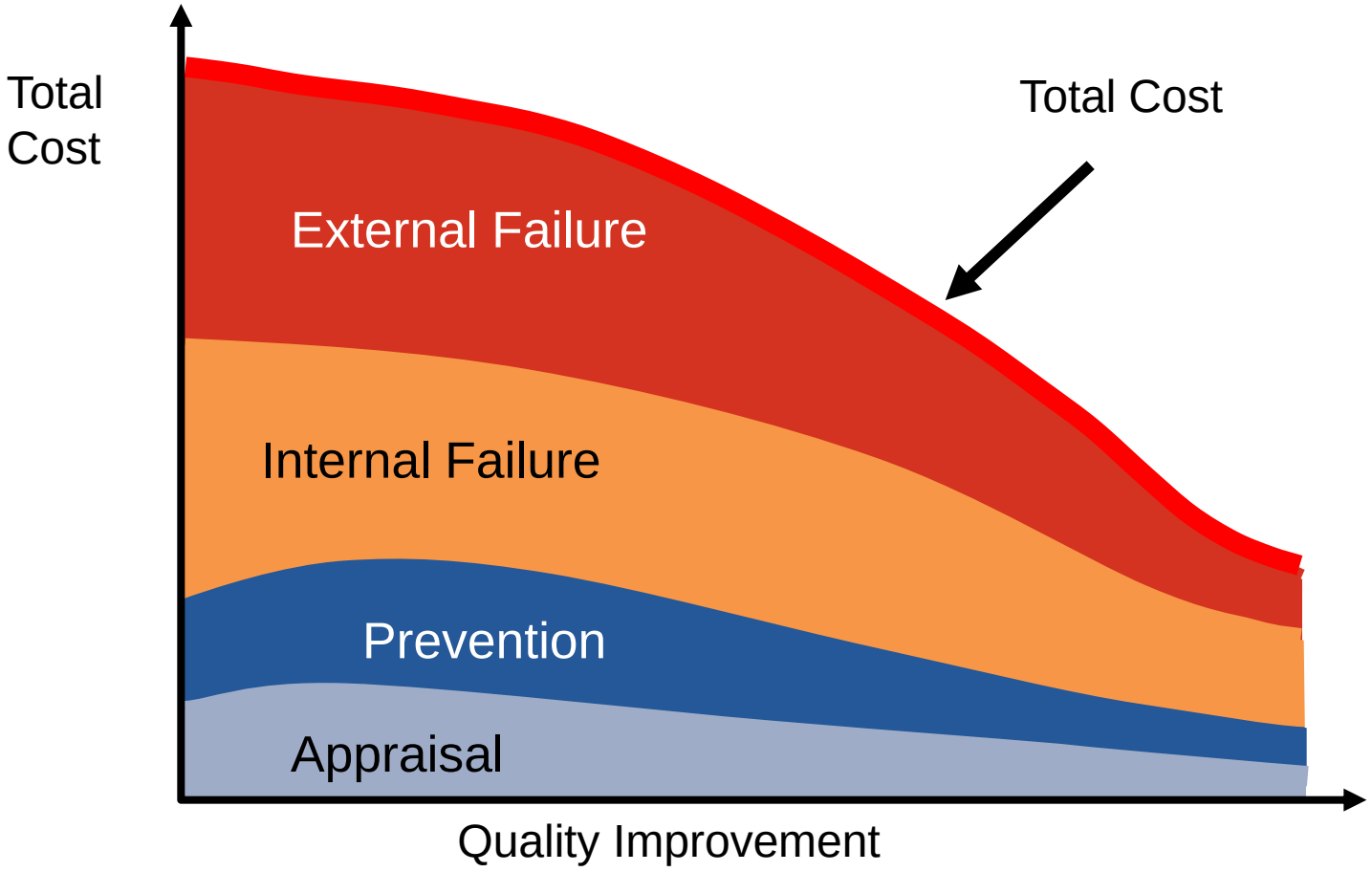
Prevention Costs: These are expenses to prevent defects before they occur, such as redesigning processes, simplifying products, training employees, and collaborating with suppliers to improve quality. Example: Investing in staff training for better process understanding.

Appraisal Costs: These are costs of assessing performance, such as inspections and quality audits. As prevention efforts increase, appraisal costs typically decrease. Example: Quality checks on assembly lines.

Internal Failure Costs: These arise from defects detected during production, including rework and scrap. Example: Reprocessing defective items or discarding unusable products.

External Failure Costs: These occur when defects are found after the product/service reaches the customer, including warranty claims, lost sales, and damage to reputation. Example: Product recalls or legal expenses for defective goods.

Costs of Quality



Takumi

A Japanese character that symbolizes a broader dimension than quality, a deeper process than education, and a more perfect method than persistence

Leaders in Quality

TABLE 6.1	Leaders in the Field of Quality Management
LEADER	**PHILOSOPHY/CONTRIBUTION**
W. Edwards Deming	Deming insisted management accept responsibility for building good systems. The employee cannot produce products that on average exceed the quality of what the process is capable of producing. His 14 points for implementing quality improvement are presented in this chapter.
Joseph M. Juran	A pioneer in teaching the Japanese how to improve quality, Juran believed strongly in top-management commitment, support, and involvement in the quality effort. He was also a believer in teams that continually seek to raise quality standards. Juran varies from Deming somewhat in focusing on the customer and defining quality as fitness for use, not necessarily the written specifications.

Leaders in Quality

TABLE 6.1 Leaders in the Field of Quality Management

LEADER	PHILOSOPHY/CONTRIBUTION
Armand Feigenbaum	His 1961 book Total Quality Control laid out 40 steps to quality improvement processes. He viewed quality not as a set of tools but as a total field that integrated the processes of a company. His work in how people learn from each other's successes led to the field of cross-functional teamwork.
Philip B. Crosby	*Quality Is Free* was Crosby's attention-getting book published in 1979. Crosby believed that in the traditional trade-off between the cost of improving quality and the cost of poor quality, the cost of poor quality is understated. The cost of poor quality should include all of the things that are involved in not doing the job right the first time. Crosby coined the term *zero defects* and stated, "There is absolutely no reason for having errors or defects in any product or service."

Ethics and Quality Management

- Operations managers must deliver healthy, safe, quality products and services
- Poor quality risks injuries, lawsuits, recalls, and regulation
- Ethical conduct must dictate response to problems
- All stakeholders must be considered

Deming's Fourteen Points

TABLE 6.2	Deming's 14 Points for Implementing Quality Improvement
1.	Create consistency of purpose
2.	Lead to promote change
3.	Build quality into the product; stop depending on inspections to catch problems
4.	Build long-term relationships based on performance instead of awarding business on price
5.	Continuously improve product, quality, and service
6.	Start training
7.	Emphasize leadership

Deming's Fourteen Points

TABLE 6.2	Deming's 14 Points for Implementing Quality Improvement
8.	Drive out fear
9.	Break down barriers between departments
10.	Stop haranguing workers
11.	Support, help, and improve
12.	Remove barriers to pride in work
13.	Institute a vigorous program of education and self-improvement
14.	Put everyone in the company to work on the transformation

Total Quality Management (TQM)

Total quality management (TQM) is a philosophy that stresses three principles for achieving high levels of process performance and quality. These principles are related to

(1) customer satisfaction,
(2) employee involvement,
(3) continuous improvement

(1) Customer Satisfaction

Customers, internal or external, are satisfied when their expectations for a product or service are met or exceeded. Often, customers use the general term quality to describe their level of satisfaction with a service or product.

Quality is judged by factors such as:

Conformance to Specifications: Meeting advertised or implied standards (e.g., delivery speed or consistent quality).

Value: Balancing functionality with cost to deliver value to customers.

Fitness for Use: Assessing convenience, durability, appearance, and performance.

Support: Providing responsive service post-sale (e.g., warranties or customer assistance).

Psychological Impressions: Influencing customer perceptions through atmosphere, aesthetics, and employee demeanor.

(2) Employee Involvement:

In TQM, everyone in the organization must share the view that quality control is an end in itself. Errors or defects should be caught and corrected at the source, not passed along to an internal or external customer. For example, a consulting team should make sure its billable hours are correct before submitting them to the accounting department. This philosophy is called quality at the source.

In addition, firms should avoid trying to "inspect the quality of the product" by using inspectors to weed out unsatisfactory services or defective products after all operations have been performed. By contrast, in some manufacturing firms, workers have the authority to stop a production line if they spot quality problems.

(3) Continuous Improvement

Based on the concept of kaizen, continuous improvement focuses on identifying and eliminating inefficiencies (e.g., reducing scrap, improving processing times, and minimizing injuries). It emphasizes that any process can be improved, with those closest to it driving change.

