

# CHAPTER

# 1

## LEARNING OBJECTIVES

After completing this chapter, you should be able to:

- 1 Define the term *operations management*.
- 2 Identify the three major functional areas of organizations and describe how they interrelate.
- 3 Compare and contrast service and manufacturing operations.
- 4 Describe the operations function and the nature of the operations manager's job.
- 5 Differentiate between design and operation of production systems.
- 6 Describe the key aspects of operations management decision making.
- 7 Briefly describe the historical evolution of operations management.
- 8 Identify current trends in business that impact operations management.

# Introduction to Operations Management

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In the midst of the oil crisis in the 1970s, Toyota provided American consumers with small, quality fuel-efficient cars. The popularity of these cars has facilitated the company's global growth, making Toyota the world's largest automaker in 2007.

After Foxconn was founded in the 1970s, it was known for manufacturing electrical connectors used in Atari 2600. Over the years, Foxconn's operations expanded and it has become the world's largest maker of electronic components; assembling an estimated 40 percent of the world's consumer electronics for customers such as Apple, Amazon, Nokia and Hewlett-Packard. At the time, Sears, JC Penney, and Kmart dominated the retail

market. Over the years, Wal-Mart gained market share at the expense of the previous market leaders, and it has now become the largest and most profitable retailer in the world!

In 2006, Airbus ran into trouble when it could not meet production deadlines for its A380 aircraft. As a result, Airbus lost some orders, which had a negative impact on earnings and its stock price.

Why do some companies thrive while others struggle or fail? There are a variety of reasons, to be sure. However, an important key in a company's success or failure is how well it *manages its operations*.

This book is about operations management. The subject matter is fascinating and timely: Productivity, quality, e-business, global competition, and customer service are very much in the news, and all are part of operations management. This first chapter presents an introduction and overview of operations management. Among the issues it addresses are: What is operations management? Why is it important? What do operations management professionals do?

The chapter also provides a brief description of the historical evolution of operations management and a discussion of the trends that impact operations management.

## INTRODUCTION

Operations refer to the part of an organization that is responsible for producing goods and/or services. Goods are physical items inclusive of raw materials, parts, subassemblies such as the engine system used in a car, and final products such as computers and machineries. Services are activities that provide a combination of time, location, form, and psychological value. There are examples of these goods and services all around you. Every book you read, every video you watch, every e-mail you send, every telephone conversation you have, and every medical treatment you receive involves the operations function of one or more organizations. So does everything you wear, eat, travel in, sit on, and access the Internet with. The operations function in business can also be viewed from a more far-reaching perspective: The collective success or failure of companies' operations functions has an impact on the ability of a nation to compete with other nations, and on the nation's economy.

Business organizations typically have three basic functional areas, as depicted in Figure 1.1: finance, operations, and marketing. It doesn't matter whether the business is a retail store, a hospital, a manufacturing firm, a car wash, or some other type of business; all business organizations have these three basic functions.

Finance is responsible for securing financial resources at favorable prices and allocating those resources throughout the organization, as well as budgeting, analyzing investment proposals, and providing funds for operations. Marketing and operations are the primary, or "line," functions. Marketing is responsible for assessing consumer wants and needs, and selling and promoting the organization's goods or services. Operations is responsible for producing the goods or providing the services offered by the organization. To put this into perspective, if a business organization were a car, operations would be its engine. And just as the engine is the core of what a car does, in a business organization, operations is the core of what the organization does. Operations management is responsible for managing that core. Hence, **operations management** is the management of systems or processes that create goods and/or provide services.

The creation of goods or services involves transforming or converting inputs into outputs. Various inputs such as capital, labor, and information are used to create goods or services using one or more *transformation processes* (e.g., storing, transporting, cutting). To ensure that the desired outputs are obtained, an organization takes measurements at various points in the transformation process (*feedback*) and then compares them with previously established standards to determine whether corrective action is needed (*control*). Figure 1.2 depicts the conversion system.

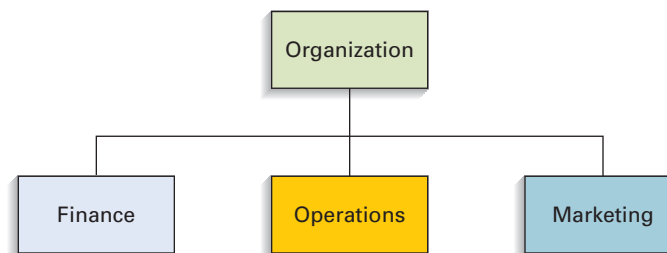
Table 1.1 provides some examples of inputs, transformation processes, and outputs. Although goods and services are listed separately in Table 1.1, it is important to note that goods and services often occur jointly. For example, having the oil changed in your car is a service, but the oil that is delivered is a good. Similarly, house painting is a service, but the paint is a good. The goods–service combination is a continuum. It can range from primarily goods, with little service, to primarily service, with few goods. Figure 1.3 illustrates this continuum. Because there are relatively few pure goods or pure services, companies usually sell *product packages*, which are a combination of goods and services. There are elements of both goods production and service delivery in these product packages. This makes managing operations more interesting, and also more challenging.

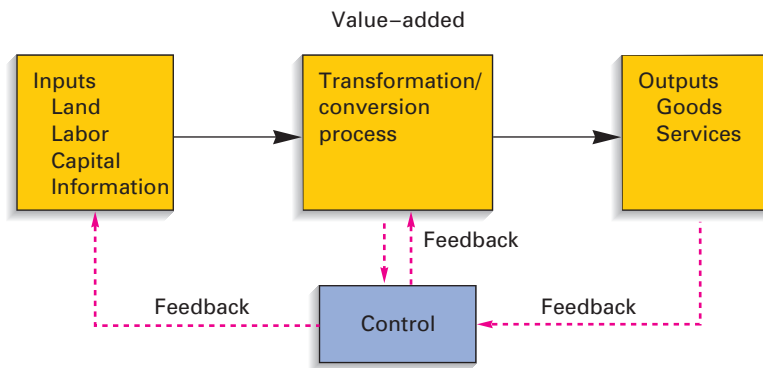
### Operations management

The management of systems or processes that *create goods and/or provide services*.

### FIGURE 1.1

The three basic functions of business organizations





**FIGURE 1.2**  
The operations function involves the conversion of inputs into outputs

Table 1.2 provides some specific illustrations of the transformation process. The essence of the operations function is to *add value* during the transformation process: **Value-added** is the term used to describe the difference between the cost of inputs and the value or price of outputs. In nonprofit organizations, the value of outputs (e.g., highway construction, police and fire protection) is their value to society; the greater the value-added, the greater the effectiveness of these operations. In for-profit organizations, the value of outputs is measured by the prices that customers are willing to pay for those goods or services. Firms use the money generated by value-added for research and development, investment in new facilities and equipment, worker salaries, and *profits*. Consequently, the greater the value-added, the greater the amount of funds available for these purposes.

**Value-added** The difference between the cost of inputs and the value or price of outputs.

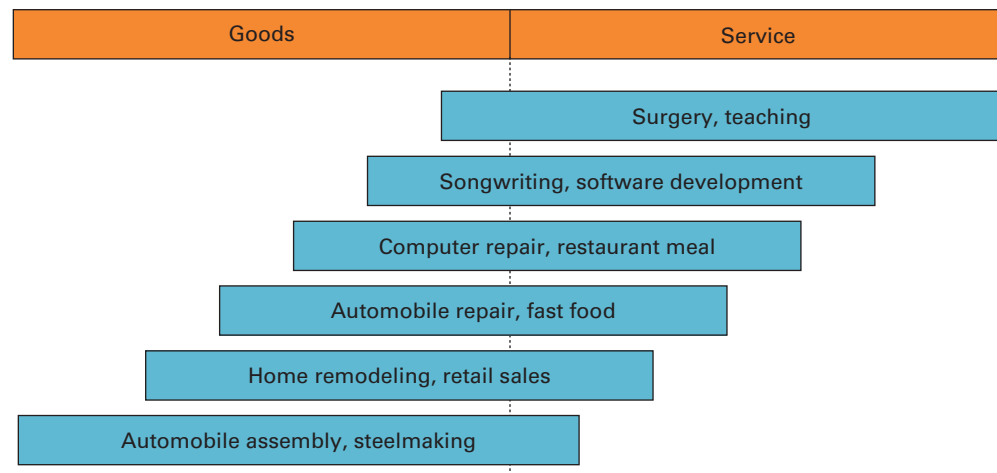
There are many factors that affect the design and management of operations systems. Among them are the degree of involvement of customers in the process and the degree to

Inputs	Transformation	Outputs
Land	Processes	High goods percentage
Human	Cutting, drilling	Houses
Physical labor	Transporting	Automobiles
Intellectual labor	Teaching	Clothing
Capital	Farming	Computers
Raw materials	Mixing	Machines
Energy	Packing	Televisions
Water	Copying, faxing	Food products
Metals		Textbooks
Wood		CD players
Equipment		High service percentage
Machines		Health care
Computers		Entertainment
Trucks		Car repair
Tools		Delivery
Facilities		Legal
Hospitals		Banking
Factories		Communication
Retail stores		Other
Other		Innovation
Information		
Time		
Legal constraints		
Government regulations		

**TABLE 1.1**  
Examples of inputs, transformation, and outputs

**FIGURE 1.3**

The goods–service continuum



which technology is used to produce and/or deliver a product or service. The greater the degree of customer involvement, the more challenging it can be to design and manage the operation. Technology choices can have a major impact on productivity, costs, flexibility, and quality and customer satisfaction.

## Production of Goods versus Delivery of Services

Although goods and services often go hand in hand, there are some very basic differences between the two, differences that impact the management of the goods portion versus management of the service portion. This section explores those differences.

Production of goods results in a *tangible output*, such as an automobile, eyeglasses, a golf ball, a refrigerator—anything that we can see or touch. It may take place in a factory, but can occur elsewhere. For example, farming produces *nonmanufactured* goods. Delivery of service, on the other hand, generally implies an *act*. A physician’s examination, TV and auto repair, lawn care, and the projection of a film in a theater are examples of services. The majority of service jobs fall into these categories:

Government (national, state, local).

Wholesale/retail (clothing, food, appliances, stationery, toys, etc.).

**TABLE 1.2**

Illustrations of the transformation process

Food Processor	Inputs	Processing	Output
	Raw vegetables	Cleaning	Canned vegetables
	Metal sheets	Making cans	
	Water	Cutting	
	Energy	Cooking	
	Labor	Packing	
	Building	Labeling	
	Equipment		
Hospital	Inputs	Processing	Output
	Doctors, nurses	Examination	Treated patients
	Hospital	Surgery	
	Medical supplies	Monitoring	
	Equipment	Medication	
	Laboratories	Therapy	

Financial services (banking, stock brokerages, insurance, etc.).

Health care (doctors, dentists, hospitals, etc.).

Personal services (laundry, dry cleaning, hair/beauty, gardening, etc.).

Business services (data processing, e-business, delivery, employment agencies, etc.).

Education (schools, colleges, etc.).

Manufacturing and service are often different in terms of *what* is done but quite similar in terms of *how* it is done. For example, both involve design and operating decisions. Manufacturers must decide what size factory is needed. Service organizations (e.g., hospitals) must decide what size building is needed. Both must make decisions on location, work schedules, capacity, and allocation of scarce resources.

Manufacturing and service organizations differ chiefly because manufacturing is goods-oriented and service is act-oriented. The differences involve the following:

**1. Degree of customer contact.** Often, by its nature, service involves a much higher degree of customer contact than manufacturing. The point of consumption occurs when a service provider interacts with customers and this results in a “moment of truth” where the service is being performed and its performance is judged by the customers. For example, repairing a leaking roof (service) must take place where the roof (customer) is and the performance of the repairman (service provider) can only be judged during the process of repair. On the other hand, manufacturing allows a separation between production and consumption, so that manufacturing can occur away from the consumer. This permits a fair degree of latitude in selecting work methods, assigning jobs, scheduling work, and exercising control over operations. Service operations, because of their contact with customers, can be much more limited in their range of options. Moreover, customers are sometimes a part of the system (e.g., self-service operations such as gas stations, shopping), so tight control is impossible. In addition, product-oriented operations can build up inventories of finished goods (e.g., cars, refrigerators), enabling them to absorb some of the shocks caused by varying demand. Service operations, however, cannot build up inventories of *time* and are much more sensitive to demand variability—banks and supermarkets alternate between lines of customers waiting for service and idle tellers or cashiers waiting for customers. Note: If a service system has little or no customer contact, it functions in much the same manner as a goods-producing operation.

