

1

CHAPTER

Introduction to Operations Management

1 Introduction to Operations Management

- 2 Competitiveness, Strategy, and Productivity
- 3 Forecasting
- 4 Product and Service Design
- 5 Strategic Capacity Planning for Products and Services
- 6 Process Selection and Facility Layout
- 7 Work Design and Measurement
- 8 Location Planning and Analysis
- 9 Management of Quality
- 10 Quality Control
- 11 Aggregate Planning and Master Scheduling
- 12 MRP and ERP
- 13 Inventory Management
- 14 JIT and Lean Operations
- 15 Supply Chain Management
- 16 Scheduling
- 17 Project Management
- 18 Management of Waiting Lines
- 19 Linear Programming

CHAPTER OUTLINE

- Introduction, 4
 - Production of Goods versus Delivery of Services, 7
- Process Management, 9
 - Managing a Process to Meet Demand, 10
 - Process Variation, 10
- The Scope of Operations Management, 11
- Why Learn about Operations Management?, 14
 - Career Opportunities and Professional Societies, 17
- Operations Management and Decision Making, 17
 - Models, 18
 - Quantitative Approaches, 19
 - Performance Metrics, 19
 - Analysis of Trade-Offs, 19
 - Degree of Customization, 20
 - A Systems Approach, 20
 - Establishing Priorities, 20

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 Identify similarities and differences between production and service operations.
- 4 Describe the operations function and the nature of the operations manager's job.

The Historical Evolution of Operations Management, 21

- The Industrial Revolution, 21
- Scientific Management, 21
- The Human Relations Movement, 23
- Decision Models and Management Science, 24
- The Influence of Japanese Manufacturers, 24

Operations Today, 24

Key Issues for Today's Business Operations 27

- Environmental Concerns 28
- Ethical Conduct 29
- The Need to Manage the Supply Chain, 30
- Elements of Supply Chain Management, 32

Operations Tour: Wegmans Food Markets, 33

Case: Hazel, 38

5 Summarize the two major aspects of process management.

6 Explain the key aspects of operations management decision making.

7 Briefly describe the historical evolution of operations management.

8 Characterize current trends in business that impact operations management.



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 and issues that impact operations management.

More specifically, you will learn about (1) the economic balance that every business organization seeks to achieve; (2) the condition that generally exists that makes achieving the economic balance challenging; (3) the line function that is the core of every business organization; (4) key steps in the history and evolution of operations management; (5) the differences and similarities between producing products and delivering services; (6) what a supply chain is, and why it is important to manage it; and (7) the key issues for today's business operations.

Recalls of automobiles, eggs, produce, toys, and other products; major oil spills; and even dysfunctional state legislatures are all examples of operations failures. They underscore the need for effective operations management.

INTRODUCTION

Goods Physical items produced by business organizations.

Services Activities that provide some combination of time, location, form, and psychological value.



Operations is that part of a business organization that is responsible for producing goods and/or services. **Goods** are physical items that include raw materials, parts, subassemblies such as motherboards that go into computers, and final products such as cell phones and automobiles. **Services** are activities that provide some combination of time, location, form, or psychological value. Examples of goods and services are found 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.

The ideal situation for a business organization is to achieve a match of supply and demand. Having excess supply or excess capacity is wasteful and costly; having too little means lost opportunity and possible customer dissatisfaction. The key functions on the supply side are operations and supply chains, and sales and marketing on the demand side.

While the operations function is responsible for producing products and/or delivering services, it needs the support and input from other areas of the organization. Business organizations have three basic functional areas, as depicted in Figure 1.1: finance, marketing, and operations. 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.

Operations and supply chains are intrinsically linked and no business organization could exist without both. 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 1.2. 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 1.3 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.

Operations management

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

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



SUPPLY CHAIN

FIGURE 1.1

The three basic functions of business organizations

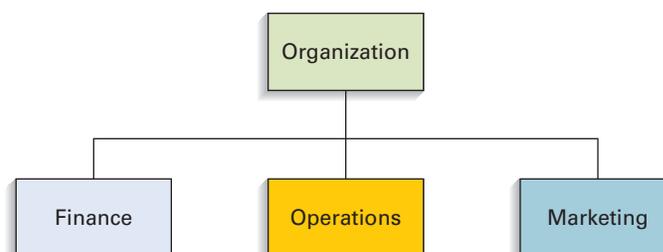




FIGURE 1.2
A simple product supply chain

Supply chains are both external and internal to the organization. The external parts of a supply chain provide raw materials, parts, equipment, supplies, and/or other inputs to the organization, and they deliver outputs that are goods to the organization’s customers. The internal parts of a supply chain are part of the operations function itself, supplying operations with parts and materials, performing work on products and/or services, and passing the work on to the next step in the process.

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, repairing). 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 1.4 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