Seven Concepts of TQM

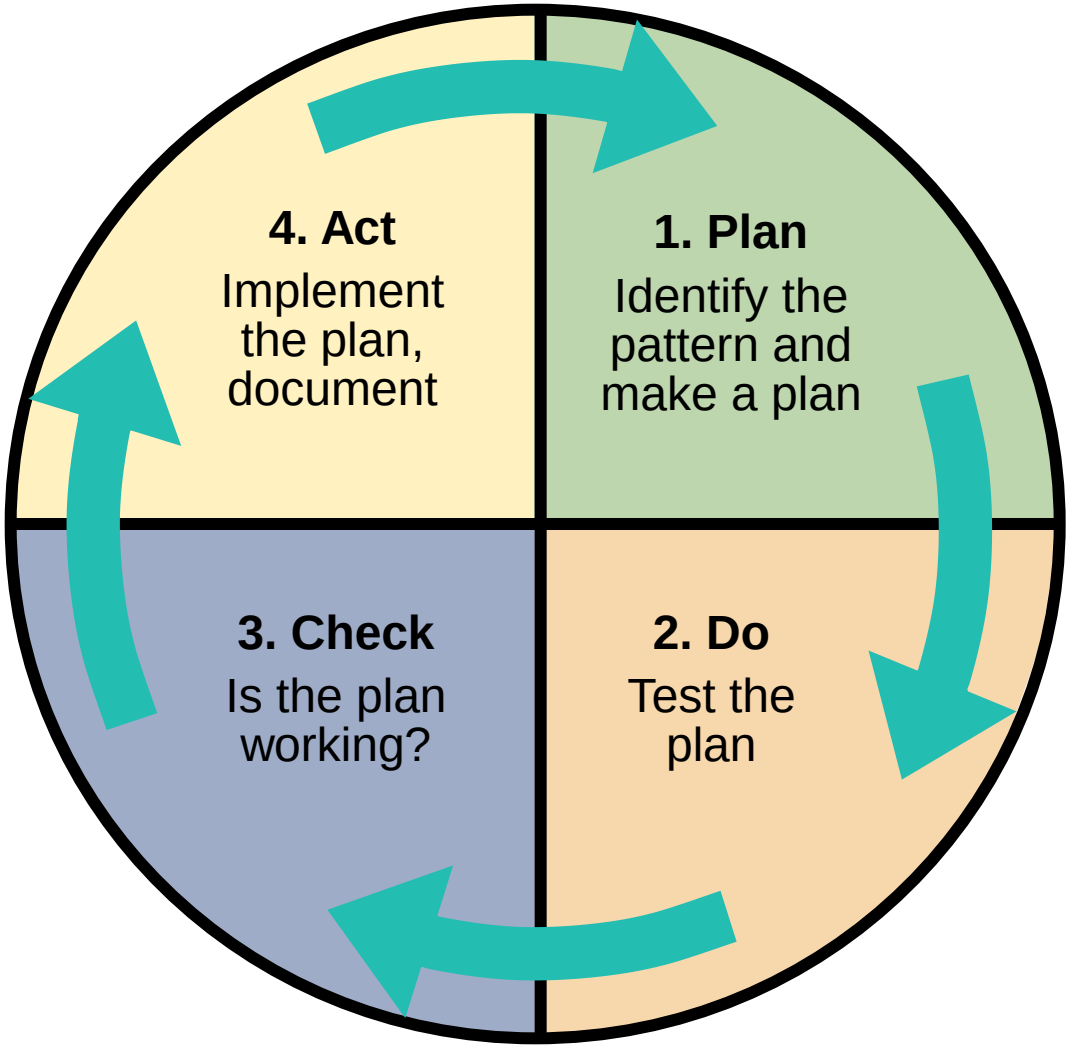
1) Continuous improvement
2) Six Sigma
3) Employee empowerment
4) Benchmarking
5) Just-in-time (JIT)
6) Taguchi concepts
7) Knowledge of TQM tools

Continuous Improvement

- Never-ending process of continuous improvement
- Covers people, equipment, suppliers, materials, procedures
- Every operation can be improved

Shewhart's PDCA Model

Figure 6.3



Continuous Improvement

- *Kaizen* describes the ongoing process of unending improvement
- *TQM* and *zero defects* also used to describe continuous improvement

Six Sigma

- Two meanings
  - *Statistical* definition of a process that is 99.9997% capable, 3.4 defects per million opportunities (DPMO)
  - A *program* designed to reduce defects, lower costs, save time, and improve customer satisfaction
- A comprehensive system for achieving and sustaining business success

Six Sigma

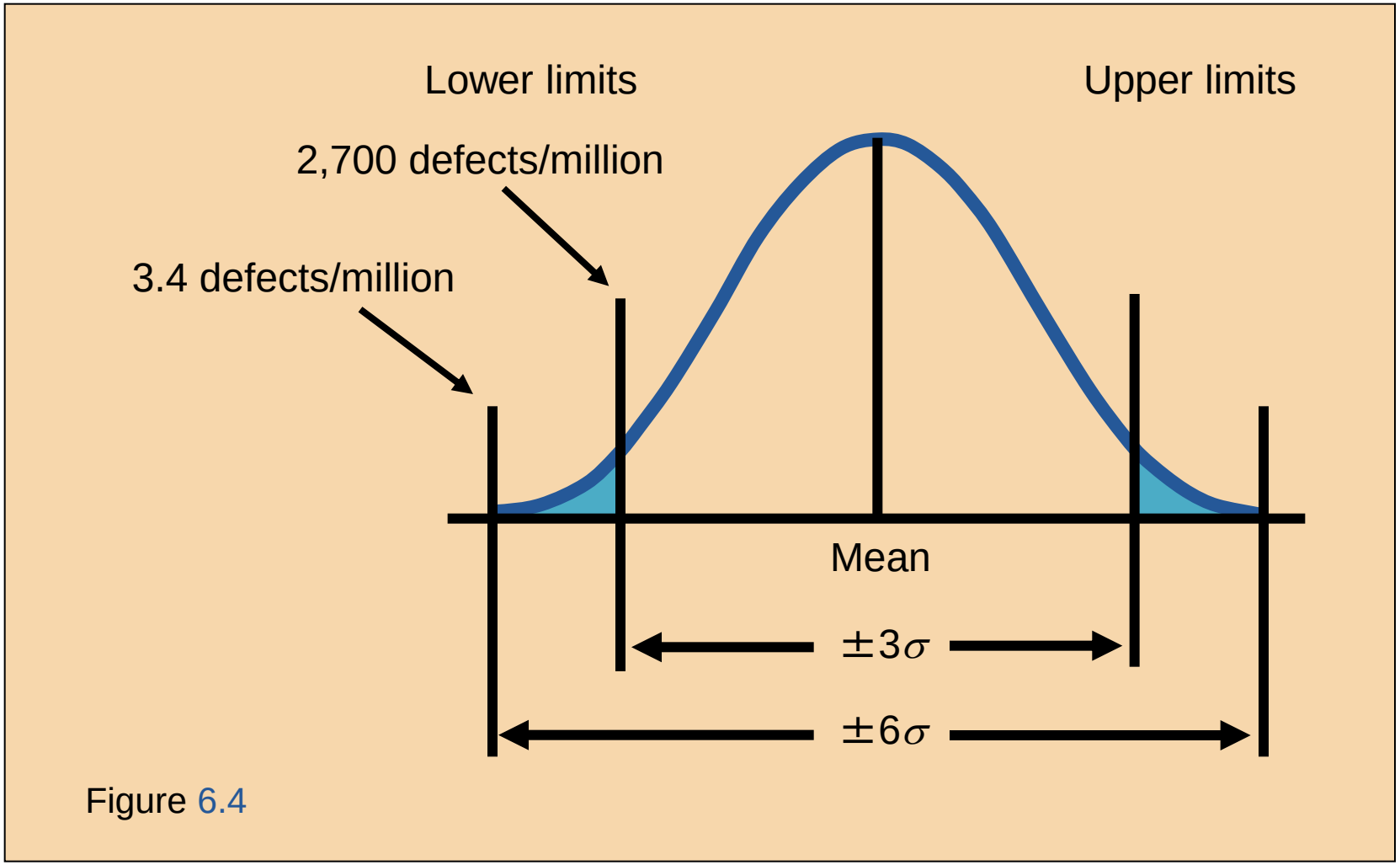


Figure 6.4

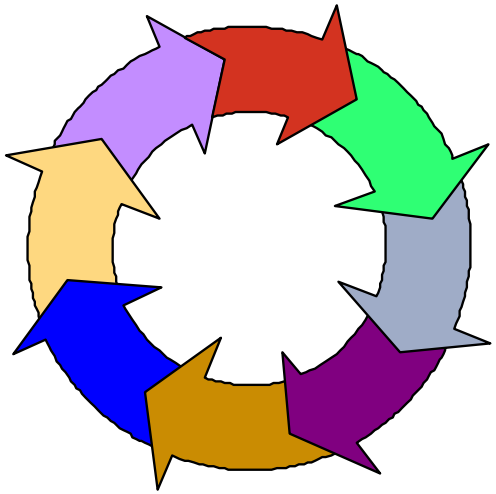
Six Sigma Program

- Originally developed by Motorola, adopted and enhanced by Honeywell and GE
- Highly structured approach to process improvement
  - A strategy
  - A discipline – DMAIC
  - A set of 7 tools

Six Sigma

1. ***Defines*** the project's purpose, scope, and outputs, then identifies the required process information keeping in mind the customer's definition of quality
2. ***Measures*** the process and collects data
3. ***Analyzes*** the data ensuring repeatability and reproducibility
4. ***Improves*** by modifying or redesigning existing processes and procedures
5. ***Controls*** the new process to make sure performance levels are maintained

DMAIC Approach



Implementing Six Sigma

- Emphasize defects per million opportunities as a standard metric
- Provide extensive training
- Focus on top management leadership (Champion)
- Create qualified process improvement experts (Black Belts, Green Belts, etc.)
- Set stretch objectives

Implementing Six Sigma

- Emphasize defects per million opportunities as a standard metric
- Provide extensive training
- Focus on top management leadership (Champion)
- Create qualified process improvement e
- S