**2. Uniformity of input.** Service operations are subject to greater variability of inputs than typical manufacturing operations. Each patient, each client, each lawn, and each auto repair presents a specific problem that often must be diagnosed before it can be remedied. Manufacturing operations often have the ability to carefully control the amount of variability of inputs and thus achieve low variability in outputs. Consequently, job requirements for manufacturing are generally more uniform than those for services.

**3. Labor content of jobs.** Many services involve a higher labor content than manufacturing operations.

**4. Uniformity of output.** Because high mechanization generates products with low variability, manufacturing tends to be smooth and efficient; service activities sometimes appear to be slow and awkward, and output is more variable. Automated services are an exception to this.

**5. Measurement of productivity.** Measurement of productivity is more straightforward in manufacturing due to the high degree of uniformity of most manufactured items. In service operations, variations in demand intensity and in requirements from job to job make productivity measurement considerably more difficult. For example, compare the productivity of two doctors. One may have a large number of routine cases while the other does not, so their productivity appears to differ unless a very careful analysis is made.

**6. Production and delivery.** In many instances customers receive the service as it is performed (e.g., haircut, dental care).



**7. Quality assurance.** Quality assurance is more challenging in services when production and consumption occur at the same time. Moreover, the higher variability of input creates additional opportunity for the quality of output to suffer unless quality assurance is actively managed. Quality at the point of creation is typically more evident for services than for manufacturing, where errors can be corrected before the customer receives the output.

**8. Amount of inventory.** Due to the nature of manufacturing, manufacturing systems usually have more inventory on hand (e.g., raw materials, partially completed items, finished goods inventories) than service firms. Nonetheless, all business organizations carry at least some items in inventory that are necessary for the operation of their businesses (e.g., office supplies, spare parts for equipment). And some service organizations have substantial amounts of inventory (e.g., firms that supply replacement parts for automobiles, construction equipment, or farm equipment). Hence, in spite of differing inventory requirements, managers in both manufacturing and service organizations must make decisions concerning inventory (e.g., which items to stock, how much to stock, when to reorder).

**9. Evaluation of work.** Because goods are tangible and there is often a time interval between production and delivery, evaluation of output is less demanding than it is for services.

**10. Ability to patent design.** Product designs are often easier to patent than service designs, and some service designs cannot be patented, making it easier for competitors to copy them.

Service jobs are sometimes categorized as professional or nonprofessional. Wholesale/retail and personal services generally fall into the nonprofessional category. Often these jobs tend to be on the low end of the pay scale, whereas professional services (e.g., surgery, consulting) tend to be on the high end of the pay scale. Manufacturing jobs, on the other hand, don't show this bimodal tendency, and few salaries fall in either the high or low range.

Note that many service activities are essential in goods-producing companies. These include training, human resource management, customer service, equipment repair, procurement, and administrative services.

Table 1.3 gives an overview of the differences between production of goods and service operations. Remember, though, that most systems are a blend of goods and services.



*A teller talks with a depositor at the newly launched Mizuho Bank headquarters in Tokyo. Customers continue to value personalized service, often even for routine financial transactions.*



Characteristic	Goods	Services
Customer contact .....	Low	High
Uniformity of input .....	High	Low
Labor content .....	Low	High
Uniformity of output .....	High	Low
Output .....	Tangible	Intangible
Measurement of productivity .....	Easy	Difficult
Opportunity to correct quality problems before delivery to customer .....	High	Low
Inventory .....	Much	Little
Evaluation .....	Easier	More difficult
Patentable .....	Usually	Not usually

**TABLE 1.3**

Typical differences between goods and services

## THE SCOPE OF OPERATIONS MANAGEMENT

The scope of operations management ranges across the organization. Operations management people are involved in product and service design, process selection, selection and management of technology, design of work systems, location planning, facilities planning, and quality improvement of the organization's products or services.

The operations function includes many interrelated activities, such as forecasting, capacity planning, scheduling, managing inventories, assuring quality, motivating employees, deciding where to locate facilities, and more.

We can use an airline company to illustrate a service organization's operations system. The system consists of the airplanes, airport facilities, and maintenance facilities, sometimes spread out over a wide territory. Most of the activities performed by management and employees fall into the realm of operations management:

*Forecasting* such things as weather and landing conditions, seat demand for flights, and the growth in air travel.

*Capacity planning*, essential for the airline to maintain cash flow and make a reasonable profit. (Too few or too many planes, or even the right number of planes but in the wrong places, will hurt profits.)

*Scheduling* of planes for flights and for routine maintenance; scheduling of pilots and flight attendants; and scheduling of ground crews, counter staff, and baggage handlers.

*Managing inventories* of such items as foods and beverages, first-aid equipment, in-flight magazines, pillows and blankets, and life preservers.

*Assuring quality*, essential in flying and maintenance operations, where the emphasis is on safety, and important in dealing with customers at ticket counters, check-in, telephone and electronic reservations, and curbside service, where the emphasis is on efficiency and courtesy.

*Motivating and training employees* in all phases of operations.

*Locating facilities* according to managers' decisions on which cities to provide service for, where to locate maintenance facilities, and where to locate major and minor hubs.

Now consider a bicycle factory. This might be primarily an *assembly* operation: buying components such as frames, tires, wheels, gears, and other items from suppliers, and then assembling bicycles. The factory also might do some of the *fabrication* work itself, forming frames, making the gears and chains, and buy mainly raw materials and a few parts and materials such as paint, nuts and bolts, and tires. Among the key management tasks in either case are scheduling production, deciding which components to make and which to buy, ordering parts and materials, deciding on the style of bicycle to produce and how many, purchasing



An employee assisting a potential customer at a Trek bicycle store. Trek is a world leader in bicycle products and accessories, with 1,500 employees worldwide. Designers and engineers incorporate the most advanced technology into Trek products, resulting in award-winning bikes and components.



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new equipment to replace old or worn out equipment, maintaining equipment, motivating workers, and ensuring that quality standards are met.

Obviously, an airline company and a bicycle factory are completely different types of operations. One is primarily a service operation, the other a producer of goods. Nonetheless, these two operations have much in common. Both involve scheduling activities, motivating employees, ordering and managing supplies, selecting and maintaining equipment, satisfying quality standards, and—above all—satisfying customers. And in both businesses, the success of the business depends on short- and long-term planning.

The operations function consists of all activities *directly* related to producing goods or providing services. Hence, it exists both in manufacturing and assembly operations, which are *goods-oriented*, and in areas such as health care, transportation, food handling, and retailing, which are primarily *service-oriented*. Table 1.4 provides examples of the diversity of operations management settings.

A primary function of an operations manager is to guide the system by decision making. Certain decisions affect the *design* of the system, and others affect the *operation* of the system.

**TABLE 1.4**

Examples of types of operations

Type of Operations	Examples
Goods producing . . . . .	Farming, mining, construction, manufacturing, power generating
Storage/transportation . . . . .	Warehousing, trucking, mail service, moving, taxis, buses, hotels, airlines
Exchange. . . . .	Retailing, wholesaling, financial advising, renting or leasing, library loans, stock exchange
Entertainment . . . . .	Films, radio and television, plays, concerts, recording
Communication. . . . .	Newspapers, radio and TV newscasts, telephone, satellites, the Internet

*System design* involves decisions that relate to system capacity, the geographic location of facilities, arrangement of departments and placement of equipment within physical structures, product and service planning, and acquisition of equipment. These decisions usually, but not always, require long-term commitments. Moreover, they are typically *strategic* decisions. *System operation* involves management of personnel, inventory planning and control, scheduling, project management, and quality assurance. These are generally *tactical* and *operational* decisions. Feedback on these decisions involves *measurement* and *control*. In many instances, the operations manager is more involved in day-to-day operating decisions than with decisions relating to system design. However, the operations manager has a vital stake in system design because *system design essentially determines many of the parameters of system operation*. For example, costs, space, capacities, and quality are directly affected by design decisions. Even though the operations manager is not responsible for making all design decisions, he or she can provide those decision makers with a wide range of information that will have a bearing on their decisions. Table 1.5 provides additional insights on operations management.

There are also a number of other areas that are part of the operations function. They include purchasing, industrial engineering, distribution, and maintenance.

*Purchasing* has responsibility for procurement of materials, supplies, and equipment. Close contact with operations is necessary to ensure correct quantities and timing of purchases. The purchasing department is often called on to evaluate vendors for quality, reliability, service, price, and ability to adjust to changing demand. Purchasing is also involved in receiving and inspecting the purchased goods.

*Industrial engineering* is often concerned with scheduling, performance standards, work methods, quality control, and material handling.

*Distribution* involves the shipping of goods to warehouses, retail outlets, or final customers.

*Maintenance* is responsible for general upkeep and repair of equipment, buildings and grounds, heating and air-conditioning; removing toxic wastes; parking; and perhaps security.

The operations manager is the key figure in the system: He or she has the ultimate responsibility for the creation of goods or provision of services.

The kinds of jobs that operations managers oversee vary tremendously from organization to organization largely because of the different products or services involved. Thus, managing a banking operation obviously requires a different kind of expertise than managing a steelmaking operation. However, in a very important respect, the jobs are the same: They are both essentially *managerial*. The same thing can be said for the job of any operations manager regardless of the kinds of goods or services being created.

The importance of operations management, both for organizations and for society, should be fairly obvious: The consumption of goods and services is an integral part of our society. Operations management is responsible for creating those goods and services. Organizations exist primarily to provide services or create goods. Hence, operations is the *core function* of an organization. Without this core, there would be no need for any of the other functions—the organization would have no purpose. Given the central nature of its function, it is not surprising that more than half of all employed people in this country have jobs in operations. Furthermore, the operations function is responsible for a major portion of the assets in most business organizations.

The service sector and the manufacturing sector are both important to the economy. The service sector now accounts for more than 70 percent of the jobs in the United States, and is growing in other countries as well. In Singapore, the service sector accounts for 71 percent in 2011, up from about 66 percent a decade ago. While the number of people working in services is increasing, the number of people working in manufacturing is not. (See Figures 1.4a and 1.4b.) The reason for the decline in manufacturing jobs is twofold: As the operations function in manufacturing companies finds more productive ways of

**TABLE 1.5**

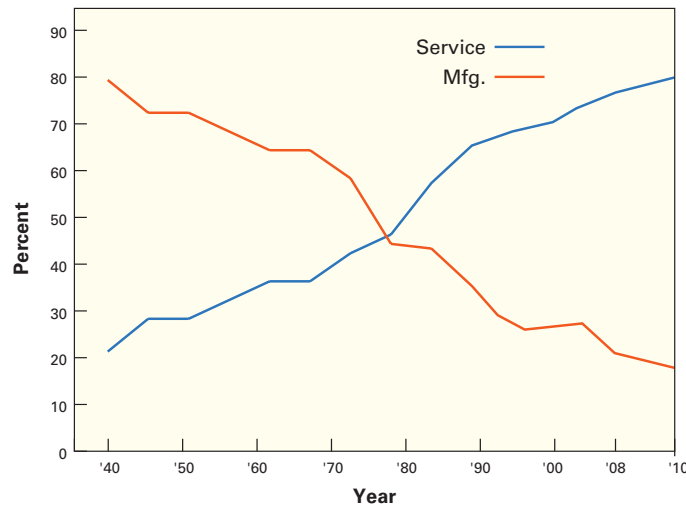
Design and operating decisions

Decision Area	Chapter	Basic Issues
Forecasting	3	What will demand be?
<b>Design</b>		
Product and service design	4	What do customers want? How can products and services be improved?
Capacity (long range)	5	How much capacity will be needed? How can the organization best meet capacity requirements?
Process selection	6	What processes should the organization use?
Layout	6	What is the best arrangement for departments, equipment, work flow, and storage in terms of cost, productivity?
Design of work systems	7	What is the best way to motivate employees? How can productivity be improved? How to measure work? How to improve work methods?
Location	8	What is a satisfactory location for a facility (factory, store, etc.)?
<b>Operation</b>		
Quality	9	How is quality defined? How are quality goods and services achieved and improved?
Quality control	10	Are processes performing adequately? What standards should be used? Are standards being met?
Supply chain management	11	How to achieve effective flows of information and goods throughout the chain?
Inventory management	12, 14	How much to order? When to reorder? Which items should get the most attention?
Aggregate planning	13	How much capacity will be needed over the intermediate range? How can capacity needs best be met?
Materials requirements planning	14	What materials, parts, and subassemblies will be needed, and when?
Just-in-time and lean systems	15	How to achieve a smooth, balanced flow of work using fewer resources?
Scheduling	16	How can jobs and resources best be scheduled? Who will do which job?
Project management	17	Which activities are the most critical to the success of a project? What are the goals of a project? What resources will be needed, and when will they be needed?

producing goods, the companies are able to maintain or even increase their output using fewer workers. Furthermore, some manufacturing work has been *outsourced* to more productive companies, many in other countries, that are able to produce goods at lower costs. Outsourcing and productivity will be discussed in more detail in this and other chapters.