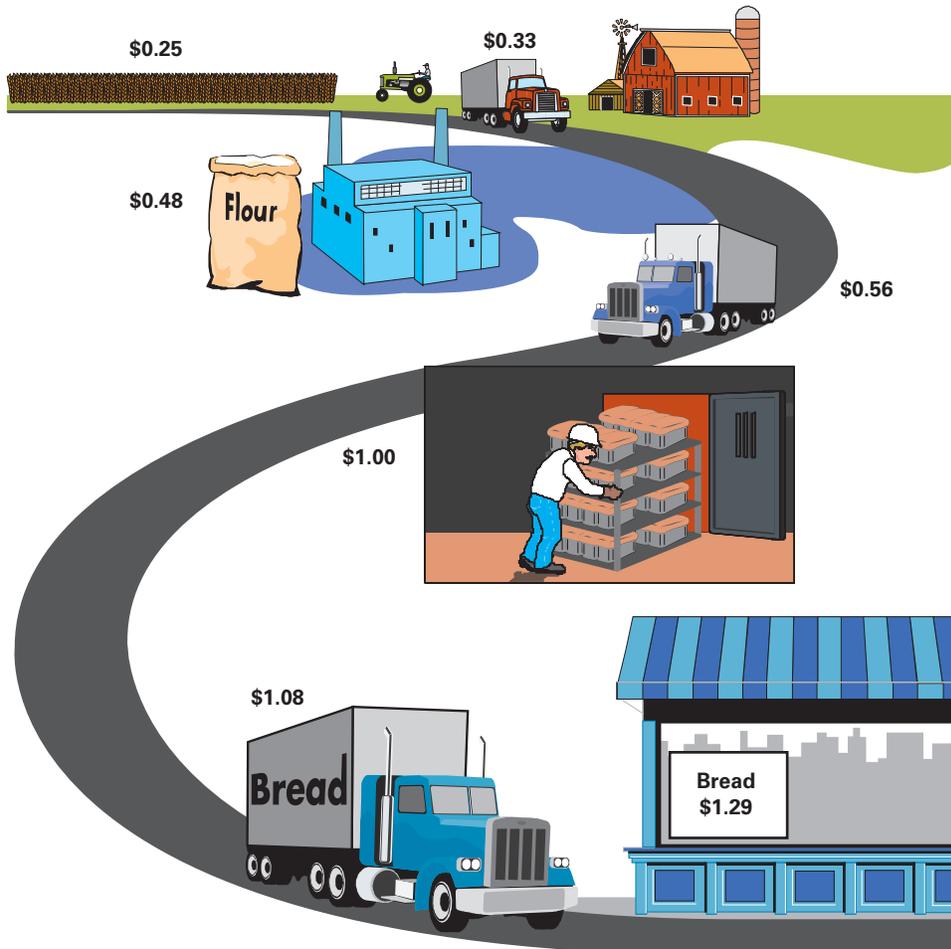
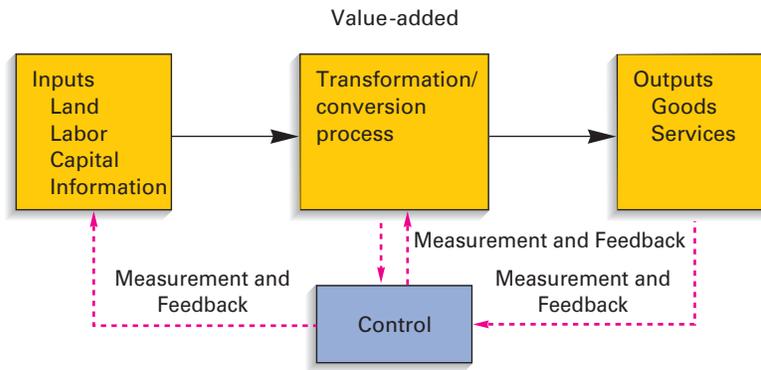


FIGURE 1.3
A supply chain for bread

FIGURE 1.4

The operations function involves the conversion of inputs into outputs



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 1.5 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.

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,

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

TABLE 1.1

Examples of inputs, transformation, and outputs

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
Water	Packing	Televisions
Metals	Copying, faxing	Food products
Wood	Analyzing	Textbooks
Equipment	Developing	CD players
Machines	Searching	High service percentage
Computers	Researching	Health care
Trucks	Repairing	Entertainment
Tools	Innovating	Car repair
Facilities	Debugging	Legal
Hospitals	Selling	Banking
Factories		Communication
Retail stores		
Energy		
Other		
Information		
Time		
Legal constraints		
Government regulations		

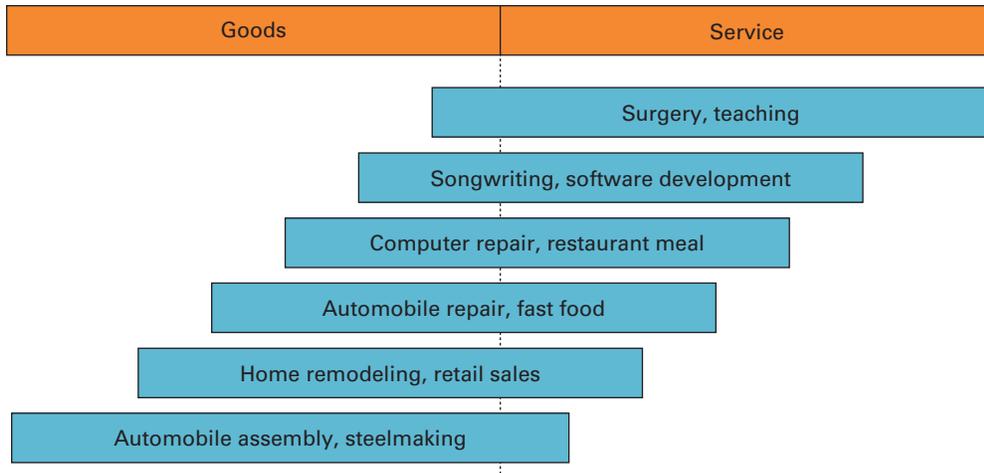


FIGURE 1.5
The goods–service continuum

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 can also be psychological, as in *branding*.

Many factors affect the design and management of operations systems. Among them are the degree of involvement of customers in the process and the degree to 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. There are also many similarities between the two.

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

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

TABLE 1.2
Illustrations of the transformation process

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:

- Professional services (e.g., financial, health care, legal).
- Mass services (e.g., utilities, Internet, communications).
- Service shops (e.g., tailoring, appliance repair, car wash, auto repair/maintenance).
- Personal care (e.g., beauty salon, spa, barbershop).
- Government (e.g., Medicare, mail, social services, police, fire).
- Education (e.g., schools, universities).
- Food service (e.g., restaurants, fast foods, catering, bakeries).
- Services within organizations (e.g., payroll, accounting, maintenance, IT, HR, janitorial).
- Retailing and wholesaling.
- Shipping and delivery (e.g., truck, railroad, boat, air).
- Residential services (e.g., lawn care, painting, general repair, remodeling, interior design).
- Transportation (e.g., mass transit, taxi, airlines, ambulance).
- Travel and hospitality (e.g., travel bureaus, hotels, resorts).
- Miscellaneous services (e.g., copy service, temporary help).

Manufacturing and service are often different in terms of *what* is done but quite similar in terms of *how* it is done.

Consider these points of comparison:

Degree of customer contact. Many services involve a high degree of customer contact, although services such as Internet providers, utilities, and mail service do not. When there is a high degree of contact, the interaction between server and customer becomes a “moment of truth” that will be judged by the customer every time the service occurs.

Labor content of jobs. Services often have a higher degree of labor content than manufacturing jobs do, although automated services are an exception.

Uniformity of inputs. Service operations are often subject to a higher degree of variability of inputs. Each client, patient, customer, repair job, and so on presents a somewhat unique situation that requires assessment and flexibility. Conversely, manufacturing operations often have a greater ability to control the variability of inputs, which leads to more-uniform job requirements.