This cannot be accomplished without a major commitment from top level management

Employee Empowerment

- Getting employees involved in product and process improvements
  - 85% of quality problems are due to materials and process
- Techniques
  1) Build communication networks that include employees
  2) Develop open, supportive supervisors
  3) Move responsibility to employees
  4) Build a high-morale organization
  5) Create formal team structures

Quality Circles

- Group of employees who meet regularly to solve problems
- Trained in planning, problem solving, and statistical methods
- Often led by a *facilitator*
- Very effective when done properly

Benchmarking

Selecting best practices to use as a standard for performance

1. Determine what to benchmark
2. Form a benchmark team
3. Identify benchmarking partners
4. Collect and analyze benchmarking information
5. Take action to match or exceed the benchmark

Best Practices for Resolving Customer Complaints

Table 6.3

BEST PRACTICE	JUSTIFICATION
Make it easy for clients to complain	It is free market research
Respond quickly to complaints	It adds customers and loyalty
Resolve complaints on first contact	It reduces cost
Use computers to manage complaints	Discover trends, share them, and align your services
Recruit the best for customer service jobs	It should be part of formal training and career advancement

Internal Benchmarking

- When the organization is large enough
- Data more accessible
- Can and should be established in a variety of areas

Just-in-Time (JIT)

- 'Pull' system of production scheduling including supply management
  - Production only when signaled
- Allows reduced inventory levels
  - Inventory costs money and hides process and material problems
- Encourages improved process and product quality

Just-in-Time (JIT)

Relationship to quality:

- JIT cuts the cost of quality
- JIT improves quality
- Better quality means less inventory and better, easier-to-employ JIT system

Taguchi Concepts

- Engineering and experimental design methods to improve product and process design
  - Identify key component and process variables affecting product variation
- Taguchi Concepts
  - *Quality robustness*
  - *Target-oriented quality*
  - *Quality loss function*

Quality Robustness

- Ability to produce products uniformly in adverse manufacturing and environmental conditions
  - Remove the *effects* of adverse conditions
  - Small variations in materials and process do not destroy product quality

Quality Loss Function

- Shows that costs increase as the product moves away from what the customer wants
- Costs include customer dissatisfaction, warranty and service, internal scrap and repair, and costs to society
- Traditional conformance specifications are too simplistic

Quality Loss Function

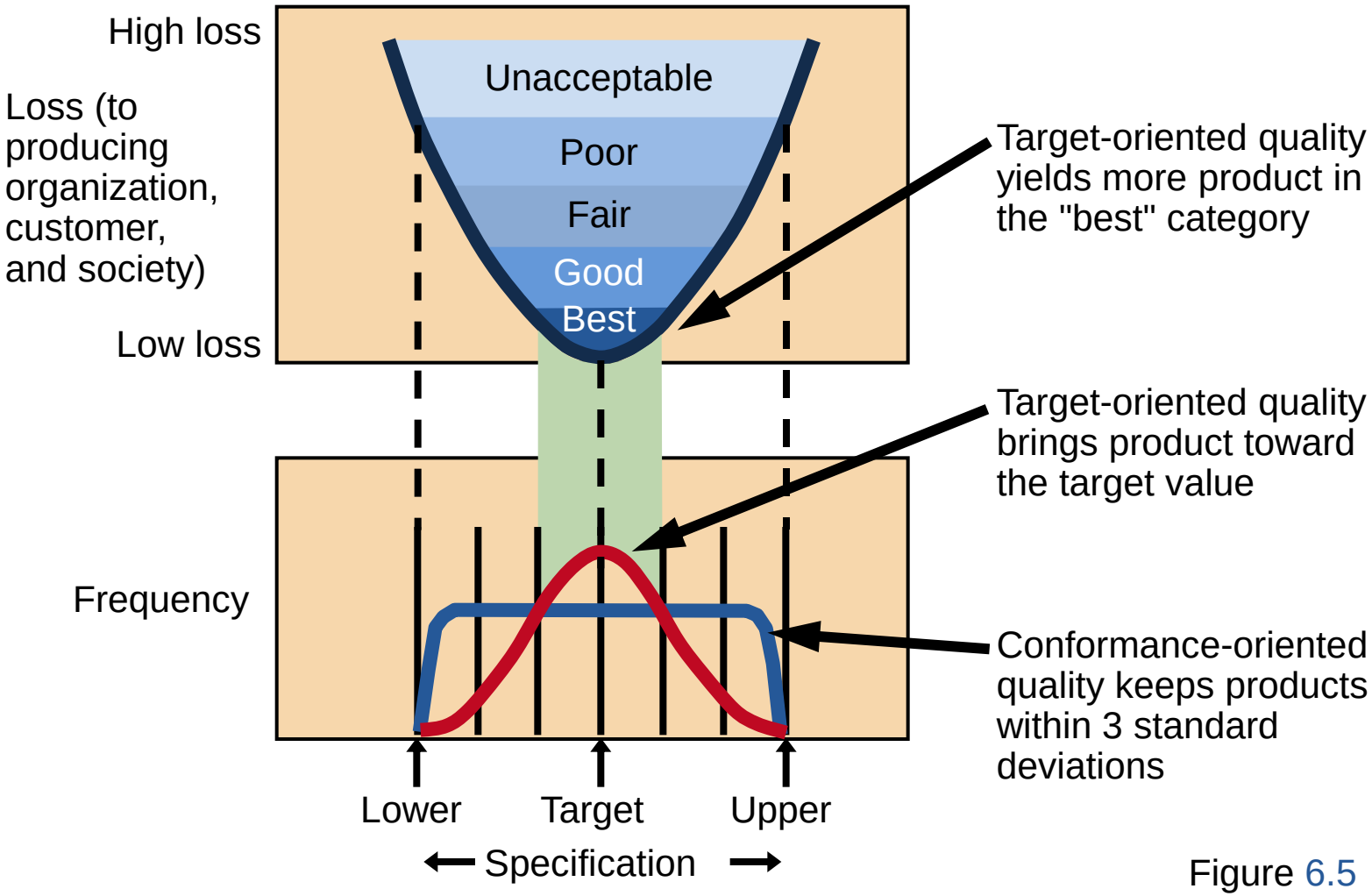


Figure 6.5

TQM Tools

- Tools for Generating Ideas
  - Check Sheet
  - Scatter Diagram
  - Cause-and-Effect Diagram
- Tools to Organize the Data
  - Pareto Chart
  - Flowchart (Process Diagram)

TQM Tools

- Tools for Identifying Problems
  - Histogram
  - Statistical Process Control Chart

Seven Tools of TQM

(a) *Check Sheet*: An organized method of recording data

	Hour							
Defect	1	2	3	4	5	6	7	8
A	///	/		/	/	/	///	/
B	//	/	/	/			//	///
C	/	//					//	////

Figure 6.6

Seven Tools of TQM

(b) *Scatter Diagram*: A graph of the value of one variable vs. another variable

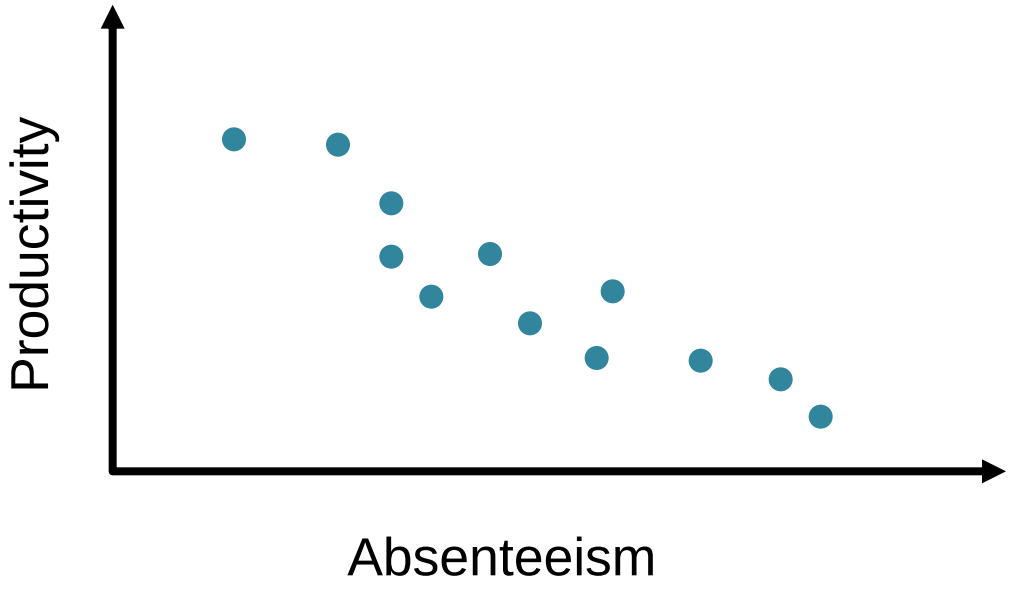


Figure 6.6

Seven Tools of TQM

(c) *Cause-and-Effect Diagram*: A tool that identifies process elements (causes) that may effect an outcome