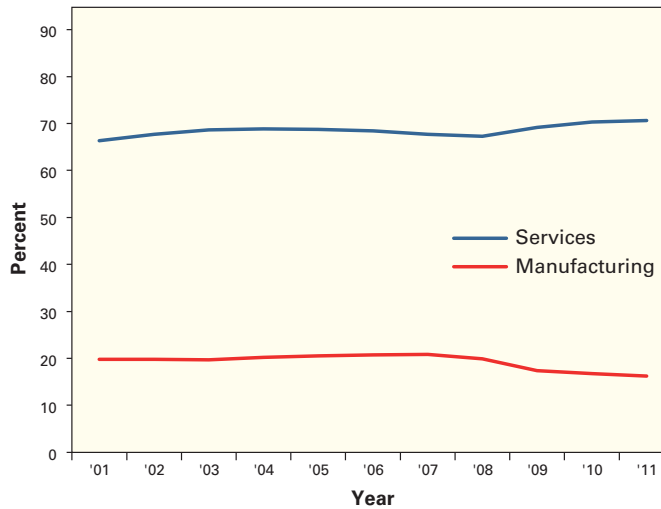
Many of the concepts presented in this book apply equally to manufacturing and service. Consequently, whether your interest at this time is on manufacturing or on service, these concepts will be important, regardless of whether a manufacturing example or service example is used to illustrate the concept.

The following reading gives another reason for the importance of manufacturing jobs, and the reading after that lists some challenges in managing service operations.



**FIGURE 1.4a**  
U.S. manufacturing versus service employment, 1940–2010

Source: U.S. Bureau of Labor Statistics.



**FIGURE 1.4b**  
Singapore manufacturing versus service employment, 2001–2011

Source: <http://www.mom.gov.sg/>.

## Why Manufacturing Still Matters

### READING

As one of a rare group of economists who believe that “manufacturing matters” for the health of the American economy, I was heartened to hear President Obama emphasize manufacturing in his State of the Union address. During the last two years, the manufacturing sector has led the economic recovery, expanding by about 10 percent and adding more than 300,000 jobs.

Admittedly, this is a small number compared with overall private-sector job gains of 3.7 million during the same period, but it reverses the trend of declining manufacturing employment since the late 1990s.

And promising signs are emerging that American companies are shifting some manufacturing production and employment back to the United States. Policies to strengthen the competitiveness of the United States as a location for manufacturing can strengthen these nascent developments.

Though there are economists who do not share my heretical view, I believe that a strong manufacturing sector matters—and deserves the attention of policy makers—for several reasons.

First, economists agree that the United States must rebalance growth away from consumption and imports financed by foreign borrowing toward exports.

Manufactured goods account for about 86 percent of merchandise exports from the United States and about 60 percent of exports of goods and services combined. Exports support more than one-quarter of manufacturing jobs in the United States.

Even though service exports are becoming more important, the only way the United States can rebalance growth and make a significant dent in its trade deficit for the foreseeable future is by increasing exports of manufactured goods.

American manufacturing exports are becoming more attractive as a result of rising wages abroad, the decline in the dollar’s value, increasing supply-chain coordination and transportation costs, and strong productivity growth in American manufacturing.

Germany and Japan, two high-wage countries, have maintained substantial shares of manufacturing in their economies, and are major exporters of manufactured goods to emerging market

*(continued)*

(concluded)

economies. Like manufacturing in these countries, manufacturing in the United States can win larger shares of global export markets with the right policies in place.

Second, on average manufacturing jobs are high-productivity, high value-added jobs with good pay and benefits. Even though the premium on manufacturing wages has been declining over time, it remains significant. Between 2005 and 2010, average weekly earnings in manufacturing were about 21 percent higher than average weekly private non-agricultural earnings. In 2009, the average manufacturing worker earned \$74,447 in annual pay and benefits compared with \$63,122 for the average non-manufacturing worker. In that year, only about 9 percent of the work force was employed in manufacturing, down from about 13 percent in 2000.

The fall in manufacturing employment during the 2000s was a major factor behind growing wage inequality and the polarization of job opportunities between the top and bottom of the wage and skill distribution, with a hollowing out of middle-income jobs.

Even with continuing labor-saving automation, stronger growth in American manufacturing would mean more middle-income job opportunities for workers both in manufacturing itself and in the many domestic business services that support it.

Third, manufacturing matters because of its substantial and disproportionate role in innovation. Few economists dispute the importance of innovation to the growth of living standards, but few acknowledge the strong links between innovation and manufacturing.

A strong manufacturing sector supports the key building blocks of the nation's innovation ecosystem—its skilled scientific, engineering and technical work force, its research and development, its ability to identify technical challenges and provide creative solutions.

Although manufacturing is only about 11 percent of gross domestic product, it employs the majority of the nation's scientists and engineers, and it accounts for 68 percent of business R.&D. spending, which in turn accounts for about 70 percent of total R.&D. spending.

American leadership in science and technology remains highly dependent on R.&D. investment by manufacturing companies, and the social returns to such investment are substantial, far exceeding the returns to the companies that fund it.

Despite the offshoring of parts of the manufacturing supply chain, manufacturing companies in the United States continue to situate most of their R.&D. investment and research work force in the United States.

American multinational companies that account for about 84 percent of all private-sector (non-bank) business R.&D. in the United States still place about 84 percent of their R.&D. activities in the United States, often in clusters around research universities, as Matthew Slaughter of Dartmouth calculated for our article, "Warning Sign From Global Companies," which will be published in *The Harvard Business Review* next month.

But this share is gradually declining as American companies shift some of their R.&D. to Asia in response to rapidly growing markets, ample supplies of technical workers and engineers and generous subsidies. The number of foreign research workers

employed by American multinational companies has more than doubled in the last decade.

China and other emerging economies are actively building their R.&D. capabilities and aggressively competing for the R.&D. of American manufacturing companies. Meanwhile the attractiveness of the United States as a location for such activities is slipping because of shortages in the skilled scientific, engineering and technical labor force and restrictions on the number of immigrants with these skills.

Congress's failure to extend and broaden the R.&D. tax credit, as President Obama has urged, is also encouraging companies in the United States to look to other countries offering far more generous R.&D. tax incentives.

In his State of the Union speech, President Obama proposed several additional changes in business taxes to discourage the outsourcing of manufacturing jobs and to encourage their creation in the United States.

A significant reduction in the corporate tax rate in the United States, which is the second highest among the developed countries, would be a much more powerful incentive to encourage American manufacturing production than these changes. Nor is it likely that they would have much effect on American manufacturing employment, because outsourcing has not been the major cause of manufacturing job losses.

Between 2000 and 2011, American manufacturing employment declined by about 5.6 million while American manufacturing output, after contracting during the 2001-2 and 2008-9 recessions, expanded by about 1 percent.

The contraction in employment occurred throughout the manufacturing sector not just in multinational companies that are often criticized for outsourcing jobs in pursuit of lower labor costs and taxes. The remarkable divergence between manufacturing output and employment reflects strong labor productivity growth, driven by labor-saving technological progress. This trend is likely to persist independent of changes in corporate taxation.

The other policies President Obama is promoting to support manufacturing—measures to increase high-school graduation rates; work-force training programs at community colleges; more support for basic research, infrastructure investment, and scientific, engineering and technical education; and immigration reform—would benefit not just manufacturing but the entire economy.

There is widespread support for such policies among economists, whatever their

## Questions

1. In what ways is the manufacturing sector important to an economy?
2. What are some reasons for the declining trend in the manufacturing sector?

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## The Challenges of Managing Services

### READING



Services can pose a variety of managerial challenges for managers—challenges that in manufacturing are either much less or nonexistent. And because services represent an increasing share of the economy, this places added importance to understanding and dealing with the challenges of managing services. Here are some of the main factors:

1. Jobs in service environments are often less structured than in manufacturing environments.
2. Customer contact is usually much higher in services.
3. In many services, worker skill levels are low compared to those of manufacturing workers.
4. Services are adding many new workers in low-skill, entry-level positions.
5. Employee turnover is often higher, especially in the low-skill jobs.

6. Input variability tends to be higher in many service environments than in manufacturing.
7. Service performance can be adversely affected by workers' emotions, distractions, customers' attitudes, and other factors, many of which are beyond managers' control.

Because of these factors, quality and costs are more difficult to control, productivity tends to be lower, the risk of customer dissatisfaction is greater, and employee motivation is more difficult.

#### Questions

1. What managerial challenges do services present that manufacturing does not?
2. Why does service management present more challenges than manufacturing?

## OPERATIONS MANAGEMENT AND DECISION MAKING

The chief role of an operations manager is that of planner and decision maker. In this capacity, the operations manager exerts considerable influence over the degree to which the goals and objectives of the organization are realized. Most decisions involve many possible alternatives that can have quite different impacts on costs or profits. Consequently, it is important to make *informed* decisions.

Operations management professionals make a number of key decisions that affect the entire organization. These include the following:

*What:* What resources will be needed, and in what amounts?

*When:* When will each resource be needed? When should the work be scheduled? When should materials and other supplies be ordered? When is corrective action needed?

*Where:* Where will the work be done?

*How:* How will the product or service be designed? How will the work be done (organization, methods, equipment)? How will resources be allocated?

*Who:* Who will do the work?

Throughout this book, you will encounter the broad range of decisions that operations managers must make, and you will be introduced to the tools necessary to handle those decisions. This section describes general approaches to decision making, including the use of models, quantitative methods, analysis of trade-offs, establishing priorities, ethics, and the systems approach. Models are often a key tool used by all decision makers.

### Models

A **model** is an abstraction of reality, a simplified representation of something. For example, a child's toy car is a model of a real automobile. It has many of the same visual features (shape, relative proportions, wheels) that make it suitable for the child's learning and playing. But the toy does not have a real engine, it cannot transport people, and it does not weigh 2,000 pounds.

Other examples of models include automobile test tracks and crash tests; formulas, graphs and charts; balance sheets and income statements; and financial ratios. Common

**Model** An abstraction of reality; a simplified representation of something.

statistical models include descriptive statistics such as the mean, median, mode, range, and standard deviation, as well as random sampling, the normal distribution, and regression equations.

Models are sometimes classified as physical, schematic, or mathematical:

*Physical models* look like their real-life counterparts. Examples include miniature cars, trucks, airplanes, toy animals and trains, and scale-model buildings. The advantage of these models is their visual correspondence with reality.