Measurement of productivity. Measurement of productivity can be more difficult for service jobs due largely to the high variations of inputs. Thus, one doctor might have a higher level of routine cases to deal with, while another might have more-difficult cases. Unless a careful analysis is conducted, it may appear that the doctor with the difficult cases has a much lower productivity than the one with the routine cases.

Quality assurance. Quality assurance is usually more challenging for services due to the higher variation in input, and because delivery and consumption occur at the same time. Unlike manufacturing, which typically occurs away from the customer and allows



mistakes that are identified to be corrected, services have less opportunity to avoid exposing the customer to mistakes.

Inventory. Many services tend to involve less use of inventory than manufacturing operations, so the costs of having inventory on hand are lower than they are for manufacturing. However, unlike manufactured goods, services cannot be stored. Instead, they must be provided “on demand.”

Wages. Manufacturing jobs are often well paid, and have less wage variation than service jobs, which can range from highly paid professional services to minimum-wage workers.

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

There are also many similarities between managing the production of products and managing services. In fact, most of the topics in this book pertain to both. When there are important service considerations, these are highlighted in separate sections. Here are some of the primary factors for both:

- a. Forecasting and capacity planning to match supply and demand.
- b. Process management.
- c. Managing variations.
- d. Monitoring and controlling costs and productivity.
- e. Supply chain management.
- f. Location planning, inventory management, quality control, and scheduling.

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 provides an overview of the differences between production of goods and service operations. Remember, though, that most systems involve a blend of goods and services.



PROCESS MANAGEMENT

A key aspect of operations management is process management. A **process** consists of one or more actions that transform inputs into outputs. In essence, the central role of all management is process management.

process One or more actions that transform inputs into outputs.

Characteristic	Goods	Services
Output	Tangible	Intangible
Customer contact	Low	High
Labor content	Low	High
Uniformity of input	High	Low
Measurement of productivity	Easy	Difficult
Opportunity to correct problems before delivery	High	Low
Inventory	Much	Little
Wages	Narrow range	Wide range
Patentable	Usually	Not usually

TABLE 1.3
Typical differences between production of goods and provision of services

Businesses are composed of many interrelated processes. Generally speaking, there are three categories of business processes:

1. **Upper-management processes.** These govern the operation of the entire organization. Examples include organizational governance and organizational strategy.
2. **Operational processes.** These are the core processes that make up the value stream. Examples include purchasing, production and/or service, marketing, and sales.
3. **Supporting processes.** These support the core processes. Examples include accounting, human resources, and IT (information technology).

Business processes, large and small, are composed of a series of supplier–customer relationships, where every business organization, every department, and every individual operation is both a customer of the previous step in the process and a supplier to the next step in the process. Figure 1.6 illustrates this concept.

A major process can consist of many subprocesses, each having its own goals that contribute to the goals of the overall process. Business organizations and supply chains have many such processes and subprocesses and they benefit greatly when management is using a process perspective. Business process management (BPM) activities include process design, process execution, and process monitoring. Two basic aspects of this for operations and supply chain management are managing processes to meet demand and dealing with process variability.



Managing a Process to Meet Demand

Ideally, the capacity of a process will be such that its output just matches demand. Excess capacity is wasteful and costly; too little capacity means dissatisfied customers and lost revenue. Having the right capacity requires having accurate forecasts of demand, the ability to translate forecasts into capacity requirements, and a process in place capable of meeting expected demand. Even so, process variation and demand variability can make the achievement of a match between process output and demand difficult. Therefore, to be effective, it is also necessary for managers to be able to deal with variation.

Process Variation

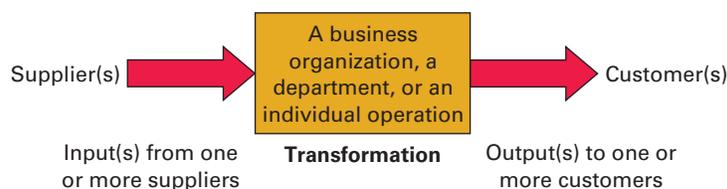
Variation occurs in all business processes. It can be due to variety or variability. For example, random variability is inherent in every process; it is always present. In addition, variation can occur as the result of deliberate management choices to offer customers variety.

There are four basic sources of variation:

1. **The variety of goods or services being offered.** The greater the variety of goods and services, the greater the variation in production or service requirements.
2. **Structural variation in demand.** These variations, which include trends and seasonal variations, are generally predictable. They are particularly important for capacity planning.
3. **Random variation.** This natural variability is present to some extent in all processes, as well as in demand for services and products, and it cannot generally be influenced by managers.
4. **Assignable variation.** These variations are caused by defective inputs, incorrect work methods, out-of-adjustment equipment, and so on. This type of variation can be reduced or eliminated by analysis and corrective action.

FIGURE 1.6

Business processes form a sequence of suppliers and customers



Variations can be disruptive to operations and supply chain processes, interfering with optimal functioning. Variations result in additional cost, delays and shortages, poor quality, and inefficient work systems. Poor quality and product shortages or service delays can lead to dissatisfied customers and damage an organization's reputation and image. It is not surprising, then, that the ability to deal with variability is absolutely necessary for managers.

Throughout this book, you will learn about some of the tools managers use to deal with variation. An important aspect of being able to deal with variation is to use metrics to describe it. Two widely used metrics are the *mean* (average) and the *standard deviation*. The standard deviation quantifies variation around the mean. The mean and standard deviation are used throughout this book in conjunction with variation. So, too, is the normal distribution. Because you will come across many examples of how the normal distribution is used, you may find the overview on working with the normal distribution in the appendix at the end of the book helpful.