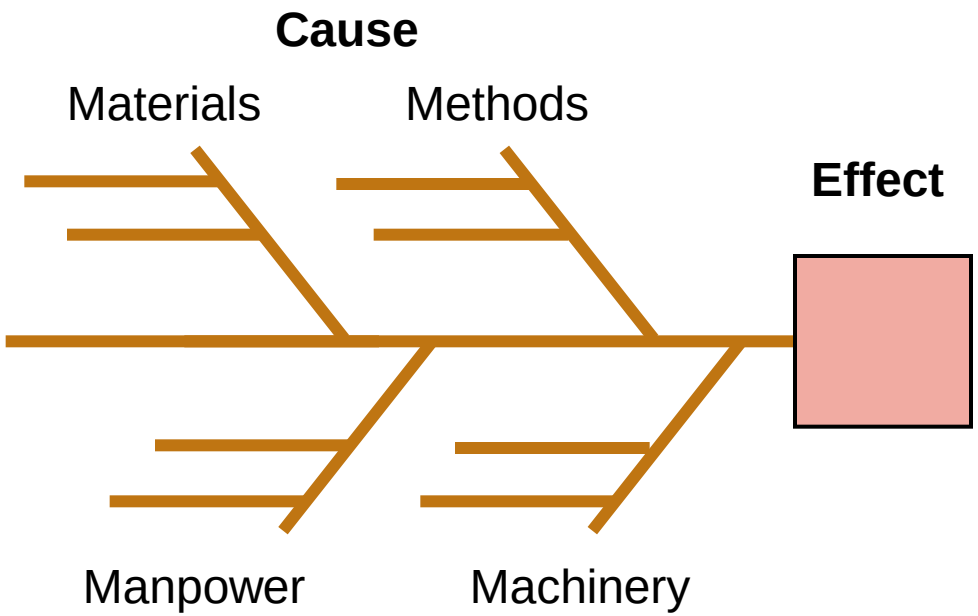


Figure 6.6

Seven Tools of TQM

(d) *Pareto Chart*: A graph to identify and plot problems or defects in descending order of frequency

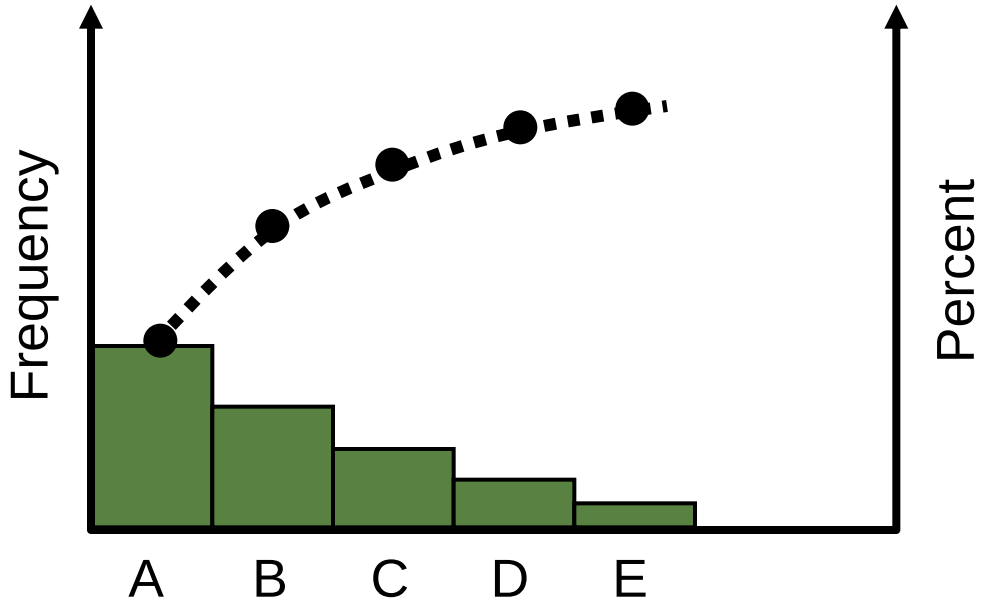


Figure 6.6

Seven Tools of TQM

(e) *Flowchart (Process Diagram)*: A chart that describes the steps in a process

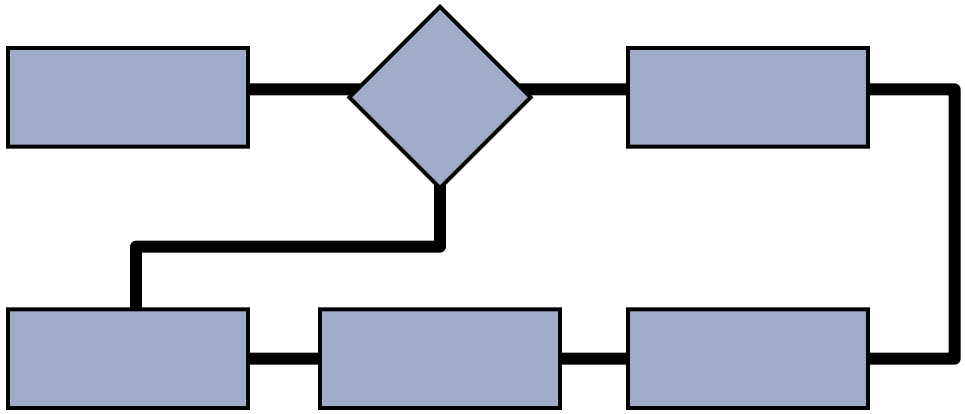


Figure 6.6

Seven Tools of TQM

(f) *Histogram*: A distribution showing the frequency of occurrences of a variable

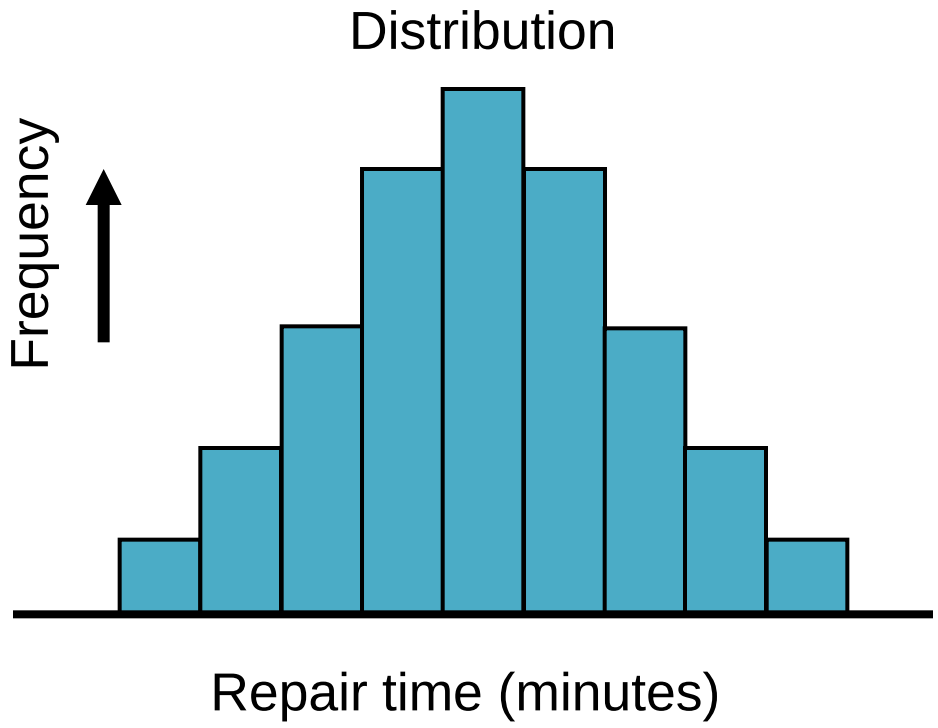


Figure 6.6

Seven Tools of TQM

(g) *Statistical Process Control C*hart: A chart with time on the horizontal axis to plot values of a statistic