*Schematic models* are more abstract than their physical counterparts; that is, they have less resemblance to the physical reality. Examples include graphs and charts, blueprints, pictures, and drawings. The advantage of schematic models is that they are often relatively simple to construct and change. Moreover, they have some degree of visual correspondence.

*Mathematical models* are the most abstract: They do not look at all like their real-life counterparts. Examples include numbers, formulas, and symbols. These models are usually the easiest to manipulate, and they are important forms of inputs for computers and calculators.

The variety of models in use is enormous. Nonetheless, all have certain common features: They are all decision-making aids and simplifications of more complex real-life phenomena. Real life involves an overwhelming amount of detail, much of which is irrelevant for any particular problem. Models omit unimportant details so that attention can be concentrated on the most important aspects of a situation.

Because models play a significant role in operations management decision making, they are heavily integrated into the material of this text. For each model, try to learn (1) its purpose, (2) how it is used to generate results, (3) how these results are interpreted and used, and (4) what assumptions and limitations apply.

The last point is particularly important because virtually every model has an associated set of requirements that indicate the conditions under which the model is valid. Failure to satisfy all of the assumptions (i.e., to use a model where it isn't meant to be used) will make the results suspect. Attempts to apply the results to a problem under such circumstances can lead to disastrous consequences.

Managers use models in a variety of ways and for a variety of reasons. Models are beneficial because they

1. Are generally easy to use and less expensive than dealing directly with the actual situation.
2. Require users to organize and sometimes quantify information and, in the process, often indicate areas where additional information is needed.
3. Increase understanding of the problem.
4. Enable managers to analyze "What if?" questions.
5. Serve as a consistent tool for evaluation and provide a standardized format for analyzing a problem.
6. Enable users to bring the power of mathematics to bear on a problem.

This impressive list of benefits notwithstanding, models have certain limitations of which you should be aware. The following are three of the more important limitations:

1. Quantitative information may be emphasized at the expense of qualitative information.
2. Models may be incorrectly applied and the results misinterpreted. The widespread use of computerized models adds to this risk because highly sophisticated models may be placed in the hands of users who are not sufficiently knowledgeable to appreciate the subtleties of a particular model; thus, they are unable to fully comprehend the circumstances under which the model can be successfully employed.
3. The use of models does not guarantee good decisions.

## Quantitative Approaches

Quantitative approaches to problem solving often embody an attempt to obtain mathematically optimal solutions to managerial problems. *Linear programming* and related mathematical techniques are widely used for optimum allocation of scarce resources. *Queuing techniques* are useful for analyzing situations in which waiting lines form. *Inventory models* are widely used to control inventories. *Project models* such as PERT (program evaluation and review technique) and CPM (critical path method) are useful for planning, coordinating, and controlling large-scale projects. *Forecasting techniques* are widely used in planning and scheduling. *Statistical models* are currently used in many areas of decision making.

In large measure, *quantitative approaches* to decision making in operations management (and in other functional business areas) have been accepted because of calculators and high-speed computers capable of handling the required calculations. Computers have had a major impact on operations management. Moreover, the growing availability of software packages for quantitative techniques has greatly increased management's use of the computer.

Because of the emphasis on quantitative approaches in operations management decision making, it is important to note that managers typically use a combination of qualitative and quantitative approaches, and many important decisions are based on qualitative approaches.

## Performance Metrics

All managers use metrics to manage and control operations. There are many metrics in use, including those related to profits, costs, quality, productivity, assets, inventories, schedules, and forecast accuracy. As you read each chapter, note the metrics being used and how they are used to manage operations.

## Analysis of Trade-Offs

Operations personnel frequently encounter decisions that can be described as *trade-off* decisions. For example, in deciding on the amount of inventory to stock, the decision maker must take into account the trade-off between the increased level of customer service that the additional inventory would yield and the increased costs required to stock that inventory. In selecting equipment, a decision maker must evaluate the merits of extra features relative to the cost of those extra features. And in the scheduling of overtime to increase output, the manager must weigh the value of the increased output against the higher costs of overtime (e.g., higher labor costs, lower productivity, lower quality, and greater risk of accidents).

Throughout this book you will be presented with decision models that reflect these kinds of trade-offs. Decision makers sometimes deal with these decisions by listing the advantages and disadvantages—the pros and cons—of a course of action to better understand the consequences of the decisions they must make. In some instances, decision makers add weights to the items on their list that reflect the relative importance of various factors. This can help them “net out” the potential impacts of the trade-offs on their decision.

## A Systems Approach

A systems viewpoint is almost always beneficial in decision making. A **system** can be defined as a set of interrelated parts that must work together. In a business organization, the organization can be thought of as a system composed of subsystems (e.g., marketing subsystem, operations subsystem, finance subsystem), which in turn are composed of lower subsystems. The systems approach emphasizes interrelationships among subsystems, but its main theme is that *the whole is greater than the sum of its individual parts*. Hence, from a systems viewpoint, the output and objectives of the organization as a whole take precedence over those of any one subsystem. An alternative approach is to concentrate on efficiency within subsystems and thereby achieve overall efficiency. But that approach overlooks the fact that organizations must operate in an environment of scarce resources and that subsystems are often in direct competition for those scarce resources, so that an orderly approach to the allocation of resources is called for.

**System** A set of interrelated parts that must work together.



A systems approach is essential whenever something is being designed, redesigned, implemented, improved, or otherwise changed. It is important to take into account the impact on all parts of the system. For example, if the upcoming model of an automobile will add antilock brakes, a designer must take into account how customers will view the change, instructions for using the brakes, chances for misuse, the cost of producing the new brakes, installation procedures, recycling worn-out brakes, and repair procedures. In addition, workers will need training to make and/or assemble the brakes, production scheduling may change, inventory procedures may have to change, quality standards will have to be established, advertising must be informed of the new features, and parts suppliers must be selected.

Global competition and outsourcing are increasing the length of companies' value chains, making it more important than ever for companies to use a systems approach to take the "big picture" into account in their decision making.

## Establishing Priorities

In virtually every situation, managers discover that certain factors are more important than others. Recognizing this enables the managers to direct their efforts to where they will do the most good and to avoid wasting time and energy on insignificant factors.

Consider owning and operating an automobile. It has many parts and systems that can malfunction. Some of these are critical: The automobile would not function or would be dangerous to operate without them. Critical items include the engine and drive train, steering, brakes, tires, electrical system, and cooling system. In terms of maintaining and repairing the car, these items should receive the highest priority if the goal is to have safe, reliable transportation.

There are other items that are of much less importance, such as scratches in the paint, minor dents, a missing piece of chrome, and worn seatcovers. In terms of transportation, these should receive attention only after other, more important items have been attended to.

Between these two extremes lies a range of items of intermediate priority. These should be given attention corresponding to their importance to the overall goal. The list might include soft tires, weak battery, wheel alignment, noisy muffler, body rust, inoperative radio, and headlights out of adjustment.

Obviously, certain parts of an automobile are more critical to its operation than others. The same concept applies to management. By recognizing this and setting priorities, a manager will be in a position to manage more effectively.

It is axiomatic that a relatively few factors are often most important, so that dealing with those factors will generally have a disproportionately large impact on the results achieved. This is referred to as the **Pareto phenomenon**, which means that all things are not equal; some things (a few) will be very important for achieving an objective or solving a problem, and other things (many) will not. The implication is that a manager should examine each situation, searching for the few factors that will have the greatest impact, and give them the highest priority. This is one of the most important and pervasive concepts in operations management. In fact, this concept can be applied at all levels of management and to every aspect of decision making, both professional and personal.

**Pareto phenomenon** A few factors account for a high percentage of the occurrence of some event(s).

## Ethics

The financial difficulties of companies such as Enron, China Oil Aviation, Arthur Andersen, Lehman Brothers, Daewoo Industrial, and Shin Corporation brought into question the ethical standards and, sometimes, the behavior of high-ranking company officials.

In making decisions, managers must consider how their decisions will affect shareholders, management, employees, customers, the community at large, and the environment. Finding solutions that will be in the best interests of all of these stakeholders is not always easy, but it is a goal that all managers should strive to achieve. Furthermore, even managers with the best intentions will sometimes make mistakes. If mistakes do occur, managers should act responsibly to correct those mistakes as quickly as possible, and to address any negative consequences.

Operations managers, like all managers, have the responsibility to make ethical decisions. Ethical issues arise in many aspects of operations management, including

- Financial statements: accurately representing the organization’s financial condition.
- Worker safety: providing adequate training, maintaining equipment in good working condition, maintaining a safe working environment.
- Product safety: providing products that minimize the risk of injury to users or damage to property or the environment.
- Quality: honoring warranties, avoiding hidden defects.
- The environment: not doing things that will harm the environment.
- The community: being a good neighbor.
- Hiring and firing workers: avoiding false pretenses (e.g., promising a long-term job when that is not what is intended).
- Closing facilities: taking into account the impact on a community, and honoring commitments that have been made.
- Workers’ rights: respecting workers’ rights, dealing with workers’ problems quickly and fairly.

Many organizations have developed *codes of ethics* to guide employees’ or members’ conduct.

## Environmental Concerns

With growing concern on global environmental changes, stricter regulations especially in developed nations are being imposed, thus affecting the way businesses are operating. With heightened pressure to reduce carbon footprint, businesses are actively searching for alternative modes to reduce the amount of carbon dioxide produced while increase the sustainability of their operations.

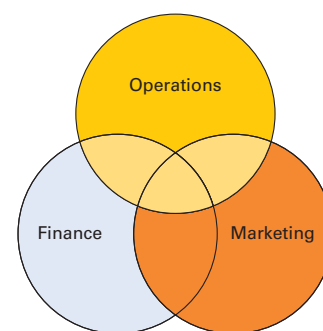
Sustainability refers to the service and production processes that use resources in ways that do no harm the ecological systems that support human existence, both present and in the future. Product and service design, supply chain waste management and outsourcing decisions are business areas most likely to be affected. Outsourcing production could increase transportation cost, result in greater consumption of fuel, and thus releasing more carbon into the air.

Operations management is central to achieving sustainability. Often referred to as “green initiatives,” businesses have begun to adopt measures such as reducing packaging, materials, water and energy use in anticipation of reducing the environmental damage. Other possibilities include recycling, reselling or reconditioning of items such as used equipment.

## WHY STUDY OPERATIONS MANAGEMENT?

If your major field is not operations management, you may be wondering why you need to study operations management. Actually, there are compelling reasons for studying operations management. One is that 50 percent or more of all jobs are in operations management or related fields. Also, recall the image of a business organization as a car, with operations as its engine. In order for that car to function properly, all of the parts must work together. So, too, all of the parts of a business organization must *work together* in order for the organization to function successfully.

Working together successfully means that all members of the organization understand not only their own role, they also understand the roles of others. This is precisely why all business students, regardless of their particular major, are required to take a common core of courses that will enable them to learn about all aspects of business. Because operations management is central to the functioning of all business organizations, it is included in the core of courses business students are required to take. And even though individual courses have a narrow focus (e.g., accounting, marketing), in practice, there is significant interfacing and *collaboration* among the various functional areas, involving *exchange of information* and *cooperative decision making*. For example, although the three primary functions in business organizations perform different activities, many of their decisions impact the other areas of the organization. Consequently, these functions have numerous interactions, as depicted by the overlapping circles shown in Figure 1.5.



**FIGURE 1.5**  
The three major functions of business organizations overlap

Finance and operations management personnel cooperate by exchanging information and expertise in such activities as the following:

1. *Budgeting.* Budgets must be periodically prepared to plan financial requirements. Budgets must sometimes be adjusted, and performance relative to a budget must be evaluated.
2. *Economic analysis of investment proposals.* Evaluation of alternative investments in plant and equipment requires inputs from both operations and finance people.
3. *Provision of funds.* The necessary funding of operations and the amount and timing of funding can be important and even critical when funds are tight. Careful planning can help avoid cash-flow problems.