THE SCOPE OF OPERATIONS MANAGEMENT

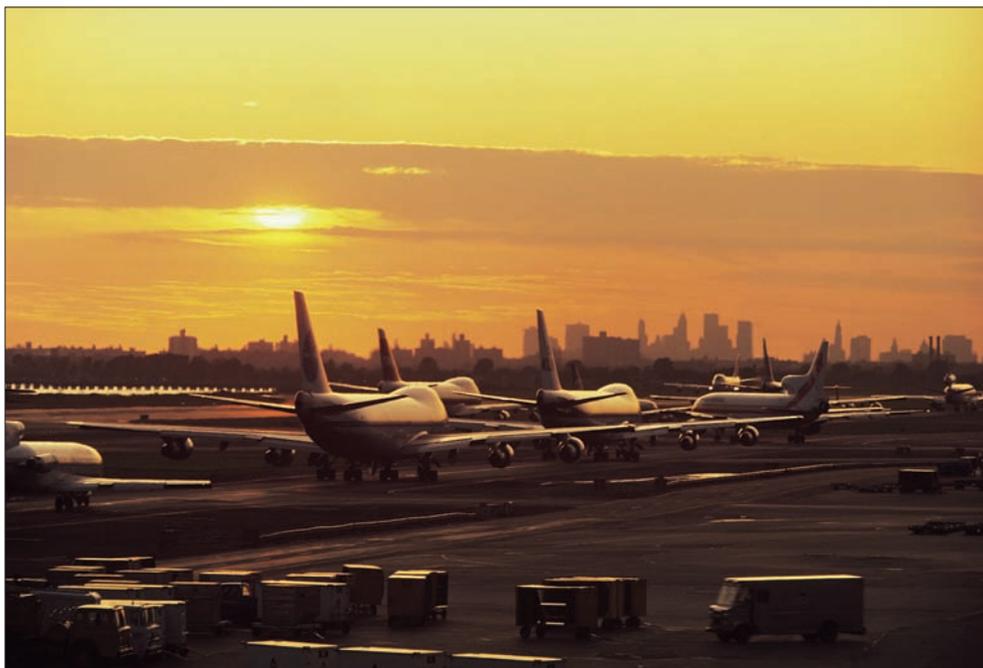
The scope of operations management ranges across the organization. Operations management people are involved in product and service design, process selection, selection and management of technology, design of work systems, location planning, facilities planning, and quality improvement of the organization's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

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 planes, cargo, and flight and ground crews is an operations function for an airline.

Facilities and layout, important in achieving effective use of workers and equipment.

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 curb 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 it might 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 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*.



SERVICE

A worker is making the bottom bracket lug for a Trek OCLV carbon road bike at Trek Bicycle Company in Waterloo, Wisconsin, world headquarters for Trek. 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.



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.

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.

A number of other areas are part of, or support, 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 service sector and the manufacturing sector are both important to the economy. The service sector now accounts for more than 70 percent of jobs in the United States, and it is growing in other countries as well. Moreover, the number of people working in services is increasing, while the number of people working in manufacturing is not. (See Figure 1.7.) The reason for the decline in manufacturing jobs is twofold: As the operations function in manufacturing companies finds more productive ways of 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.

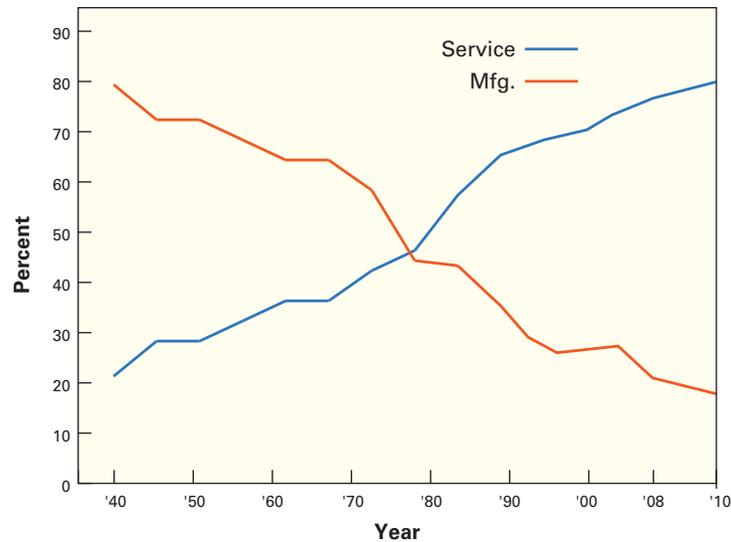
The reading on page 14 gives another reason for the importance of manufacturing jobs.



FIGURE 1.7

U.S. manufacturing versus service employment, 1940–2010

Source: U.S. Bureau of Labor Statistics.



Why Manufacturing Matters

READING



The U.S. economy is becoming more and more service-based. The percentage of employment in manufacturing continues to decrease while the percentage employed in services continues to increase. However, it would be unwise to assume that manufacturing isn't important to the economy, or that service is more important. Let's see why.

Not only is the percentage of manufacturing jobs decreasing, but the actual number of manufacturing jobs is also decreasing. There are two main reasons for the decline: increases in productivity which means fewer workers are needed to maintain manufacturing output; and outsourcing, especially to countries that have much lower wages, an attractive option for companies seeking to maintain their competitiveness and boost their bottom lines.

However, when companies outsource part (or in some cases, all) of their manufacturing to lower-cost countries, the loss of jobs results in the loss of service jobs as well. Some are lost in the community in retail businesses patronized by the manufacturing workers. Also included in that figure are factory service workers (e.g., workers who do machine repairs, maintenance, material handling, packaging, and so on). General estimates are that three service jobs are lost for each manufacturing job lost.

As the manufacturing base shrinks, workers who lose their manufacturing job are finding it tougher to find another opening in

manufacturing. Instead they join the ranks of the unemployed, or take a service job, usually at a lower wage rate than what manufacturing paid.

From a national perspective, not only is work transferred to a foreign country, intellectual knowledge is transferred. Moreover, as time passes, the domestic base of manufacturing skills and know-how is lost.

There are important consequences for taxes as well. Unemployment benefits are costly, and the erosion of federal, state, and local tax bases results in lower tax revenues collected from individuals and from corporations.

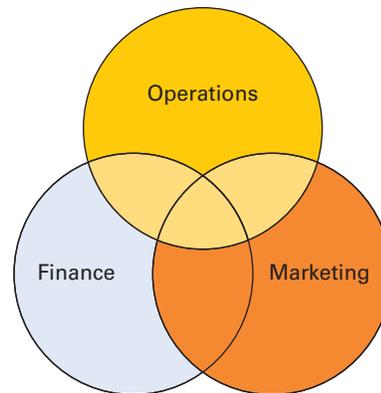
At the Montana Economic Development Summit in Butte, Montana on Monday, September 13, 2010, GE CEO Jeffery Immelt said that since the 1970s the economy has been driven by consumer credit and a misguided notion of building a service economy. "It was just wrong. It was stupid. It was insane," Immelt said of the push for a service-based economy. Instead, he said, in the future the economy has to be as an exporter, and that manufacturing, with an aim to reduce the trade deficit, is the key.