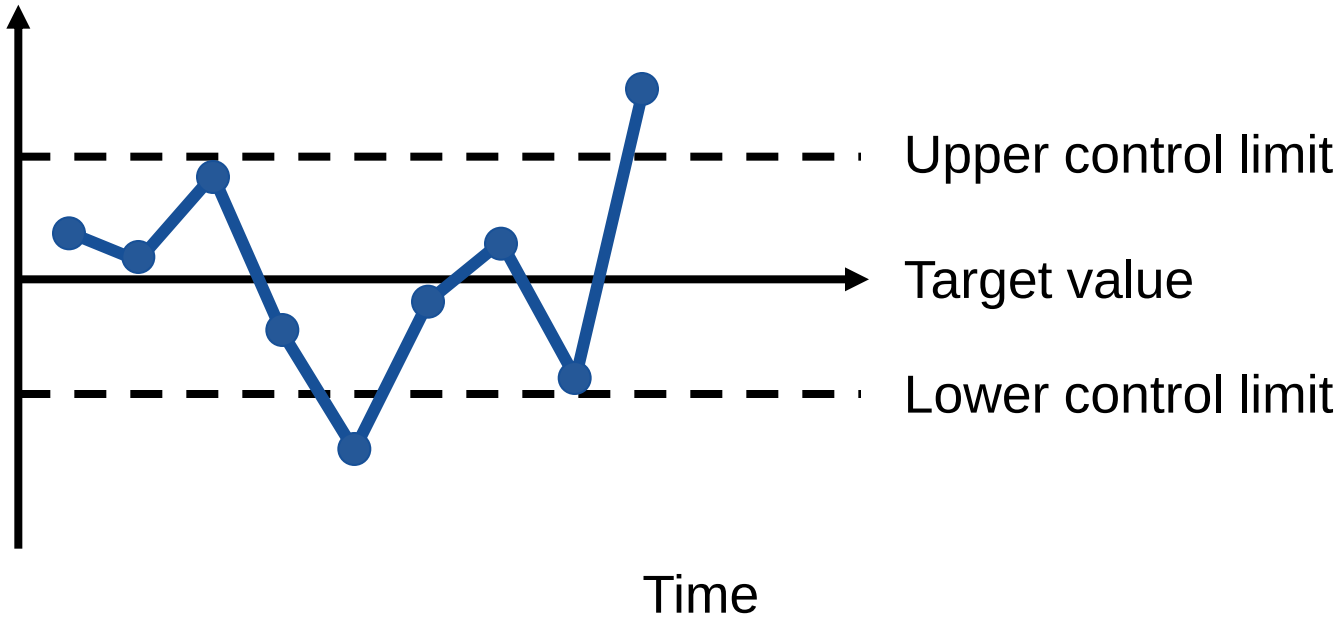


Figure 6.6

Cause-and-Effect Diagrams

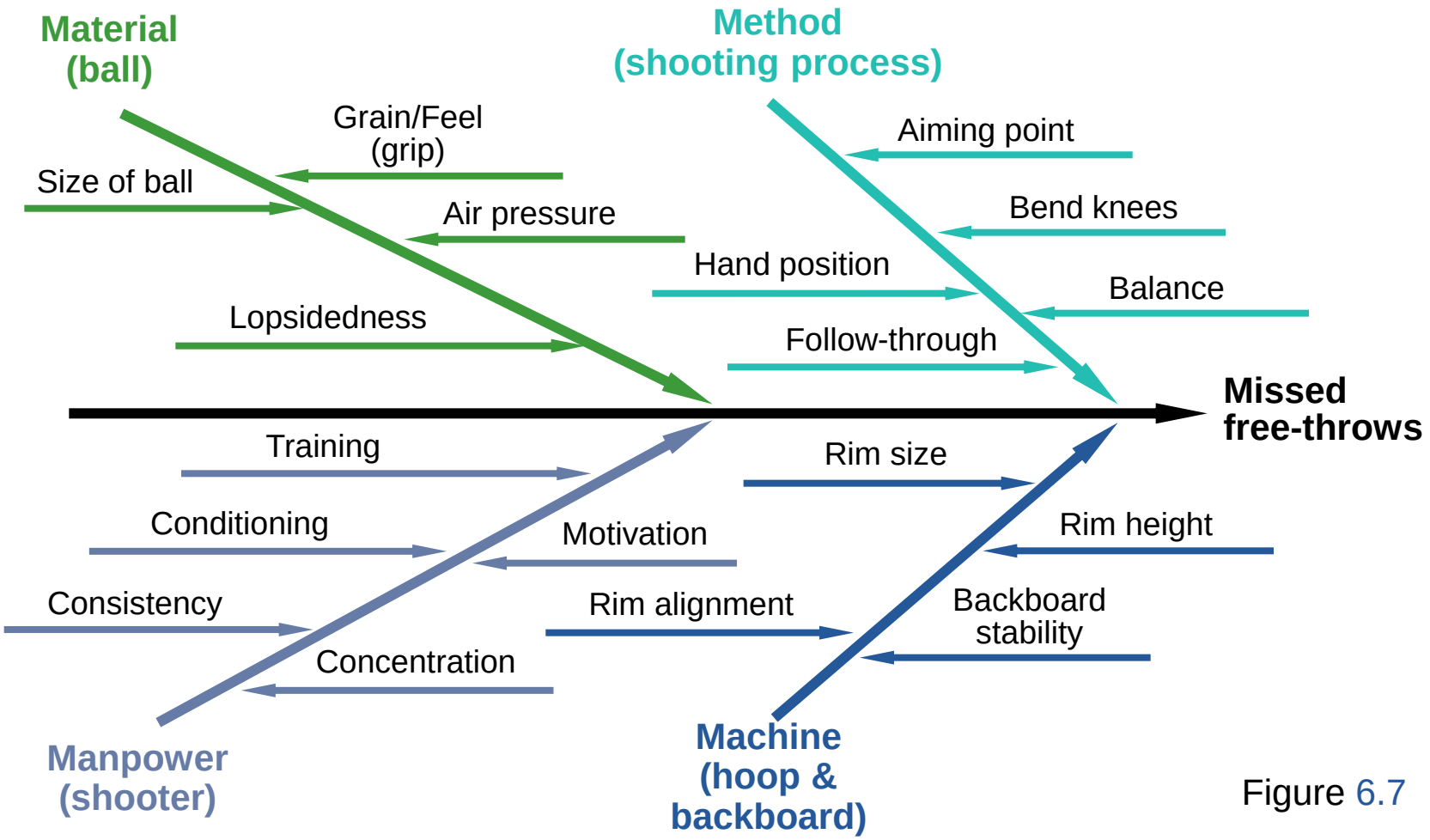
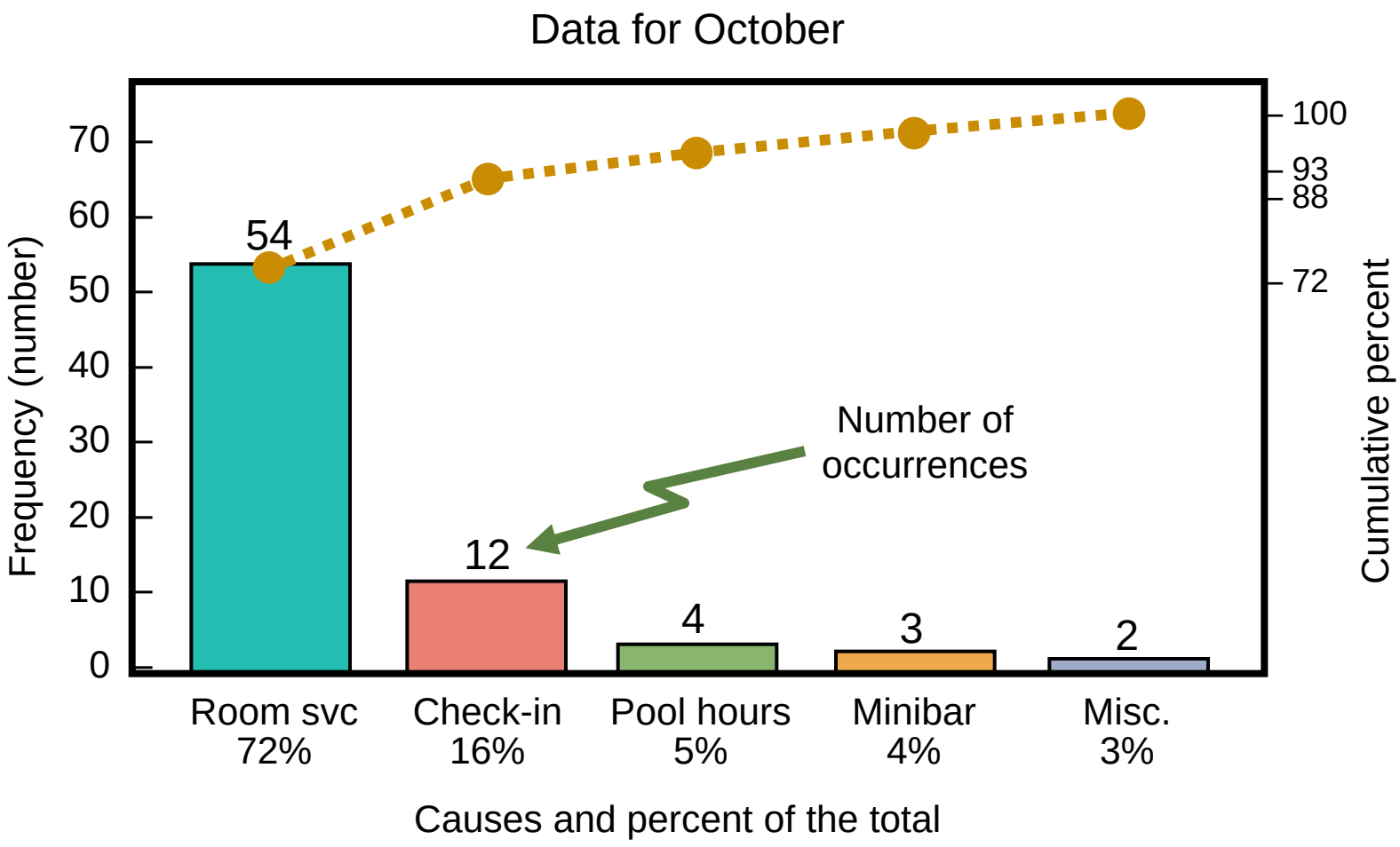


Figure 6.7

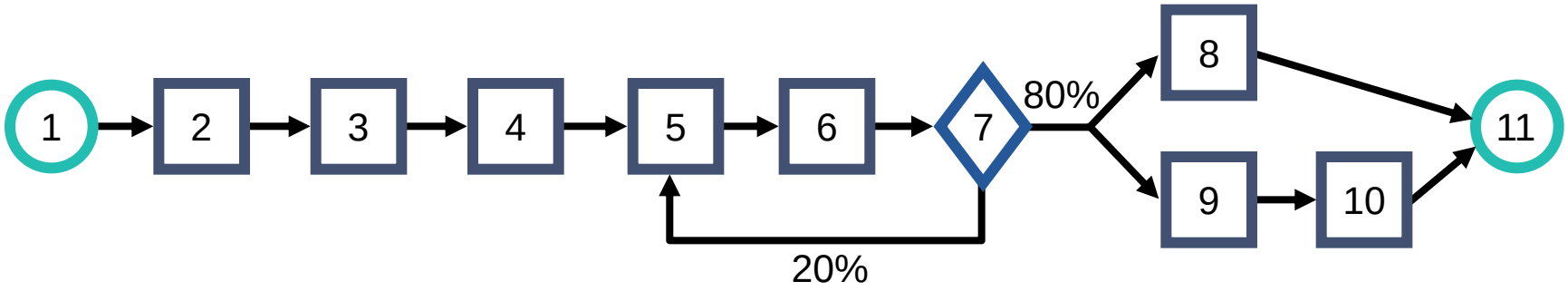
Pareto Charts



Flow Charts

MRI Flowchart

1. Physician schedules MRI
2. Patient taken to MRI
3. Patient signs in
4. Patient is prepped
5. Technician carries out MRI
6. Technician inspects film
7. If unsatisfactory, repeat
8. Patient taken back to room
9. MRI read by radiologist
10. MRI report transferred to physician
11. Patient and physician discuss