Marketing's focus is on selling and/or promoting the goods or services of an organization. Marketing is also responsible for assessing customer wants and needs, and for communicating those to operations people (short term) and to design people (long term). That is, operations needs information about demand over the short to intermediate term so that it can plan accordingly (e.g., purchase materials or schedule work), while design people need information that relates to improving current products and services and designing new ones. Marketing, design, and production must work closely together to successfully implement design changes and to develop and produce new products. Marketing can provide valuable insight on what competitors are doing. Marketing also can supply information on consumer preferences so that design will know the kinds of products and features needed; operations can supply information about capacities and judge the *manufacturability* of designs. Operations will also have advance warning if new equipment or skills will be needed for new products or services. Finance people should be included in these exchanges in order to provide information on what funds might be available (short term) and to learn what funds might be needed for new products or services (intermediate to long term). One important piece of information marketing needs from operations is the manufacturing or service **lead time** in order to give customers realistic estimates of how long it will take to fill their orders.

**Lead time** The time between ordering a good or service and receiving it.

Thus, marketing, operations, and finance must interface on product and process design, forecasting, setting realistic schedules, quality and quantity decisions, and keeping each other informed on the other's strengths and weaknesses.

People in every area of business need to appreciate the importance of managing and coordinating operations decisions that affect the supply chain and the matching of supply and demand, and how those decisions impact other functions in an organization.

Operations also interacts with other functional areas of the organization, including legal, management information systems (MIS), accounting, personnel/human resources, and public relations, as depicted in Figure 1.6.

**FIGURE 1.6**  
Operations interfaces with a number of supporting functions



The *legal* department must be consulted on contracts with employees, customers, suppliers, and transporters, as well as on liability and environmental issues.

*Accounting* supplies information to management on costs of labor, materials, and overhead, and may provide reports on items such as scrap, downtime, and inventories.

*Management information systems (MIS)* is concerned with providing management with the information it needs to effectively manage. This occurs mainly through designing systems to capture relevant information and designing reports. MIS is also important for managing the control and decision-making tools used in operations management.

The *personnel* or *human resources* department is concerned with recruitment and training of personnel, labor relations, contract negotiations, wage and salary administration, assisting in manpower projections, and ensuring the health and safety of employees.

*Public relations* has responsibility for building and maintaining a positive public image of the organization. Good public relations provides many potential benefits. An obvious one is in the marketplace. Other potential benefits include public awareness of the organization as a good place to work (labor supply), improved chances of approval of zoning change requests, community acceptance of expansion plans, and instilling a positive attitude among employees.

## Career Opportunities

There are many career opportunities in the operations management field. Among the numerous job titles are operations manager, production analyst, production manager, industrial engineer, time study analyst, inventory manager, purchasing manager, schedule coordinator, distribution manager, supply chain manager, quality analyst, and quality manager.

People who work in the operations field should have a skill set that includes both people skills and knowledge skills. People skills include political awareness; mentoring ability; and collaboration, negotiation, and communication skills. Knowledge skills, necessary for credibility and good decision making, include product and/or service knowledge, process knowledge, industry and global knowledge, and financial and accounting skills.

If you are thinking of a career in operations management, you can benefit by joining one or more of the professional societies.

*Logistics Association of Australia (LAA)*  
PO Box W154 Parramatta NSW 2150

*China Federation of Logistics and Purchasing (CFLP)*  
North Street, Xicheng District Beijing 100834 Forum on the 25th

*Global Logistics Council of Taiwan (GLCT)*  
10F, No. 45, Sec 2, Fu Xing South Road, Taipei

*Chartered Institute of Logistics and Transport, Singapore*  
5 Jalan Kilang Barat #06-03 Petro Centre Singapore 159349

*Singapore Logistics Association (SLA)*  
No. 2 Bukit Merah Central #04-02 SPRING Singapore 159835



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## THE HISTORICAL EVOLUTION OF OPERATIONS MANAGEMENT

Systems for production have existed since ancient times. The Great Wall of China, Angkor Wat, Borobudur, the palaces of Persepolis, and the roads of the Incan empire provide examples of the human ability to organize for production. Even so, most of these examples

could be classified as “public works” projects. The production of goods for sale, at least in the modern sense, and the modern factory system had their roots in the Industrial Revolution.

## The Industrial Revolution

The Industrial Revolution began in the 1770s in England and spread to the rest of Europe and to the United States during the 19th century. Prior to that time, goods were produced in small shops by craftsmen and their apprentices. Under that system, it was common for one person to be responsible for making a product, such as a horse-drawn wagon or a piece of furniture, from start to finish. Only simple tools were available; the machines that we use today had not been invented.

Then, a number of innovations in the 18th century changed the face of production forever by substituting machine power for human power. Perhaps the most significant of these was the steam engine, because it provided a source of power to operate machines in factories. The spinning jenny and the power loom revolutionized the textile industry. Ample supplies of coal and iron ore provided materials for generating power and making machinery. The new machines, made of iron, were much stronger and more durable than the simple wooden machines they replaced.

In the earliest days of manufacturing, goods were produced using **craft production**: highly skilled workers using simple, flexible tools produced goods according to customer specifications.

Craft production had major shortcomings. Because products were made by skilled craftsmen who custom fitted parts, production was slow and costly. And when parts failed, the replacements also had to be custom made, which was also slow and costly. Another shortcoming was that production costs did not decrease as volume increased; there were no *economies of scale*, which would have provided a major incentive for companies to expand. Instead, many small companies emerged, each with its own set of standards.

A major change occurred that gave the Industrial Revolution a boost: the development of standard gauging systems. This greatly reduced the need for custom-made goods. Factories began to spring up and grow rapidly, providing jobs for countless people who were attracted in large numbers from rural areas.

Despite the major changes that were taking place, management theory and practice had not progressed much from early days. What was needed was an enlightened and more systematic approach to management.

## Scientific Management

The scientific management era brought widespread changes to the management of factories. The movement was spearheaded by the efficiency engineer and inventor Frederick Winslow Taylor, who is often referred to as the father of scientific management. Taylor believed in a “science of management” based on observation, measurement, analysis and improvement of work methods, and economic incentives. He studied work methods in great detail to identify the best method for doing each job. Taylor also believed that management should be responsible for planning, carefully selecting and training workers, finding the best way to perform each job, achieving cooperation between management and workers, and separating management activities from work activities.

Taylor’s methods emphasized maximizing output. They were not always popular with workers, who sometimes thought the methods were used to unfairly increase output without a corresponding increase in compensation. Certainly some companies did abuse workers in their quest for efficiency. Eventually, the public outcry reached the halls of Congress, and hearings were held on the matter. Taylor himself was called to testify in 1911, the same year in which his classic book, *The Principles of Scientific Management*, was published. The

**Craft production** System in which highly skilled workers use simple, flexible tools to produce small quantities of customized goods.

publicity from those hearings actually helped scientific management principles to achieve wide acceptance in industry.

A number of other pioneers also contributed heavily to this movement, including the following:

*Frank Gilbreth* was an industrial engineer who is often referred to as the father of motion study. He developed principles of motion economy that could be applied to incredibly small portions of a task.

*Henry Gantt* recognized the value of nonmonetary rewards to motivate workers, and developed a widely used system for scheduling, called Gantt charts.

*Harrington Emerson* applied Taylor's ideas to organization structure and encouraged the use of experts to improve organizational efficiency. He testified in a congressional hearing that railroads could save a million dollars a day by applying principles of scientific management.

*Henry Ford*, the great industrialist, employed scientific management techniques in his factories.

During the early part of the 20th century, automobiles were just coming into vogue in the United States. Ford's Model T was such a success that the company had trouble keeping up with orders for the cars. In an effort to improve the efficiency of operations, Ford adopted the scientific management principles espoused by Frederick Winslow Taylor. He also introduced the *moving assembly line*, which had a tremendous impact on production methods in many industries.

Among Ford's many contributions was the introduction of **mass production** to the automotive industry, a system of production in which large volumes of standardized goods are produced by low-skilled or semiskilled workers using highly specialized, and often costly, equipment. Ford was able to do this by taking advantage of a number of important concepts. Perhaps the key concept that launched mass production was **interchangeable parts**, sometimes attributed to Eli Whitney, an American inventor who applied the concept to assembling muskets in the late 1700s. The basis for interchangeable parts was to standardize parts so that any part in a batch of parts would fit any automobile coming down the assembly line. This meant that parts did not have to be custom fitted, as they were in craft production. The standardized parts could also be used for replacement parts. The result was a tremendous decrease in assembly time and cost. Ford accomplished this by standardizing the gauges used to measure parts during production and by using newly developed processes to produce uniform parts.

A second concept used by Ford was the **division of labor**, which Adam Smith wrote about in *The Wealth of Nations* (1776). Division of labor means that an operation, such as assembling an automobile, is divided up into a series of many small tasks, and individual workers are assigned to one of those tasks. Unlike craft production, where each worker was responsible for doing many tasks, and thus required skill, with division of labor the tasks were so narrow that virtually no skill was required.



www.ford.com

**Mass production** System in which low-skilled workers use specialized machinery to produce high volumes of standardized goods.

**Interchangeable parts** Parts of a product made to such precision that they do not have to be custom fitted.

**Division of labor** The breaking up of a production process into small tasks, so that each worker performs a small portion of the overall job.

## ASSEMBLY LINES

Assembly lines are one of several approaches to the production of goods and delivering services. But the importance of assembly lines to business and society is hard to overstate. Often associated with Henry Ford's automobile production, they were the hallmark of mass production, achieving high volumes of standardized products. As such, they played a pivotal role in the development of what we now refer to as industrialized nations. By shifting from

craft production methods to assembly lines, producers were able to successfully employ large numbers of unskilled workers. By using assembly lines, they achieved tremendous gains in industrial productivity, produced affordable products, and in the process greatly increased the standard of living of people in industrial nations. As you will learn later in the book, assembly lines also play an important role in a newer approach to operations called lean production or, more generally, lean operations.

Together, these concepts enabled Ford to tremendously increase the production rate at his factories using readily available inexpensive labor. Both Taylor and Ford were despised by many workers, because they held workers in such low regard, expecting them to perform like robots. This paved the way for the human relations movement.

## The Human Relations Movement

Whereas the scientific management movement heavily emphasized the technical aspects of work design, the human relations movement emphasized the importance of the human element in job design. Lillian Gilbreth, a psychologist and the wife of Frank Gilbreth, worked with her husband, focusing on the human factor in work. (The Gilbreths were the subject of a classic 1950s film, *Cheaper by the Dozen*.) Many of her studies in the 1920s dealt with worker fatigue. In the following decades, there was much emphasis on motivation. During the 1930s, Elton Mayo conducted studies at the Hawthorne division of Western Electric. His studies revealed that in addition to the physical and technical aspects of work, worker motivation is critical for improving productivity. During the 1940s, Abraham Maslow developed motivational theories, which Frederick Herzberg refined in the 1950s. Douglas McGregor added Theory X and Theory Y in the 1960s. These theories represented the two ends of the spectrum of how employees view work. Theory X, on the negative end, assumed that workers do not like to work, and have to be controlled—rewarded and punished—to get them to do good work. This attitude was quite common in the automobile industry and in some other industries, until the threat of global competition forced them to rethink that approach. Theory Y, on the other end of the spectrum, assumed that workers enjoy the physical and mental aspects of work and become committed to work. The Theory X approach resulted in an adversarial environment, whereas the Theory Y approach resulted in empowered workers and a more cooperative spirit. In the 1970s, William Ouchi added Theory Z, which combined the Japanese approach with such features as lifetime employment, employee problem solving, and consensus building, and the traditional Western approach that features short-term employment, specialists, and individual decision making and responsibility.

## Decision Models and Management Science

The factory movement was accompanied by the development of several quantitative techniques. F. W. Harris developed one of the first models in 1915: a mathematical model for inventory management. In the 1930s, three coworkers at Bell Telephone Labs, H.F. Dodge, H.G. Romig, and W. Shewhart, developed statistical procedures for sampling and quality control. In 1935, L.H.C. Tippett conducted studies that provided the groundwork for statistical-sampling theory.