Questions

1. How important is the loss of manufacturing jobs to the nation?
2. Can you suggest some actions the government (federal, state, or local) can take to stem the job loss?

WHY LEARN ABOUT OPERATIONS MANAGEMENT?

There are many career-related reasons for wanting to learn about operations management, whether you plan to work in the field of operations or not. This is because every aspect of business affects or is affected by operations. Operations and sales are the two line functions

**FIGURE 1.8**

The three major functions of business organizations overlap

in a business organization. All other functions—accounting, finance, marketing, IT, and so on—support the two line functions. Among the service jobs that are closely related to operations are financial services (e.g., stock market analyst, broker, investment banker, and loan officer), marketing services (e.g., market analyst, marketing researcher, advertising manager, and product manager), accounting services (e.g., corporate accountant, public accountant, and budget analyst), and information services (e.g., corporate intelligence, library services, management information systems design services).

Apart from the career-related reasons is a not so obvious one: Through learning about operations and supply chains, you will have a much better understanding of the world you live in, the global dependencies of companies and nations, some of the reasons that companies succeed or fail, and the importance of working with others.

Working together successfully means that all members of the organization understand not only their own role, but 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 every business organization, 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 1.8.

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 1.9.

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.

FIGURE 1.9

Operations interfaces with a number of supporting functions



Career Opportunities and Professional Societies

There are many career opportunities in the operations management and supply chain fields. 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.

APICS, the Association for Operations Management
8430 West Bryn Mawr Avenue, Suite 1000, Chicago, Illinois 60631 www.apics.org

American Society for Quality (ASQ)
230 West Wells Street, Milwaukee, Wisconsin 53203 www.asq.org

Institute for Supply Management (ISM)
2055 East Centennial Circle, Tempe, Arizona 85284 www.ism.ws

Institute for Operations Research and the Management Sciences (INFORMS)
901 Elkridge Landing Road, Linthicum, Maryland 21090-2909 www.informs.org

The Production and Operations Management Society (POMS)
College of Engineering, Florida International University, EAS 2460,
10555 West Flagler Street, Miami, Florida 33174 www.poms.org

The Project Management Institute (PMI)
4 Campus Boulevard, Newtown Square, Pennsylvania 19073-3299 www.pmi.org

Council of Supply Chain Management Professionals (CSCMP)
333 East Butterfield Road, Suite 140, Lombard, Illinois 60148 <http://cscmp.org>

APICS, ASQ, ISM, and other professional societies offer a practitioner certification examination that can enhance your qualifications. Information about job opportunities can be obtained from all of these societies as well as from other sources, such as the Decision Sciences Institute (University Plaza, Atlanta, Georgia 30303) and the Institute of Industrial Engineers (25 Technology Park, Norcross, Georgia 30092).

OPERATIONS MANAGEMENT AND DECISION MAKING

The chief role of an operations manager is that of planner/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

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

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 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 assumptions or conditions under which the model is valid. Failure to satisfy all of the assumptions 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 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 those techniques.

Although quantitative approaches are widely used 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, flexibility, assets, inventories, schedules, and forecast accuracy. As you read each chapter, note the metrics being used and how they are applied 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.

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.

Degree of Customization

A major influence on the entire organization is the degree of customization of products or services being offered to its customers. Providing highly customized products or services such as home remodeling, plastic surgery, and legal counseling tends to be more labor intensive than providing standardized products such as those you would buy “off the shelf” at a mall store or a supermarket or standardized services such as public utilities and Internet services. Furthermore, production of customized products or provision of customized services is generally more time consuming, requires more highly skilled people, and involves more flexible equipment than what is needed for standardized products or services. Customized processes tend to have a much lower volume of output than standardized processes, and customized output carries a higher price tag. The degree of customization has important implications for process selection and job requirements. The impact goes beyond operations and supply chains. It affects marketing, sales, accounting, finance, and information systems.

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 facts 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.



The big picture—a Systems view.

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 issues or items are more important than others. Recognizing this enables the managers to direct their efforts to where they will do the most good.

Typically, a relatively few issues or items are very important, so that dealing with those factors will generally have a disproportionately large impact on the results achieved. This well-known effect is referred to as the **Pareto phenomenon**. The implication is that a manager should examine each situation, searching for the few factors that will have



SUPPLY CHAIN

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

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.

THE HISTORICAL EVOLUTION OF OPERATIONS MANAGEMENT

Systems for production have existed since ancient times. 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 in 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. 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.

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

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 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

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

Row of "Tin Lizzies," or Model T's, being manufactured on the Ford assembly line.



An Assembly Line
of the
Ford Motor Company

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.

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.

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.

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.

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 order size. 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, due in part to the influence of Americans W. Edwards Deming and Joseph Juran. 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 spawning the “quality revolution” that occurred in industrialized countries, and with generating widespread interest in lean 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 1.4 provides a chronological summary of some of the key developments in the evolution of operations management.

OPERATIONS TODAY

Advances in information technology and global competition have had a major influence on operations management. While the *Internet* offers great potential for business organizations, 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.

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.

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.

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 ordering	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
1980s	Emphasis on flexibility, time-based competition, lean production	T. Ohno, S. Shingo, Toyota
1980s	Emphasis on quality	W. Edwards Deming, J. Juran, K. Ishikawa
1990s	Internet, supply chain management	Numerous
2000s	Applications service providers and outsourcing	Numerous

TABLE 1.4

Historical summary of operations management

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 North American Free Trade Agreement (NAFTA) opened borders for trade between the United States and Canada and Mexico. The General Agreement on Tariffs and Trade (GATT) of 1994 reduced tariffs and subsidies in many countries, expanding world trade. The resulting global competition and global markets have 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.

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.

Competitive pressures and changing economic conditions have caused business organizations to put more emphasis on

Operations strategy.

Working with fewer resources.

Revenue management.

Process analysis and improvement, and quality improvement.

Agility

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; Union Carbide was able to cut \$400 million of fixed expenses; and Bell Atlantic was able to cut the time needed to hook up long-distance carriers from 15 days to less than 1, at a savings of \$82 million.

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

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

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

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.

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 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. This approach has now spread to services, including health care, offices, and shipping and delivery.