Statistical Process Control (SPC)

- Uses statistics and control charts to tell when to take corrective action
- Drives process improvement
- Four key steps
  - Measure the process
  - When a change is indicated, find the assignable cause
  - Eliminate or incorporate the cause
  - Restart the revised process

Control Charts

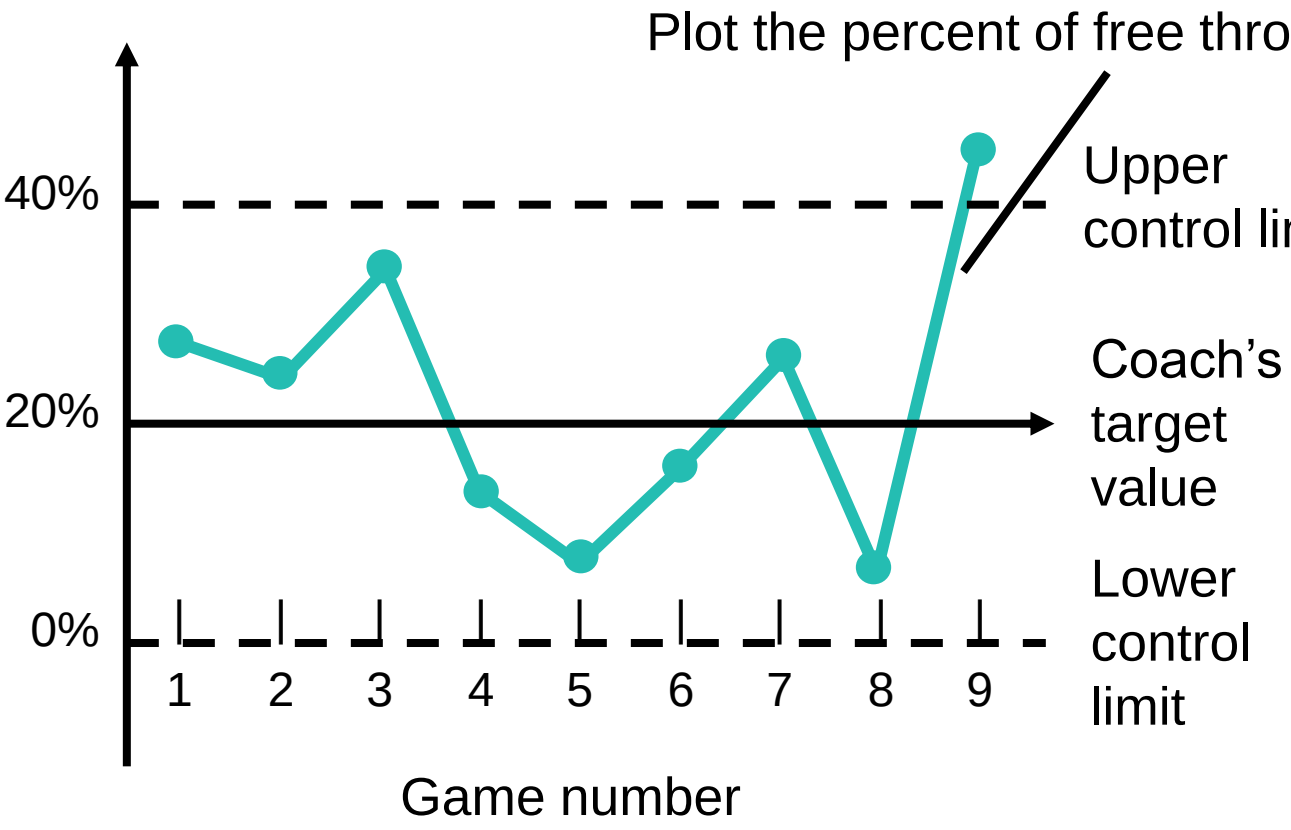


Figure 6.8

Inspection

- Involves examining items to see if an item is good or defective
- Detect a defective product
  - Does not correct deficiencies in process or product
  - It is expensive
- Issues
  - When to inspect
  - Where in process to inspect

When and Where to Inspect

1. At the supplier's plant while the supplier is producing
2. At your facility upon receipt of goods from your supplier
3. Before costly or irreversible processes
4. During the step-by-step production process
5. When production or service is complete
6. Before delivery to your customer
7. At the point of customer contact

Inspection

- Many problems
  - Worker fatigue
  - Measurement error
  - Process variability
- Cannot inspect quality into a product
- Robust design, empowered employees, and sound processes are better solutions

Source Inspection

- Also known as source control
- The next step in the process is your customer
- Ensure perfect product to your customer

Source Inspection

- **Poka-yoke** is the concept of foolproof devices or techniques designed to pass only acceptable products
- **Checklists** ensure consistency and completeness

Service Industry Inspection

TABLE 6.4 Examples of Inspection in Services

ORGANIZATION	WHAT IS INSPECTED	STANDARD
Alaska Airlines	Last bag on carousel	Less than 20 minutes after arrival at the gate
	Airplane door opened	Less than 2 minutes after arrival at the gate
Jones Law Office	Receptionist performance	Phone answered by the second ring
	Billing	Accurate, timely, and correct format
	Attorney	Promptness in returning calls
Hard Rock Hotel	Reception desk	Use customer's name
	Doorman	Greet guest in less than 30 seconds
	Room	All lights working, spotless bathroom
	Minibar	Restocked and charges accurately posted to bill

Service Industry Inspection

TABLE 6.4	Examples of Inspection in Services	
ORGANIZATION	**WHAT IS INSPECTED**	**STANDARD**
Arnold Palmer Hospital	Billing	Accurate, timely, and correct format
	Pharmacy	Prescription accuracy, inventory accuracy
	Lab	Audit for lab-test accuracy
	Nurses	Charts immediately updated
	Admissions	Data entered correctly and completely
Olive Garden Restaurant	Busboy	Serves water and bread within 1 minute
	Busboy	Clears all entrée items and crumbs prior to dessert
	Waiter	Knows and suggest specials, desserts

Service Industry Inspection

TABLE 6.4	Examples of Inspection in Services	
ORGANIZATION	**WHAT IS INSPECTED**	**STANDARD**
Nordstrom Department Store	Display areas	Attractive, well-organized, stocked, good lighting
	Stockrooms	Rotation of goods, organized, clean
	Salesclerks	Neat, courteous, very knowledgeable

Attributes Versus Variables

- *Attributes*
  - Items are either good or bad, acceptable or unacceptable
  - Does not address *degree* of failure
- *Variables*
  - Measures dimensions such as weight, speed, height, or strength
  - Falls within an acceptable range
- Use different statistical techniques

TQM In Services

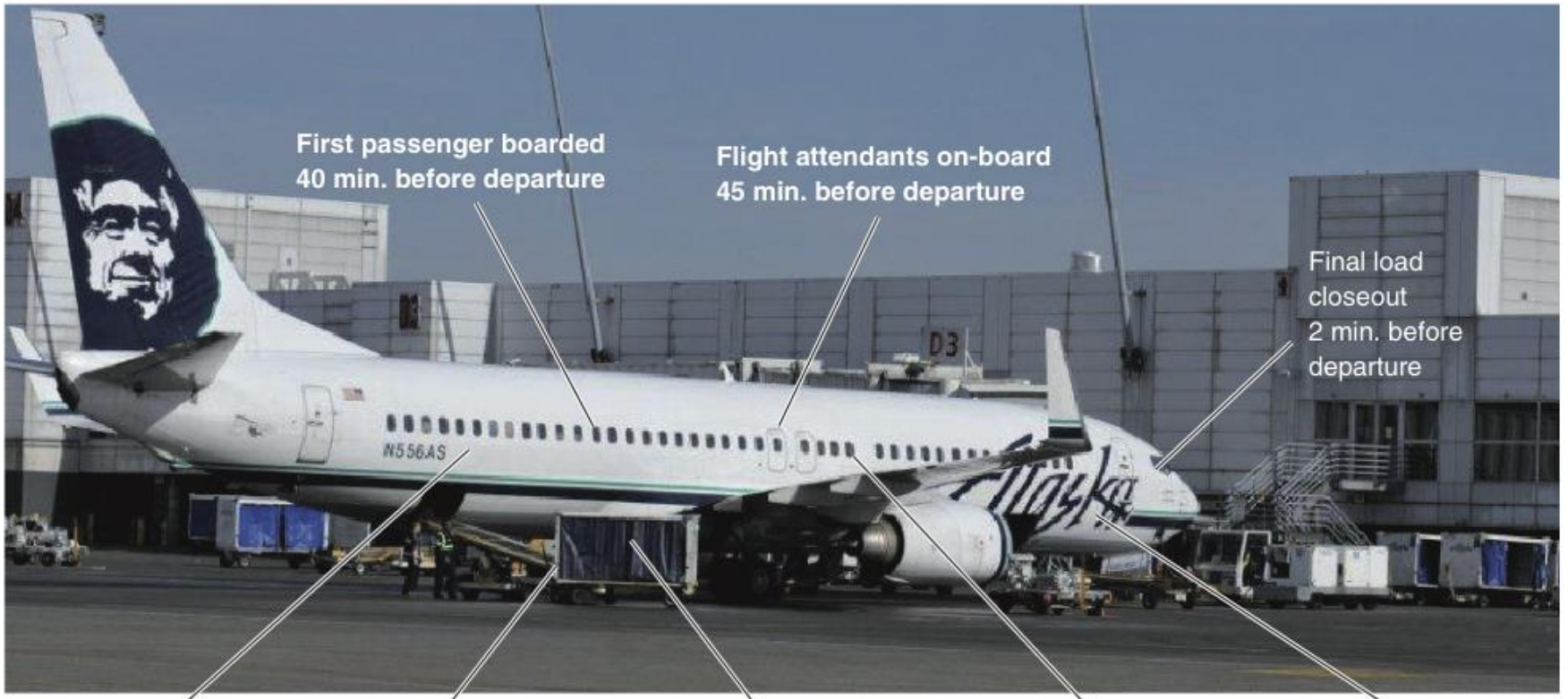
- Service quality is more difficult to measure than the quality of goods
- Service quality perceptions depend on
  1) *Intangible differences between products*
  2) *Intangible expectations customers have of those products*