At first, these quantitative models were not widely used in industry. However, the onset of World War II changed that. The war generated tremendous pressures on manufacturing output, and specialists from many disciplines combined efforts to achieve advancements in the military and in manufacturing. After the war, efforts to develop and refine quantitative tools for decision making continued, resulting in decision models for forecasting, inventory management, project management, and other areas of operations management.

During the 1960s and 1970s, management science techniques were highly regarded; in the 1980s, they lost some favor. However, the widespread use of personal computers and user-friendly software in the workplace contributed to a resurgence in the popularity of these techniques.

## The Influence of Japanese Manufacturers

A number of Japanese manufacturers developed or refined management practices that increased the productivity of their operations and the quality of their products. This made them very competitive, sparking interest in their approaches by companies outside Japan. Their approaches emphasized quality and continual improvement, worker teams and empowerment, and achieving customer satisfaction. The Japanese can be credited with

Approximate Date	Contribution/Concept	Originator
1776	Division of labor	Adam Smith
1790	Interchangeable parts	Eli Whitney
1911	Principles of scientific management	Frederick W. Taylor
1911	Motion study, use of industrial psychology	Frank and Lillian Gilbreth
1912	Chart for scheduling activities	Henry Gantt
1913	Moving assembly line	Henry Ford
1915	Mathematical model for inventory management	F.W. Harris
1930	Hawthorne studies on worker motivation	Elton Mayo
1935	Statistical procedures for sampling and quality control	H.F. Dodge, H.G. Romig, W. Shewhart, L.H.C. Tippett
1940	Operations research applications in warfare	Operations research groups
1947	Linear programming	George Dantzig
1951	Commercial digital computers	Sperry Univac, IBM
1950s	Automation	Numerous
1960s	Extensive development of quantitative tools	Numerous
1960s	Industrial dynamics	Jay Forrester
1975	Emphasis on manufacturing strategy	W. Skinner
	Emphasis on quality, flexibility, time-based competition, lean production	Japanese manufacturers, especially Toyota, and Taiichi Ohno
1990s	Internet, supply chain management	Numerous
2000s	Applications service providers and outsourcing	Numerous

**TABLE 1.6**

Historical summary of operations management

spawning the “quality revolution” that occurred in industrialized countries, and with generating widespread interest in time-based management (just-in-time production).

The influence of the Japanese on U.S. manufacturing and service companies has been enormous and promises to continue for the foreseeable future. Because of that influence, this book will provide considerable information about Japanese methods and successes.

Table 1.6 provides a chronological summary of some of the key developments in the evolution of operations management.

## TRENDS IN BUSINESS

Business organizations must be cognizant of current trends and take them into account in their strategic planning. In this section you will learn about some major trends as well as some other important trends.

### Major Trends

Advances in information technology and global competition have influenced the major trends. Although different organizations have different priorities, and hence are differently affected by various trends, a representative list of major trends includes

- The Internet, e-commerce, and e-business.
- Management of technology.
- Globalization.
- Management of supply chains.



Outsourcing.  
Agility.  
Ethical behavior.

The *Internet* offers great potential for business organizations, but the potential as well as the risks must be clearly understood in order to determine if and how to exploit this potential. In many cases, the Internet has altered the way companies compete in the marketplace.

**E-business** Use of the Internet to transact business.

**E-commerce** Consumer-to-business transactions.



**Technology** The application of scientific discoveries to the development and improvement of goods and services.

Electronic business, or **e-business**, involves the use of the Internet to transact business. E-business is changing the way business organizations interact with their customers and their suppliers. Most familiar to the general public is **e-commerce**, consumer–business transactions such as buying online or requesting information. However, business-to-business transactions such as e-procurement represent an increasing share of e-business. E-business is receiving increased attention from business owners and managers in developing strategies, planning, and decision making.

The word **technology** has several definitions, depending on the context. Generally, *technology* refers to the application of scientific discoveries to the development and improvement of goods and services. It can involve knowledge, materials, methods, and equipment. The term *high technology* refers to the most advanced and developed machines and methods. Operations management is primarily concerned with three kinds of technology: product and service technology, process technology, and information technology (IT). All three can have a major impact on costs, productivity, and competitiveness.

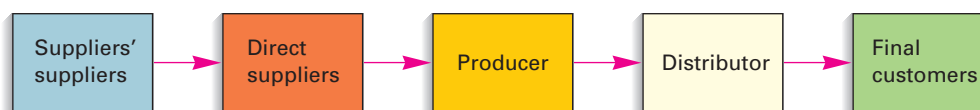
**Product and service technology** refers to the discovery and development of new products and services. This is done mainly by researchers and engineers, who use the scientific approach to develop new knowledge and translate that into commercial applications.

**Process technology** refers to methods, procedures, and equipment used to produce goods and provide services. They include not only processes within an organization but also supply chain processes.

**Information technology (IT)** refers to the science and use of computers and other electronic equipment to store, process, and send information. Information technology is heavily ingrained in today’s business operations. This includes electronic data processing, the use of bar codes to identify and track goods, obtaining point-of-sale information, data transmission, the Internet, e-commerce, e-mail, and more.

*Management of technology* is high on the list of major trends, and it promises to be high well into the future. For example, computers have had a tremendous impact on businesses in many ways, including new product and service features, process management, medical diagnosis, production planning and scheduling, data processing, and communication. Advances in materials, methods, and equipment also have had an impact on competition and productivity. Advances in information technology also have had a major impact on businesses. Obviously there have been—and will continue to be—many benefits from technological advances. However, technological advance also places a burden on management. For example, management must keep abreast of changes and quickly assess both their benefits and risks. Predicting advances can be tricky at best, and new technologies often carry a high price tag and usually a high cost to operate or repair. And in the case of computer operating systems, as new systems are introduced, support for older versions is discontinued, making periodic upgrades necessary. Conflicting technologies can exist that make technological choices even more difficult. Technological innovations in both *products* and *processes* will continue to change the way businesses operate, and hence require continuing attention.

The U.S.-Singapore Free Trade Agreement has enhanced trade between Singapore and the United States. The World Trade Organization (WTO) has liberalized trade among nations, expanding world trade. The resulting global competition and global markets have



**FIGURE 1.7**  
A simple product supply chain

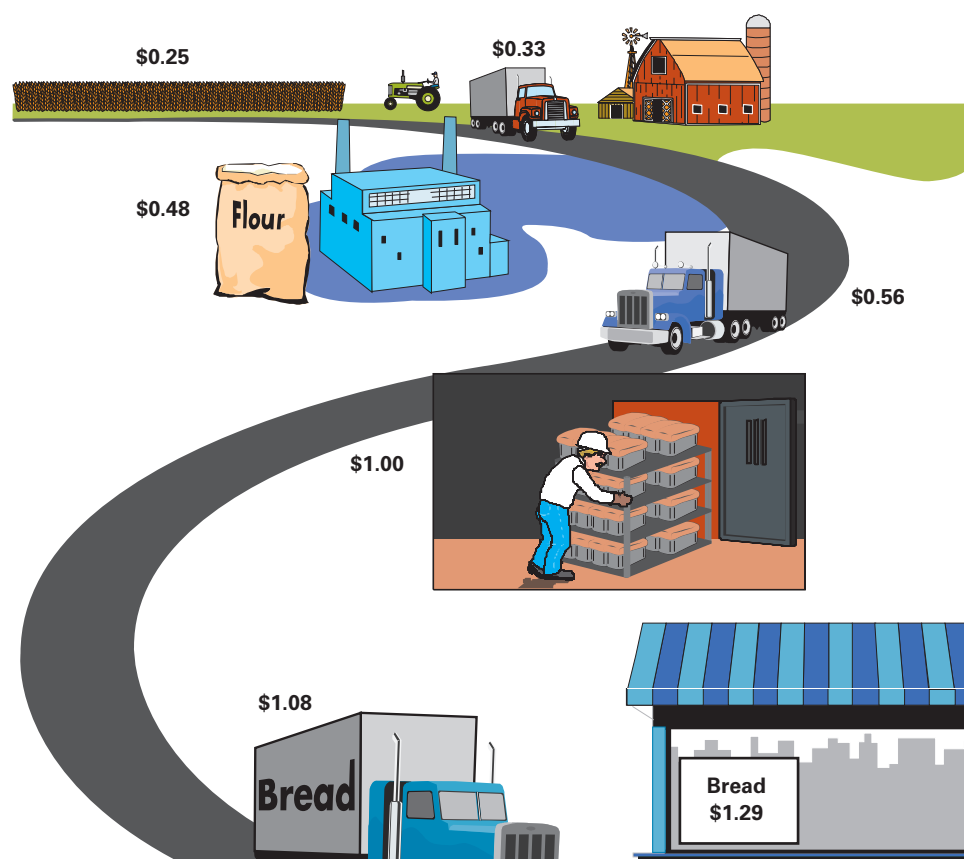
had an impact on the strategies and operations of businesses large and small around the world. One effect is the importance business organizations are giving to management of their *supply chains*.

A **supply chain** is the sequence of organizations—their facilities, functions, and activities—that are involved in producing and delivering a product or service. The sequence begins with basic suppliers of raw materials and extends all the way to the final customer, as seen in Figure 1.7. Facilities might include warehouses, factories, processing centers, offices, distribution centers, and retail outlets. Functions and activities include forecasting, purchasing, inventory management, information management, quality assurance, scheduling, production, distribution, delivery, and customer service. Figure 1.8 provides another illustration of a supply chain: a chain that begins with wheat growing on a farm and ends with a customer buying a loaf of bread in a supermarket. Notice that the value of the product increases as it moves through the supply chain.

A growing aspect of supply chain management is **outsourcing**—that is, buying goods or services rather than producing goods or performing services within the organization. Outsourcing—and the loss of jobs it entails, especially when it involves outsourcing to other countries—has become a challenging issue for politicians, labor organizations, and operations managers as companies increasingly outsource both manufacturing and service jobs.

**Supply chain** A sequence of activities and organizations involved in producing and delivering a good or service.

**Outsourcing** Obtaining a product or service from outside the organization.



**FIGURE 1.8**  
A supply chain for bread

Although Chapter 11 is devoted to a detailed look at supply chain management, you will find that it is included in discussions throughout the book, due to the importance of the topic.

*Globalization* and the need for global supply chains have broadened the scope of supply chain management. However, tightened border security in certain instances has slowed some movement of goods and people. Moreover, in some cases, organizations are reassessing their use of offshore outsourcing.

**Agility** The ability of an organization to respond quickly to demands or opportunities.

**Agility** refers to the ability of an organization to respond quickly to demands or opportunities. It is a strategy that involves maintaining a flexible system that can quickly respond to changes in either the volume of demand or changes in product/service offerings. This is particularly important as organizations scramble to remain competitive and cope with increasingly shorter product life cycles and strive to achieve shorter development times for new or improved products and services.

*Ethical behavior* and conduct is getting increased attention from management at all levels. Accounting scandals, stock brokers releasing misleading information, product liability claims, and breaches in privacy and security of computer files are just some of the behaviors that have led to public outcries and congressional investigations. In making decisions, managers must consider how their decisions will affect shareholders, management, employees, customers, community, and the environment. It is the goal of managers to find solutions that will be in the best interests of all stakeholders. This goal is not easy to achieve, and if mistakes occur, managers should act responsibly to correct mistakes and address any negative consequences. Many organizations have developed codes of conduct and ethical standards to guide the behavior of managers and employees.

*Sustainability* refers to production processes that use resources in ways that do not harm ecological systems that support environmental and human existence. In recent years, global warming and pollution have had an increasing impact on how businesses are carried out. Stricter environmental regulations are being imposed, particularly in developed countries, to pressure business organizations to reduce the amount of carbon dioxide generated by their operations and supply chains (or carbon footprint). Many of the processes that affect sustainability fall under the purview of operations such product and service design, waste management, production, transportation, packaging, and outsourcing. Therefore, managing operations is crucial in addressing sustainability. Increasingly, organizations are practicing “green operations” or embarking on “green initiatives” to promote a more sustainable environment.