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 an operation 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.

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

KEY ISSUES FOR TODAY'S BUSINESS OPERATIONS

There are a number of issues that are high priorities of many business organizations. Although not every business is faced with these issues, many are. Chief among the issues are the following:

Economic conditions. The lingering recession and slow recovery in various sectors of the economy has made managers cautious about investment and rehiring workers that had been laid off during the recession.

Innovating. Finding new or improved products or services are only two of the many possibilities that can provide value to an organization. Innovations can be made in processes, the use of the Internet, or the supply chain that reduce costs, increase productivity, expand markets, or improve customer service.

Quality problems. The numerous operations failures mentioned at the beginning of the chapter underscore the need to improve the way operations are managed. That relates to product design and testing, oversight of suppliers, risk assessment, and timely response to potential problems.

Risk management. The need for managing risk is underscored by recent events that include the crisis in housing, product recalls, oil spills, and natural and man-made disasters, and economic ups and downs. Managing risks starts with identifying risks, assessing



SUPPLY CHAIN

vulnerability and potential damage (liability costs, reputation, demand), and taking steps to reduce or share risks.

Competing in a global economy. Low labor costs in third-world countries have increased pressure to reduce labor costs. Companies must carefully weigh their options, which include outsourcing some or all of their operations to low-wage areas, reducing costs internally, changing designs, and working to improve productivity.

Three other key areas require more in-depth discussion: environmental concerns, ethical conduct, and managing the supply chain.

Environmental Concerns

Concern about global warming and pollution has had an increasing effect on how businesses operate.

Stricter environmental regulations, particularly in developed nations, are being imposed. Furthermore, business organizations are coming under increasing pressure to reduce their carbon footprint (the amount of carbon dioxide generated by their operations and their supply chains) and to generally operate sustainable processes. **Sustainability** refers to service and production processes that use resources in ways that do not harm ecological systems that support both current and future human existence. Sustainability measures often go beyond traditional environmental and economic measures to include measures that incorporate social criteria in decision making.

All areas of business will be affected by this. Areas that will be most affected include product and service design, consumer education programs, disaster preparation and response, supply chain waste management, and outsourcing decisions. Note that outsourcing of goods production increases not only transportation costs, but also fuel consumption and carbon released into the atmosphere. Consequently, sustainability thinking may have implications for outsourcing decisions.

Because they all fall within the realm of operations, operations management is central to dealing with these issues. Sometimes referred to as “green initiatives,” the possibilities include reducing packaging, materials, water and energy use, and the environmental impact of the supply chain, including buying locally. Other possibilities include reconditioning used equipment (e.g., printers and copiers) for resale, and recycling.

Sustainability Using resources in ways that do not harm ecological systems that support human existence.

Puma's “Clever Little Bag” changes the idea of the shoebox by wrapping footwear in a cardboard structure with 65 percent less cardboard. It uses a bag made of recycled plastic as the outer layer that holds the inner cardboard structure together. Puma expects to cut carbon dioxide emissions by 10,000 tons per year and water, energy, and diesel use by 60 percent by using fewer materials—8,500 fewer tons of paper to be specific—and the new packaging's lighter weight.



Universities Embrace Sustainability

READING



Universities and colleges are increasingly embracing sustainability, linking it to global warming, biodiversity, and global commerce. Some are building sustainability into existing courses, while others are offering new courses, certificate programs, or degree programs. And some, such as Arizona State University and the Rochester Institute of Technology, are offering advanced degree programs.

Some universities are also “practicing what they preach,” by applying sustainable practices in their operations. Among them

are Dartmouth College, Harvard University, Stanford, Williams College, and the University of British Columbia, which was named by the environmental magazine *Grist* as one of the top 15 universities in the world in reducing greenhouse gas emissions and being energy efficient.

Source: Based on “The Sustainable University: Saving the Planet by Degrees,” *Chronicle of Higher Education*, Special Report, October 20, 2006, Stanford News Service, January 2007, and “B.C.’s School of Greener Learning,” *Toronto Globe and Mail*, August 25, 2007, p. A6.

The following reading suggests that even our choice of diet can affect the environment.

Diet and the Environment: Vegetarian vs. Nonvegetarian

READING



It is interesting to examine the environmental impact of dietary choices. There’s ample evidence that agricultural practices pollute the soil, air, and water. Factors range from the distance food travels to get to the consumer, to the amount of water and fertilizer used. Of particular concern is the environmental impact of a diet high in animal protein. The Food and Agricultural Organization (FAO) of the United Nations recently reported that livestock production is one of the major causes of global warming and air and water pollution. Using a methodology that considers the entire supply chain, the FAO estimated that livestock accounts for 18 percent of greenhouse gas emissions.

A Vegetarian versus Nonvegetarian Diet and the Environment The eco-friendliness of a meat eater’s diet was

the subject of a “study conducted by researchers from the Departments of Environmental Health and Nutrition of Loma Linda University in California. They compared the environmental effects of a vegetarian vs. nonvegetarian diet in California in terms of agricultural production inputs, including pesticides and fertilizers, water and energy.

“The study results showed that for the combined production of 11 food items the nonvegetarian diet required 2.9 times more water, 2.5 times more primary energy, 13 times more fertilizer, and 1.4 times more pesticides than did the vegetarian diet. The biggest differences came from including beef in the diet.”

Source: Based on “Finding a Scientific Connection Between Food Choices and the Environment,” *Environmental Nutrition Newsletter*, October 2009, p. 3.

Ethical Conduct

The need for ethical conduct in business is becoming increasingly obvious, given numerous examples of questionable actions in recent history. 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.



The Fair Trade Certified™ label guarantees to consumers that strict economic, social, and environmental criteria were met in the production and trade of an agricultural product.

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.

Ethics A standard of behavior that guides how one should act in various situations.

Many organizations have developed *codes of ethics* to guide employees' or members' conduct. **Ethics** is a standard of behavior that guides how one should act in various situations. The Markula Center for Applied Ethics at Santa Clara University identifies five principles for thinking ethically:

- The **Utilitarian Principle** is that the good done by an action should outweigh any harm it causes. An example is not allowing a person who has had too much to drink to drive.
- The **Rights Principle** is that actions should respect and protect the moral rights of others. An example is not taking advantage of a vulnerable person.
- The **Fairness Principle** is that equals should be held to, or evaluated by, the same standards. An example is equal pay for equal work.
- The **Common Good Principle** is that actions should contribute to the common good of the community. An example is an ordinance on noise abatement.
- The **Virtue Principle** is that actions should be consistent with certain ideal virtues. Examples include honesty, compassion, generosity, tolerance, fidelity, integrity, and self-control.