Service Quality

The operations manager must recognize:

- The tangible component of services is important
- The service process is important
- The service is judged against the customer's expectations
- Exceptions will occur

Service Specifications



Determinants of Service Quality

Table 6.5
Reliability involves consistency of performance and dependability
Responsiveness concerns the willingness or readiness of employees to provide service
Competence means possession of the required skills and knowledge to perform the service
Access involves approachability and ease of contact
Courtesy involves politeness, respect, consideration, and friendliness
Communication means keeping customers informed and listening to them
Credibility involves trustworthiness, believability, and honesty
Security is the freedom from danger, risk, or doubt
Understanding/knowing the customer involves making the effort to understand the customer's needs
Tangibles include the physical evidence of the service

Service Recovery Strategy

- Managers should have a plan for when services fail
- Marriott's **LEARN** routine
  - Listen
  - Empathize
  - Apologize
  - React
  - Notify

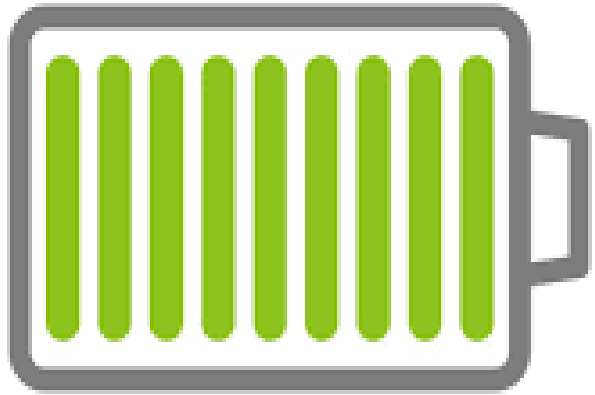
Capacity & Capacity Management

Capacity

Capacity is the maximum rate of output of a process or a system.

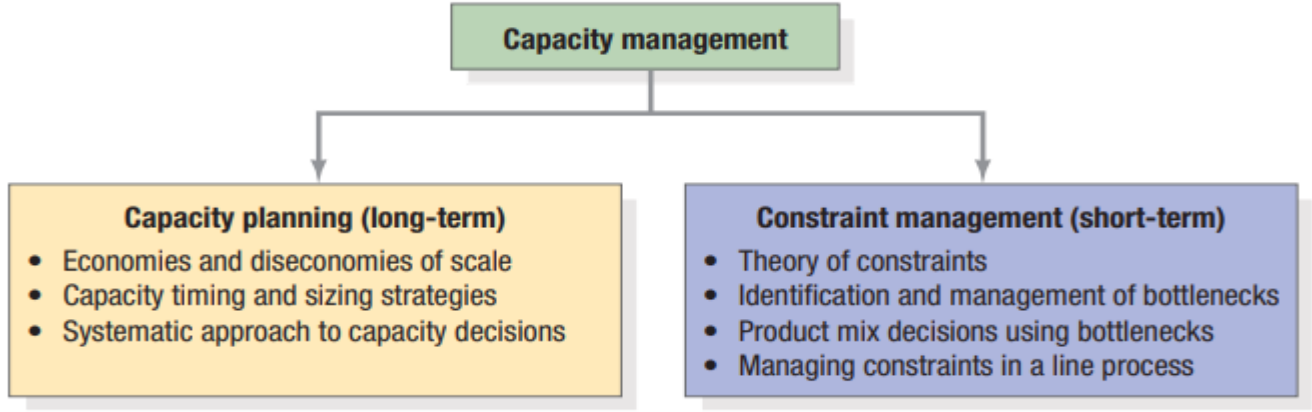
Managers are responsible for ensuring that the firm can meet current and future demand. Otherwise, the organization will miss out on opportunities for growth and profits. Making adjustments to decrease capacity, or to overcome capacity shortfalls as Sharp Corporation did when trailing its nearest competitors for LCD TVs, is therefore an important part of the job.

Acquisition of new capacity requires extensive planning, and often involves significant expenditure of resources and time. Bringing new capacity online can take several years, for instance in the semiconductor industry or in the construction of new nuclear power plants.



Capacity Management

•Capacity management refers to the act of ensuring a business maximizes its potential activities and production output—at all times, under all conditions.
•Companies must remain nimble enough to constantly meet expectations in a cost-effective manner.
•Companies that poorly execute capacity management may experience diminished revenues due to unfulfilled orders, customer attrition, and decreased market share.



Measures of Capacity

Capacity measures vary depending on the context. A retailer uses annual sales per square foot, an airline measures available seat-miles (ASMs) per month, and a theater considers the number of seats. Generally, capacity is measured as either output or input.

1.Output Measures: Suitable for high-volume, standardized processes. For example, a car manufacturing plant measures capacity as cars produced per day. However, when customization or variety increases, output measures become less effective.

2.Input Measures: Used for low-volume, flexible processes. For instance, a custom furniture maker may measure capacity in terms of workers or workstations. Since demand is expressed as output, the furniture maker must convert demand (e.g., annual furniture units) into input requirements like labor hours to meet demand effectively.

Utilization

Utilization is the degree to which a resource such as equipment, space, or the workforce is currently being used, and is measured as the ratio of average output rate to maximum capacity (expressed as a percent). The average output rate and the capacity must be measured in the same terms—that is, time, customers, units, or dollars. The utilization rate indicates the need for adding extra capacity or eliminating unneeded capacity.

$$\text{Utilization} = \frac{\text{Average output rate}}{\text{Maximum capacity}} \times 100\%$$

Here, refer to maximum capacity as the greatest level of output that a process can reasonably sustain for a longer period, using realistic employee work schedules and the equipment currently in place. In some processes, this capacity level implies a one-shift operation; in others, it implies a three-shift operation. A process can be operated above its capacity level using marginal methods of production, such as overtime, extra shifts, temporarily reduced maintenance activities, overstaffing, and subcontracting. Although they help with temporary peaks, these options cannot be sustained for long.

Economies of Scale

Economies of Scale Deciding on the best level of capacity involves consideration for the efficiency of the operations. A concept known as economies of scale states that the average unit cost of a service or good can be reduced by increasing its output rate.

Four principal reasons explain why economies of scale can drive costs down when output increases:

(1)Fixed costs are spread over more units;
(2)construction costs are reduced;
(3)costs of purchased materials are cut; and
(4)process advantages are found.

Four principal reasons…..

Spreading Fixed Costs: In the short term, certain costs do not vary with changes in the output rate. These fixed costs include heating costs, debt service, and managers' salaries. The depreciation of plant and equipment already owned is also a fixed cost in the accounting sense. When the average output rate—and, therefore, the facility's utilization rate—increases, the average unit cost drops because fixed costs are spread over more units.

Reducing Construction Costs: Certain activities and expenses are required to build small and large facilities alike: building permits, architects' fees, and rental of building equipment. Doubling the size of the facility usually does not double construction costs.

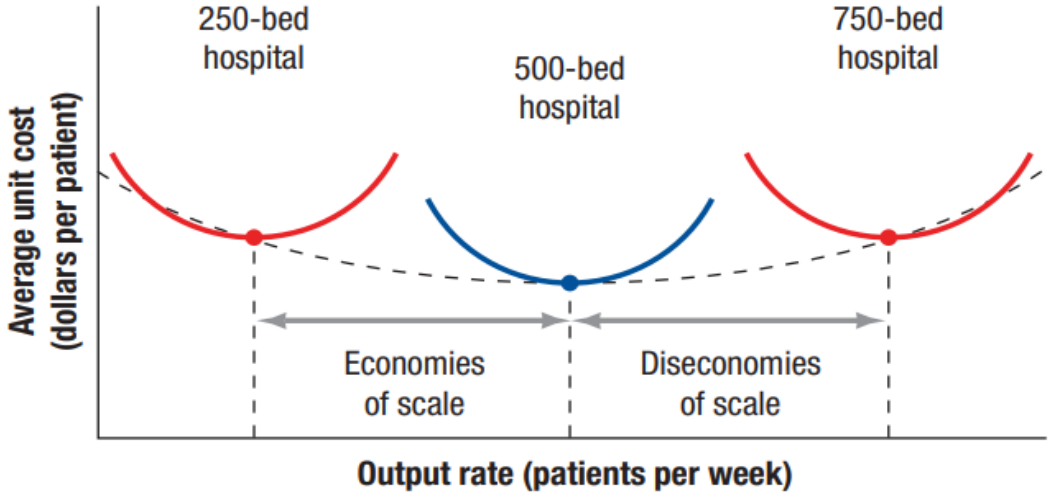
Cutting Costs of Purchased Materials: Higher volumes can reduce the costs of purchased materials and services. They give the purchaser a better bargaining position and the opportunity to take advantage of quantity discounts. Retailers such as Walmart reap significant economies of scale because their national and international stores buy and sell huge volumes of each item.