## Other Important Trends

While the preceding issues are getting much needed attention, there are also other important issues that must be addressed. These include greater emphasis on

- Operations strategy.
- Working with fewer resources.
- Revenue management.
- Process analysis and improvement, and quality improvement.
- Increased regulation and product liability issues.
- Lean production.

During the 1970s and 1980s, many companies neglected to include *operations strategy* in their corporate strategy. Some of them paid dearly for that neglect. Now more and more companies are recognizing the importance of operations strategy on the overall success of their business as well as the necessity for relating it to their overall business strategy.

*Working with fewer resources* due to layoffs, corporate downsizing, and general cost cutting is forcing managers to make trade-off decisions on resource allocation, and to place increased emphasis on cost control and productivity improvement.

*Revenue management* is a method used by some companies to maximize the revenue they receive from fixed operating capacity by influencing demand through price

manipulation. Also known as yield management, it has been successfully used in the travel and tourism industries by airlines, cruise lines, hotels, amusement parks, and rental car companies, and in other industries such as trucking and public utilities.

*Process analysis and improvement* includes cost and time reduction, productivity improvement, process yield improvement, and quality improvement and increasing customer satisfaction. This is sometimes referred to as a **six sigma** process.

Given a boost by the “quality revolution” of the 1980s and 1990s, *quality* is now ingrained in business. Some businesses use the term *total quality management (TQM)* to describe their quality efforts. A quality focus emphasizes *customer satisfaction* and often involves *teamwork*. *Process improvement* can result in improved quality, cost reduction, and *time reduction*. Time relates to costs and to competitive advantage, and businesses seek ways to reduce the time to bring new products and services to the marketplace to gain a competitive edge. If two companies can provide the same product at the same price and quality, but one can deliver it four weeks earlier than the other, the quicker company will invariably get the sale. Time reductions are being achieved in many companies now. Kodak was able to cut in half the time needed to bring a new camera to market; JR-East (East Japan Railway Company) was able to provide faster customer response through the use of the Casio IT-10, a mobile terminal device, to issue tickets and check boarding information, thus increasing conductor efficiency as well.

Increased *regulation* and some very costly *product liability* claims have continued to make these issues important management issues. These issues are discussed in Chapter 4.

*Lean production*, a new approach to production, emerged in the 1990s. It incorporates a number of the recent trends listed here, with an emphasis on quality, flexibility, time reduction, and teamwork. This has led to a *flattening* of the organizational structure, with fewer levels of management.

**Lean production** systems are so named because they use much less of certain resources than typical mass production systems use—space, inventory, and workers—to produce a comparable amount of output. Lean systems use a highly skilled workforce and flexible equipment. In effect, they incorporate advantages of both mass production (high volume, low unit cost) and craft production (variety and flexibility). And quality is higher than in mass production.

The skilled workers in lean production systems are more involved in maintaining and improving the system than their mass production counterparts. They are taught to stop production if they discover a defect, and to work with other employees to find and correct the cause of the defect so that it won’t recur. This results in an increasing level of quality over time, and eliminates the need to inspect and rework at the end of the line.

Because lean production systems operate with lower amounts of inventory, additional emphasis is placed on anticipating when problems might occur *before* they arise, and avoiding those problems through planning. Even so, problems can still occur at times, and quick resolution is important. Workers participate in both the planning and correction stages.

Compared to workers in traditional systems, much more is expected of workers in lean production systems. They must be able to function in teams, playing active roles in operating and improving the system. Individual creativity is much less important than team success. Responsibilities also are much greater, which can lead to pressure and anxiety not present in traditional systems. Moreover, a flatter organizational structure means career paths are not as steep in lean production organizations. Workers tend to become generalists rather than specialists, another contrast to more traditional organizations.

## Operations Tours

Throughout the book you will discover operations tours that describe operations in all sorts of companies. The tour you are about to read is Wegmans Food Markets, a major regional supermarket chain and one of the largest privately held companies in the United States. Wegmans has been consistently ranked high on *Fortune* magazine’s list of the 100 Best Companies to Work For since the inception of the survey a decade ago. In 2005 Wegmans was ranked number one on the list.

**Six sigma** A process for reducing costs, improving quality, and increasing customer satisfaction.



The St. Regis Hotel in Shanghai. St. Regis is a five-star hotel known for its customer service. Its Shanghai location offers a wide range of complimentary services, including pressing of garments upon arrival and fresh fruit and flowers daily.



www.stregis.com

**Lean production** System that uses minimal amounts of resources to produce a high volume of high-quality goods with some variety.

## Wegmans Food Markets

### OPERATIONS TOUR



www.wegmans.com

Wegmans Food Markets, Inc., is one of the premier grocery chains in the United States. Headquartered in Rochester, New York, Wegmans operates over 70 stores, mainly in Rochester, Buffalo, and Syracuse. There are also a handful of stores elsewhere in New York State and in New Jersey, Pennsylvania, and Virginia. The company employs over 37,000 people, and has annual sales of over \$3 billion.

Wegmans has a strong reputation for offering its customers high product quality and excellent service. Through a combination of market research, trial and error, and listening to its customers, Wegmans has evolved into a very successful organization. Its sales per square foot are 50 percent higher than the industry average.

### Superstores

Many of the company's stores are giant 100,000-square-foot superstores, double or triple the size of average supermarkets. You can get an idea about the size of these stores from this: they usually have between 25 and 35 checkout lanes, and during busy periods, all of the checkouts are in operation. A superstore typically employs from 500 to 600 people.

Individual stores differ somewhat in terms of actual size and some special features. Aside from the features normally found in supermarkets, they generally have a full-service deli (typically a 12-meter display case), a 50-square-meter fisherman's wharf that

has perhaps 10 different fresh fish offerings most days, a large bakery section (each store bakes its own bread, rolls, cakes, pies, and pastries), and extra-large produce sections. They also offer film processing, a complete pharmacy, a card shop, video rentals, and an Olde World Cheese section. In-store floral shops range in size up to 80 square meters of floor space and offer a wide variety of fresh-cut flowers, flower arrangements, vases, and plants. In-store card shops cover over 100 square meters of floor space. The bulk foods department provides customers with the opportunity to select the quantities they desire from a vast array of foodstuffs and some nonfood items such as birdseed and pet food.

Each store is a little different. Among the special features in some stores are a dry cleaning department, a wokery, and a salad bar. Some stores feature a Market Café that has different food stations, each devoted to preparing and serving a certain type of food. For example, one station will have pizza and other Italian specialties, and another oriental food, and still another chicken or fish. There also will be a sandwich bar, a salad bar, and a dessert station. Customers often wander among stations as they decide what to order. In some Market Cafés, diners can have wine with their meals and have brunch on Sundays. In several affluent locations, customers can stop in on their way home from work and choose from a selection of freshly prepared dinner entrees such as medallions of beef with herb butter, chicken Marsala, stuffed flank steak with mushrooms, Cajun tuna, crab cakes, and accompaniments such as roasted red potatoes, grilled vegetables, and Caesar salad. Many Wegmans stores offer ready-made sandwiches as well as made-to-order sandwiches. Some stores have a coffee-shop section with tables and chairs where shoppers can enjoy regular or specialty coffees and a variety of tempting pastries.

*(continued)*



Wegmans Food Markets headquarters in Rochester, New York.



Wegmans' Patisserie is an authentic French pastry shop.

### Produce Department

The company prides itself on fresh produce. Produce is replenished as often as 12 times a day. The larger stores have produce sections that are four to five times the size of a produce section in an average supermarket. Wegmans offers locally grown produce in season. Wegmans uses a “farm to market” system whereby some local growers deliver their produce directly to individual stores, bypassing the main warehouse. That reduces the company’s inventory holding costs and gets the produce into the stores as quickly as possible. Growers may use specially designed containers that go right onto the store floor instead of large bins. This avoids the bruising that often occurs when fruits and vegetables are transferred from bins to display shelves and the need to devote labor to transfer the produce to shelves.

### Meat Department

In addition to large display cases of both fresh and frozen meat products, many stores have a full-service butcher shop that offers a variety of fresh meat products and where butchers are available to provide customized cuts of meat for customers.

Meat department employees attend Wegmans’ “Meat University,” where they learn about different cuts of meat and how to best prepare them. They also learn about other items to pair with various meats, and suggest side dishes, breads, and wine. This helps instill a “selling culture” among employees, who often spend 75 percent of their time talking with customers.

Wegmans continually analyzes store operations to improve processes. In the meat department, a change from in-store cutting and traditional packaging to using a centralized meat processing facility and vacuum packaging extended the shelf life of meats and reduced staffing requirements in meat departments, reducing costs and providing customers with an improved product.



Fresh seafood is delivered daily, often direct from boat to store the same day it was caught.

### Ordering

Each department handles its own ordering. Although sales records are available from records of items scanned at the checkouts, they are not used directly for replenishing stock. Other factors—such as pricing, special promotions, and local circumstances (e.g., festivals, weather conditions)—must all be taken into account. However, for seasonal periods, such as holidays, managers often check scanner records to learn what past demand was during a comparable period.

The superstores typically receive one truckload of goods per day from the main warehouse. During peak periods, a store may receive two truckloads from the main warehouse. The short lead time greatly reduces the length of time an item might be out of stock, unless the main warehouse is also out of stock.

The company exercises strict control over suppliers, insisting on product quality and on-time deliveries.

### Inventory Management

Wegmans uses a companywide system to keep track of inventory. Departments take a monthly inventory count to verify the amount shown in the companywide system. Departments receive a periodic report indicating how many days of inventory the department has on hand. Having an appropriate amount on hand is important to department managers: If they have too much inventory on hand, that will add to their department’s costs, whereas having too little inventory will result in shortages and thus lost sales and dissatisfied customers.

### Employees

The company recognizes the value of good employees. It typically invests an average of \$7,000 to train each new employee. In addition to learning about store operations, new employees learn the

*(continued)*



Wegmans’ chefs fill the Chef’s Case with ready-to-eat and ready-to-heat entrees, side dishes, and salads.

(concluded)

importance of good customer service and how to provide it. The employees are helpful, cheerfully answering customer questions or handling complaints. Employees are motivated through a combination of compensation, profit sharing, and benefits. Employee turnover for full-time workers is about 6 percent, compared to the industry average of about 20 percent.

### Quality

Quality and customer satisfaction are utmost in the minds of Wegmans management and its employees. Private-label food items as well as name brands are regularly evaluated in test kitchens, along with potential new products. Managers are responsible for checking and maintaining product and service quality in their departments. Moreover, employees are encouraged to report problems to their managers.

If a customer is dissatisfied with an item, and returns it, or even a portion of the item, the customer is offered a choice of a replacement or a refund. If the item is a Wegmans brand food item, it is then sent to the test kitchen to determine the cause of the problem. If the cause can be determined, corrective action is taken.

### Technology

Wegmans continues to adopt new technologies to maintain its competitive edge, including new approaches to tracking inventory and managing its supply chain, and new ways to maintain freshness in the meat and produce departments.

### Sustainability

In order to steer the business into a greener direction, Wegmans advocates the three “R’s” of the environment – Reduce, Reuse and Recycle. Wegmans saves energy by replacing the light fixtures to fluorescent lighting in all of its 4,000 distribution centers; conserving sufficient energy to power 470 homes for one year. On top of recycling 3 million pound of plastic bags and wrapping material in 2007, Wegmans also encourages its consumers to reuse paper or plastic bags for another purpose instead of disposing them or simply switch to reusable shopping bags. Sustainability has thus been added into the company’s priority list and Wegmans will continue to work on better practices and solutions for the long run.

### Questions

1. How do customers judge the quality of a supermarket?
2. Indicate how and why each of these factors is important to the successful operation of a supermarket:
  - a. Customer satisfaction.
  - b. Forecasting.
  - c. Capacity planning.
  - d. Location.
  - e. Inventory management.
  - f. Layout of the store.
  - g. Scheduling.
3. What are some of the ways Wegmans uses technology to gain an edge over its competition?