Ethical framework

A sequence of steps intended to guide thinking and subsequent decision or action.

The center expands these principles to create a framework for ethical conduct. An **ethical framework** is a sequence of steps intended to guide thinking and subsequent decisions or actions. Here is the one developed by the Markula Center for Applied Ethics:

1. Recognize an ethical issue by asking if an action could be damaging to a group or an individual. Is there more to it than just what is legal?
2. Make sure the pertinent facts are known, such as who will be impacted, and what options are available.
3. Evaluate the options by referring to each of the preceding five ethical principles.
4. Identify the "best" option and then further examine it by asking how someone you respect would view it.
5. In retrospect, consider the effect your decision had and what you can learn from it.

More detail is available at the Center's Web site: <http://www.scu.edu/ethics/practicing/decision/framework.html>.

The Need to Manage the Supply Chain

Supply chain management is being given increasing attention as business organizations face mounting pressure to improve management of their supply chains. In the past, most organizations did little to manage their supply chains. Instead, they tended to concentrate on their own



Chinese-made Mr. Cool tainted toothpaste is displayed at the Ministry of Health in San Jose, Costa Rica. China said it was investigating reports that toothpaste containing a potentially deadly chemical had been exported to Central America, one in a series of scandals involving tainted Chinese products. Costa Rica has ordered the removal of Chinese toothpaste and other brands from store shelves.

operations and on their immediate suppliers. Moreover, the planning, marketing, production and inventory management functions in organizations in supply chains have often operated independently of each other. As a result, supply chains experienced a range of problems that were seemingly beyond the control of individual organizations. The problems included large oscillations of inventories, inventory stockouts, late deliveries, and quality problems. These and other issues now make it clear that management of supply chains is essential to business success. The other issues include the following:

1. **The need to improve operations.** During the last decade, many organizations adopted practices such as lean operation and total quality management (TQM). As a result, they were able to achieve improved quality while wringing much of the excess costs out of their systems. Although there is still room for improvement, for many organizations, the major gains have been realized. Opportunity now lies largely with procurement, distribution, and logistics—the supply chain.

2. **Increasing levels of outsourcing.** Organizations are increasing their levels of **outsourcing**, buying goods or services instead of producing or providing them themselves. As outsourcing increases, organizations are spending increasing amounts on supply-related activities (wrapping, packaging, moving, loading and unloading, and sorting). A significant amount of the cost and time spent on these and other related activities may be unnecessary. Issues with imported products, including tainted food products, toothpaste, and pet foods, as well as unsafe tires and toys, have led to questions of liability and the need for companies to take responsibility for monitoring the safety of outsourced goods.

3. **Increasing transportation costs.** Transportation costs are increasing, and they need to be more carefully managed.

4. **Competitive pressures.** Competitive pressures have led to an increasing number of new products, shorter product development cycles, and increased demand for customization. And in some industries, most notably consumer electronics, product life cycles are relatively short. Added to this are adoption of quick-response strategies and efforts to reduce lead times.

5. **Increasing globalization.** Increasing globalization has expanded the physical length of supply chains. A global supply chain increases the challenges of managing a supply chain. Having far-flung customers and/or suppliers means longer lead times and greater opportunities for disruption of deliveries. Often currency differences and monetary fluctuations are factors, as well as language and cultural differences. Also, tightened border security in some instances has slowed shipments of goods.

Outsourcing Buying goods or services instead of producing or providing them in-house.

6. **Increasing importance of e-business.** The increasing importance of e-business has added new dimensions to business buying and selling and has presented new challenges.

7. **The complexity of supply chains.** Supply chains are complex; they are dynamic, and they have many inherent uncertainties that can adversely affect them, such as inaccurate forecasts, late deliveries, substandard quality, equipment breakdowns, and canceled or changed orders.

8. **The need to manage inventories.** Inventories play a major role in the success or failure of a supply chain, so it is important to coordinate inventory levels throughout a supply chain. Shortages can severely disrupt the timely flow of work and have far-reaching impacts, while excess inventories add unnecessary costs. It would not be unusual to find inventory shortages in some parts of a supply chain and excess inventories in other parts of the same supply chain.

Elements of Supply Chain Management

Supply chain management involves coordinating activities across the supply chain. Central to this is taking customer demand and translating it into corresponding activities at each level of the supply chain.

The key elements of supply chain management are listed in Table 1.5. The first element, customers, is the driving element. Typically, marketing is responsible for determining what customers want as well as forecasting the quantities and timing of customer demand. Product and service design must match customer wants with operations capabilities.

Processing occurs in each component of the supply chain: it is the core of each organization. The major portion of processing occurs in the organization that produces the product or service for the final customer (the organization that assembles the computer, services the car, etc.). A major aspect of this for both the internal and external portions of a supply chain is scheduling.

Inventory is a staple in most supply chains. Balance is the main objective; too little causes delays and disrupts schedules, but too much adds unnecessary costs and limits flexibility.

Purchasing is the link between an organization and its suppliers. It is responsible for obtaining goods and or services that will be used to produce products or provide services for the organization’s customers. Purchasing selects suppliers, negotiates contracts, establishes alliances, and acts as liaison between suppliers and various internal departments.

The supply portion of a value chain is made up of one or more suppliers, all links in the chain, and each one capable of having an impact on the effectiveness—or the ineffectiveness—of the supply chain. Moreover, it is essential that the planning and execution be carefully coordinated between suppliers and all members of the demand portion of their chains.



TABLE 1.5
Elements of supply chain management

Element	Typical Issues	Chapter(s)
Customers	Determining what products and/or services customers want	3, 4
Forecasting	Predicting the quantity and timing of customer demand	3
Design	Incorporating customers, wants, manufacturability, and time to market	4
Capacity planning	Matching supply and demand	5, 11
Processing	Controlling quality, scheduling work	10, 16
Inventory	Meeting demand requirements while managing the costs of holding inventory	12, 13, 14
Purchasing	Evaluating potential suppliers, supporting the needs of operations on purchased goods and services	15
Suppliers	Monitoring supplier quality, on-time delivery, and flexibility; maintaining supplier relations	15
Location	Determining the location of facilities	8
Logistics	Deciding how to best move information and materials	15

Location can be a factor in a number of ways. Where suppliers are located can be important, as can location of processing facilities. Nearness to market, nearness to sources of supply, or nearness to both may be critical. Also, delivery time and cost are usually affected by location.