Four principal reasons…..

Finding Process Advantages: High-volume production provides many opportunities for cost reduction. At a higher output rate, the process shifts toward a line process, with resources dedicated to individual products. Firms may be able to justify the expense of more efficient technology or more specialized equipment. The benefits from dedicating resources to individual services or products may include speeding up the learning effect, lowering inventory, improving process and job designs, and reducing the number of changeovers.

Diseconomies of Scale

Bigger is not always better, however. At some point, a facility can become so large that diseconomies of scale set in; that is, the average cost per unit increases as the facility's size increases. The reason is that excessive size can bring complexity, loss of focus, and inefficiencies that raise the average unit cost of a service or product. Too many layers of employees and bureaucracy can cause management to lose touch with employees and customers. A less agile organization loses the flexibility needed to respond to changing demand. Many large companies become so involved in analysis and planning that they innovate less and avoid risks. The result is that small companies outperform corporate giants in numerous industries.



Operations managers must examine three dimensions of capacity strategy before making capacity decisions:

1. sizing capacity cushions,
2. timing and sizing expansion, and
3. linking process capacity and other operating decisions.

(1) Sizing Capacity Cushions:

Average utilization rates for any resource should not get too close to 100 percent over the long term, though it may occur for some processes from time to time in the short run. If the demand keeps increasing over time, then long-term capacity must be increased as well to provide some buffer against uncertainties. When average utilization rates approach 100 percent, it is usually a signal to increase capacity or decrease order acceptance to avoid declining productivity. The capacity cushion is the amount of reserve capacity a process uses to handle sudden increases in demand or temporary losses of production capacity; it measures the amount by which the average utilization (in terms of total capacity) falls below 100 percent.

Specifically, Capacity cushion = 100 (%) - Average Utilization rate (%)

(2) Timing and Sizing Expansion:

Capacity adjustments depend on market trends and strategic objectives. For instance, General Motors expanded production of the Chevrolet Volt from 30,000 to 45,000 units in 2012 due to strong demand. Conversely, some industries, like airlines, may need to reduce capacity. Airlines have consolidated routes and merged, such as United Airlines with Continental, to manage costs amid rising oil prices.

Two key strategies for capacity expansion include:

1. **Expansionist Strategy**: Large, infrequent capacity increases to meet anticipated demand, reducing the risk of shortages but requiring significant upfront investment.
2. **Wait-and-See Strategy**: Smaller, frequent capacity increases, minimizing financial risk but potentially leading to delays in meeting demand.

(3) Linking Capacity and Other Decisions:

Capacity decisions are closely tied to process design, resource flexibility, inventory management, and facility location, as they collectively impact overall efficiency and adaptability. For example, at Lincolnway Energy, a midsize ethanol plant, competition has intensified, requiring careful capacity planning to remain viable.

Key considerations include:

1.Capacity Cushions: These buffers protect against demand uncertainty. Adjustments to capacity cushions often correlate with changes in other areas:

1. Reduced emphasis on fast delivery (competitive priorities) or improved quality (fewer yield losses) allows for smaller cushions.
2. Capital-intensive equipment or flexible workers can also lower the need for high cushions.

2.Dynamic Pricing: Smoothing output by adjusting prices—raising them when inventory is low and lowering them when it is high—can further reduce capacity cushion needs.

Effective capacity planning ensures alignment with strategic priorities while mitigating risks.

A Systematic Approach to Long-Term Capacity Decisions

Long-term capacity decisions, such as adding a new plant or adjusting workforce size, require years to implement, making a systematic planning approach essential. A four-step procedure can guide these decisions:

1. **Estimate Future Capacity Requirements**: Forecast future demand to determine the capacity needed. *Example*: A manufacturer predicts increased demand for electric vehicles and calculates the required production capacity.
2. **Identify Gaps**: Compare future capacity requirements with current capacity to identify shortfalls or surpluses. *Example*: The manufacturer finds that current facilities will fall short by 20,000 units annually.
3. **Develop Alternative Plans**: Create strategies to address the gaps, such as building new facilities, outsourcing, or improving efficiency. *Example*: Options include constructing a new plant, upgrading existing lines, or collaborating with contract manufacturers.
4. **Evaluate and Choose**: Assess each option qualitatively (e.g., alignment with strategic goals) and quantitatively (e.g., cost, ROI) to select the best alternative. *Example*: After a cost-benefit analysis, the manufacturer opts for expanding existing facilities due to faster implementation and lower cost.

This systematic approach ensures decisions are data-driven and aligned with organizational goals.

Tools for Capacity Planning

Capacity planning requires demand forecasts for an extended period of time. Unfortunately, forecast accuracy declines as the forecasting horizon lengthens. In addition, anticipating what competitors will do increases the uncertainty of demand forecasts. Demand during any period of time may not be evenly distributed; peaks and valleys of demand may (and often do) occur within the time period. These realities necessitate the use of capacity cushions.

Three tools that deal more formally with demand uncertainty and variability:

(1) waiting-line model,
(2) simulation, and
(3) decision trees.

Waiting-Line Models:

These models evaluate customer arrival and service variability to estimate average waiting times, queue lengths, and work center utilization. Waiting lines tend to develop in front of a work center, such as an airport ticket counter, a machine center, or a central computer. The reason is that the arrival time between jobs or customers varies, and the processing time may vary from one customer to the next. Waiting-line models use probability distributions to provide estimates of average customer wait time, average length of waiting lines, and utilization of the work center. Managers can use this information to choose the most cost-effective capacity, balancing customer service and the cost of adding capacity.

For example, consider a professor meeting students during office hours, where the arrival rate is 3 students per hour, and the service rate is 6 students per hour. Although the capacity cushion is 50%, the model shows that students still spend 20 minutes on average in the system, and the probability of having two or more students at the office is 25%. This helps balance service quality with cost considerations.

Simulation: Simulation is used for complex systems where random demand and predictable surges occur. For instance, in a retail store, customer traffic may peak during weekends and holidays. Simulation software like ProModel or SimQuick can model these variations, identify bottlenecks (e.g., cash registers or fitting rooms), and recommend optimal capacity cushions to handle the surges without overstaffing during off-peak periods.

Decision Trees: Decision trees help evaluate capacity expansion options when future demand is uncertain. For example, a restaurant owner may face low or high demand growth probabilities of 40% and 60%, respectively. If the initial expansion is small and demand grows rapidly, a second expansion may be required later, incurring higher costs. Alternatively, a large initial expansion could optimize costs but risk underutilization if demand grows slowly. Decision trees calculate expected payoffs for each scenario, guiding the choice that maximizes long-term benefits.

You have been asked to put together a capacity plan for a critical operation at the Surefoot Sandal Company. Your capacity measure is number of machines. Three products (men's, women's, and children's sandals) are manufactured. The time standards (processing and setup), lot sizes, and demand forecasts are given in the following table. The firm operates two 8-hour shifts, 5 days per week, 50 weeks per year. Experience shows that a capacity cushion of 5 percent is sufficient.

	TIME STANDARDS			
Product	**Processing (hr/pair)**	**Setup (hr/pair)**	**Lot Size (pairs/lot)**	**Demand Forecast (pairs/yr)**
Men's sandals	0.05	0.5	240	80,000
Women's sandals	0.10	2.2	180	60,000
Children's sandals	0.02	3.8	360	120,000

a. If the operation currently has two machines, what is the capacity gap?

b. How many machines are needed?

a. The number of hours of operation per year, N, is $N = (2 \text{ shifts/day})(8 \text{ hours/shifts})(250 \text{ days/machine-year}) = 4{,}000 \text{ hours/machine-year}$

The number of machines required, M, is the sum of machine-hour requirements for all three products divided by the number of productive hours available for one machine:

$$M = \frac{[Dp + (D/Q)s]_{\text{men}} + [Dp + (D/Q)s]_{\text{women}} + [Dp + (D/Q)s]_{\text{children}}}{N\,[1-(C/100)]}$$

$$= \frac{\begin{array}{r}[80{,}000(0.05) + (80{,}000/240)0.5] + [60{,}000(0.10) + (60{,}000/180)2.2] \\ + [120{,}000(0.02) + (120{,}000/360)3.8]\end{array}}{4{,}000[1 - (5/100)]}$$

$$= \frac{14{,}567 \text{ hours/year}}{3{,}800 \text{ hours/machine} - \text{year}} = 3.83 \text{ or } 4 \text{ machines}$$

b. The capacity gap is 1.83 machines $(3.83 - 2)$. Two more machines should be purchased, unless management decides to use short-term options to fill the gap.