## SUMMARY

Operations management is responsible for producing goods and providing services. As such, it is the core function of every business organization. Operations management plans and coordinates the use of the organization’s resources to convert inputs into outputs.

Operations decisions involve design decisions and operating decisions. Design decisions are strategic; they relate to capacity planning, product design, process design, layout of facilities, and selecting locations for facilities. Operating decisions relate to quality assurance, scheduling, inventory management, and project management.

In for-profit organizations, effective operations management can lead to higher productivity, lower costs, higher quality, and other competitive advantages, and increased shareholder wealth. In not-for-profit organizations, effective operations management can lead to lower costs, higher levels of customer service, and more efficient use of resources.

The chapter also presents a brief overview of the historical evolution of operations management and it ends with a list of strategic issues that are currently high priority for business organizations. At the top of that list are the Internet and e-business, outsourcing, supply chain management, management of technology, and agility.

## KEY TERMS

agility, 28	model, 15
craft production, 22	operations management, 4
division of labor, 23	outsourcing, 27
e-business, 26	Pareto phenomenon, 18
e-commerce, 26	six sigma, 29
interchangeable parts, 23	supply chain, 27
lead time, 20	system, 17
lean production, 29	technology, 26
mass production, 23	value-added, 5

1. Briefly describe the term *operations management*.
2. Identify the three major functional areas of business organizations and briefly describe how they interrelate.
3. Describe the operations function and the nature of the operations manager's job.
4. List five important differences between goods production and service operations; then list five important similarities.
5. Briefly discuss each of these terms related to the historical evolution of operations management:
  - a. Industrial Revolution
  - b. Scientific management
  - c. Interchangeable parts
  - d. Division of labor
6. Why are services important? Why is manufacturing important? What are nonmanufactured goods?
7. What are models and why are they important?
8. Can you think of a business that doesn't have operations management?
9. List the trade-offs you would consider for each of these decisions:
  - a. Driving your own car versus public transportation.
  - b. Buying a computer now versus waiting for an improved model.
  - c. Buying a new car versus buying a used car.
  - d. Speaking up in class versus waiting to get called on by the instructor.
10. Describe each of these systems: craft production, mass production, and lean production.
11. Why might some workers prefer not to work in a lean production environment?
12. How has technological change affected you? Are there any downsides to technological change? Explain.
13. Identify some of the current trends in operations management and relate them to recent news items or to personal experience.
14. Why do people do things that are unethical?
15. Explain the term *value-added*.
16. Discuss the various impacts of outsourcing.

## DISCUSSION AND REVIEW QUESTIONS

This item appears at the end of each chapter. It is intended to focus your attention on three key issues for business organizations in general, and operations management in particular. Those issues are trade-off decisions, collaboration among various functional areas of the organization, and the impact of technology. You will see three or more questions relating to these issues. Here is the first set of questions:

1. What are trade-offs? Why is careful consideration of trade-offs important in decision making?
2. Why is it important for the various functional areas of a business organization to collaborate?
3. In what general ways does technology have an impact on operations management decision making?

## TAKING STOCK

This item also will appear in every chapter. It allows you to critically apply information you learned in the chapter to a practical situation. Here is the first exercise:

Many organizations offer a combination of goods and services to their customers. As you learned in this chapter, there are some key differences between production of goods and delivery of services. What are the implications of these differences relative to managing operations?

## CRITICAL THINKING EXERCISE

1. These exercises appear at the end of each chapter. They are designed to help you see the relevance of operations management firsthand.

Visit a fast food restaurant and answer these questions:

- a. In what ways is quality, or lack of quality, visible?
- b. What items must be stocked in addition to the food?
- c. How important do you think employee scheduling is? Explain.
- d. How might capacity decisions affect the success or failure of the restaurant?

## GROUP/ EXPERIENTIAL LEARNING EXERCISES



2. Form groups of three or four members, and appoint one member as the spokesperson who will communicate your findings to the class when called upon by the instructor. In your group, discuss the following scenario:

Due to the recent economic downturn, you and your partners are tasked with reducing costs in order to increase overall sustainability of the business. One suggestion brought up by the management board was to outsource parts of the operations function (e.g., purchasing, transportation, warehousing).

- a. As a group, discuss the role of the operations function in supporting business sustainability.
- b. How and in what areas can operations reduce costs?
- c. Debate the pros and cons of outsourcing operations. What are the major considerations for selecting areas in operations to outsource?

## Hazel

## CASE



Hazel had worked for the same Fortune 500 company for almost 15 years. Although the company had gone through some tough times, things were starting to turn around. Customer orders were up, and quality and productivity had improved dramatically from what they had been only a few years earlier due to a company-wide quality improvement program. So it came as a real shock to Hazel and about 400 of her coworkers when they were suddenly terminated following the new CEO's decision to downsize the company.

After recovering from the initial shock, Hazel tried to find employment elsewhere. Despite her efforts, after eight months of searching she was no closer to finding a job than the day she started. Her funds were being depleted and she was getting more discouraged. There was one bright spot, though: She was able to bring in a little money by mowing lawns for her neighbors. She got involved quite by chance when she heard one neighbor remark that now that his children were on their own, nobody was around to cut the grass. Almost jokingly, Hazel asked him how much he'd be willing to pay. Soon Hazel was mowing the lawns of five neighbors. Other neighbors wanted her to work on their lawns, but she didn't feel that she could spare any more time from her job search.

However, as the rejection letters began to pile up, Hazel knew she had to make a decision. On a sunny Tuesday morning, she decided, like many others in a similar situation, to go into business for herself—taking care of neighborhood lawns. She was relieved to give up the stress of job hunting, and she was excited about the prospect of being her own boss. But she was also fearful of being completely on her own. Nevertheless, Hazel was determined to make a go of it.

At first, business was a little slow, but once people realized Hazel was available, many asked her to take care of their lawns. Some people were simply glad to turn the work over to her; others switched from professional lawn care services. By the end of her first year in business, Hazel knew she could earn a living this way. She also performed other services such as fertilizing lawns, weeding

gardens, and trimming shrubbery. Business became so good that Hazel hired two part-time workers to assist her and, even then, she believed she could expand further if she wanted to.

### Questions

1. In what ways are Hazel's customers most likely to judge the quality of her lawn care services?
2. Hazel is the operations manager of her business. Among her responsibilities are forecasting, inventory management, scheduling, quality assurance, and maintenance.
  - a. What kinds of things would likely require forecasts?
  - b. What inventory items does Hazel probably have? Name one inventory decision she has to make periodically.
  - c. What scheduling must she do? What things might occur to disrupt schedules and cause Hazel to reschedule?
  - d. How important is quality assurance to Hazel's business? Explain.
  - e. What kinds of maintenance must be performed?
3. What are some of the trade-offs that Hazel probably considered relative to:
  - a. Working for a company instead of for herself?
  - b. Expanding the business?
  - c. Launching a Web site?
4. The town is considering an ordinance that would prohibit putting grass clippings at the curb for pickup because local landfills cannot handle the volume. What options might Hazel consider if the ordinance is passed? Name two advantages and two drawbacks of each option.
5. Hazel decided to offer the students who worked for her a bonus of \$25 for ideas on how to improve the business, and they provided several good ideas. One idea that she initially rejected now appears to hold great promise. The student who proposed the idea has left, and is currently working for a competitor. Should Hazel send that student a check for the idea? What are the possible trade-offs?

## Toyota Recalls 700,000 Vehicles in US Amid Safety Concerns

### CASE



As a byword for reliability and safety, Toyota conquered the ferociously competitive global car market to become the number one manufacturer in the world.

But the Japanese company that once could do no wrong suffered yet another blow to its battered reputation when it said it was recalling 681,500 vehicles in the US due to safety concerns.

Toyota has now recalled more than 10m vehicles in the past three years as a litany of technical problems have bedevilled a manufacturer once renowned as a pioneer of production knowhow. It has also seen operations devastated by last year's earthquake and tsunami in Japan and floods in Thailand, where many parts are made.

Pummelled by natural disasters, faulty vehicles and the high yen, which makes exports expensive, Toyota warned in December 2011 that profit would be less than half what it was in 2010. Sales have been hit hard, and the firm has lost market share to resurgent US rivals.

No longer is Toyota the largest carmaker in the world – General Motors had grabbed back the title it lost in 2008 after decades of American hegemony, while Germany's Volkswagen has overtaken Toyota in Europe and is winning awards for reliability and design.

Colin Couchman, a senior analyst at IHS Automotive, said: "The latest Toyota recalls are the last thing the company needs, as it undermines claims they have turned a corner and will attract the sort of attention the firm could do without."

He added: "Toyota has lost market share in North America, with the Koreans making gains when it comes to smaller vehicles, and GM lifting sales of trucks and SUVs.

"The playing field has evened out in America, with US companies coming up with a lineup so good they don't have to discount as much as they did."

Instead, the Japanese need to cut prices to claw back what they have lost. This is a relatively new dynamic and "it's going to be intriguing to see how it plays out," he said.

The latest recalls, disclosed by Toyota on Thursday, include about 495,000 Tacoma trucks, made between 2005 and 2009, which need to have their steering wheel spiral cable assemblies replaced.

Toyota said friction may occur between the assembly's spiral cable and the retainer in some vehicles and, over time, cut the connection to the driver's airbag.

In addition, it is recalling about 70,500 Camry sedans made during 2009 and about 116,000 Venza crossovers made between 2009 and 2011 to replace lamp switches.

The company said it would notify affected owners when it was obtaining replacement parts, which it would fit for free. It said it was not aware of any accidents or injuries caused by the problems.

The company's carefully cultivated image as safe and reliable has taken a beating. The setbacks have dented public confidence and left senior management embarrassed, culminating two years ago in an appearance by then chief executive Akio Toyoda before a US congressional committee, during which he apologised repeatedly for the faults. There were 14 separate recalls involving Toyota vehicles in 2010 alone.

In 2010, Toyota was fined \$32.4m (£20.9m) by the US government for failing to swiftly recall millions of vehicles with faulty brakes and steering. Those fines were the maximum allowed by law. Toyota paid another \$16.4m fine related to the recalls, bringing the total to \$48.8m.

Another investigation was prompted by the fatal crash of a California highway patrol officer, Mark Saylor, and his family. They died after reporting a stuck accelerator while driving a 2009 Lexus ES 350.

Despite its travails, Toyota has returned to normal production and seen a revival in its sales in the US, one of its biggest markets. According to the latest data, Toyota's US sales increased by 12% in February from a year earlier. Analysts said the upward trend was likely to continue in the coming months despite the latest recall.

But one problem that is not going away is the strength of yen, still relatively high against the dollar. A strong yen means a dip in the value of repatriated profits for big exporters such as Toyota, as well as putting their products at a competitive pricing disadvantage in export markets.

### Questions

1. What is the role of Operations on the reputation of Toyota in the article?
2. What areas in Operations should Toyota focus on to regain its global competitiveness?

Source: Richard Wachman, "Toyota Recalls 700,000 Vehicles in US Amid Safety Concerns," *The Guardian*, 3/8/2012. Copyright © Guardian News & Media Ltd 2010. Used with permission.

Bowie, Norman E., ed. *The Blackwell Guide to Business Ethics*. Malden, MA: Blackwell, 2002.

Colvin, Geoffrey. "Managing in the Info Era." *Fortune*, March 6, 2000, pp. F6–F9.

Crainger, Stuart. *The Management Century*. New York: Jossey-Bass, 2000.

Fitzsimmons, James, and Mona Fitzsimmons. *Service Management*, 4th ed. New York: McGrawHill/Irwin, 2004.

Hopp, William J., and Mark Spearman. *Factory Physics: Foundations of Manufacturing Management*, 2nd ed. Burr Ridge, IL: Irwin, 2001.

Shinn, Sharon. "What About the Widgets?" *BizEd*, November–December 2004, pp. 30–35.

Womack, James P., Daniel Jones, and Daniel Roos. *The Machine That Changed the World*. New York: Harper Perennial, 1991.

## SELECTED BIBLIOGRAPHY AND FURTHER READING