Two types of decisions are relevant to supply chain management—strategic and operational. The strategic decisions are the design and policy decisions. The operational decisions relate to day-to-day activities: managing the flow of material and product and other aspects of the supply chain in accordance with strategic decisions.

The major decision areas in supply chain management are location, production, distribution, and inventory. The *location* decision relates to the choice of locations for both production and distribution facilities. Production and transportation costs and delivery lead times are important. *Production* and *distribution* decisions focus on what customers want, when they want it, and how much is needed. Outsourcing can be a consideration. Distribution decisions are strongly influenced by transportation cost and delivery times, because transportation costs often represent a significant portion of total cost. Moreover, shipping alternatives are closely tied to production and inventory decisions. For example, using air transport means higher costs but faster deliveries and less inventory in transit than sea, rail, or trucking options. Distribution decisions must also take into account capacity and quality issues. Operational decisions focus on scheduling, maintaining equipment, and meeting customer demand. Quality control and workload balancing are also important considerations. *Inventory* decisions relate to determining inventory needs and coordinating production and stocking decisions throughout the supply chain. Logistics management plays the key role in inventory decisions.

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.

Wegmans Food Markets

OPERATIONS TOUR



SERVICE

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 40-foot display case), a 500-square-foot 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 800 square feet of floor space and offer a wide variety of fresh-cut flowers, flower arrangements, vases, and plants. In-store card shops cover over 1,000 square feet 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.

(continued)

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.

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.

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.

(continued)



Wegmans' Patisserie is an authentic French pastry shop.

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 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

Wegmans began replacing incandescent light bulbs with compact fluorescent bulbs in 2007, and the company expects this will result in generating 3,000 fewer tons of carbon dioxide each year. Also the company installed sensors in its dairy cases that reduced the time the cooling systems run by 50 percent.

(continued)



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



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

*(concluded)***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

The operations function in business organizations is responsible for producing goods and providing services. It is a core function of every business. Supply chains are the sequential system of suppliers and customers that begins with basic sources of inputs and ends with final customers of the system. Operations and supply chains are interdependent—one couldn't exist without the other, and no business organization could exist without both.

Operations management involves system design and operating decisions related to product and service design, capacity planning, process selection, location selection, work management, inventory and supply management, production planning, quality assurance, scheduling, and project management.

The historical evolution of operations management provides interesting background information on the continuing evolution of this core business function.

The Operations Tours and Readings included in this and subsequent chapters provide insights into actual business operations.

KEY POINTS

1. The operations function is that part of every business organization that produces products and/or delivers services.
2. Operations consists of processes that convert inputs into outputs. Failure to manage those processes effectively will have a negative impact on the organization.
3. A key goal of business organizations is to achieve an economic matching of supply and demand. The operations function is responsible for providing the supply or service capacity for expected demand.
4. All processes exhibit variation that must be managed.
5. Although there are some basic differences between services and products that must be taken into account from a managerial standpoint, there are also many similarities between the two.
6. Environmental issues will increasingly impact operations decision making.
7. Ethical behavior is an integral part of good management practice.
8. All business organizations have, and are part of, a supply chain that must be managed.

KEY TERMS

agility, 26	interchangeable parts, 23	process, 9
craft production, 21	lead time, 16	services, 4
division of labor, 23	lean system, 27	six sigma, 26
e-business, 24	mass production, 22	supply chain, 4
e-commerce, 24	model, 18	sustainability, 28
ethical framework 30	operations management, 4	system, 20
ethics, 30	outsourcing, 31	technology, 24
goods, 4	Pareto phenomenon, 20	value-added, 6

DISCUSSION AND REVIEW QUESTIONS

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. Why is the degree of customization an important consideration in process planning?
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.
 - e. A small business owner having a Web site versus newspaper advertising.
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. Discuss the importance of each of the following:
 - a. Matching supply and demand
 - b. Managing a supply chain
13. List and briefly explain the four basic sources of variation, and explain why it is important for managers to be able to effectively deal with variation.
14. Why do people do things that are unethical?
15. Explain the term *value-added*.
16. Discuss the various impacts of outsourcing.
17. Discuss the term *sustainability*, and its relevance for business organizations.

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?

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 set of exercises:

1. 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?
2. Why is it important to match supply and demand? If a manager believes that supply and demand will not be equal, what actions could the manager take to increase the probability of achieving a match?
3. One way that organizations compete is through technological innovation. However, there can be downsides for both the organization and the consumer. Explain.
4.
 - a. What are some possible reasons a business person would make an unethical decision?
 - b. What are the risks of doing so?

TAKING STOCK

CRITICAL THINKING EXERCISES



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

- In what ways are Hazel's customers most likely to judge the quality of her lawn care services?
- Hazel is the operations manager of her business. Among her responsibilities are forecasting, inventory management, scheduling, quality assurance, and maintenance.
 - What kinds of things would likely require forecasts?
 - What inventory items does Hazel probably have? Name one inventory decision she has to make periodically.
 - What scheduling must she do? What things might occur to disrupt schedules and cause Hazel to reschedule?
 - How important is quality assurance to Hazel's business? Explain.
 - What kinds of maintenance must be performed?
- What are some of the trade-offs that Hazel probably considered relative to:
 - Working for a company instead of for herself?
 - Expanding the business?
 - Launching a Web site?
- 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.
- 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?
- All managers have to cope with variation.
 - What are the major sources of variation that Hazel has to contend with?
 - How might these sources of variation impact Hazel's ability to match supply and demand?
 - What are some ways she can cope with variation?
- Hazel is thinking of making some of her operations sustainable. What are some ideas she might consider?

SELECTED BIBLIOGRAPHY AND FURTHER READING

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: McGraw-Hill/Irwin, 2004.

Hanke, John E. and Dean W. Wichern. *Business Forecasting*, 9th ed. Upper Saddle River, NJ: Pearson Prentice-Hall, 2009.

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, 2007.

Wisner, Joel D., and Linda L. Stanley. *Process Management: Creating Value Along the Supply Chain*. Mason, OH: Thomson South-Western, 2008.