PART ONE

Introduction

Chapter 1 introduces you to the field of operations management. It describes the nature and scope of operations management, and how operations management relates to other parts of the organization. Among the important topics it covers are the different types of operations systems, a comparison of manufacturing and service operations, a brief history of operations management, and a list of trends in business that relate to operations. After you have read this chapter, you will have a good understanding of what the operations function of a business organization encompasses.

Chapter 2 discusses operations management in a broader context, and presents the issues of competition, strategy, and productivity. After you have read Chapter 2, you will understand the importance of the operations function relative to the goals of a business organization. This chapter also describes time-based strategies, which many organizations are now adopting as they seek to become more competitive and to better serve their customers.

Introduction to operations management includes two chapters:

1. Operations management, Chapter 1
2. Competitiveness, strategy, and productivity, Chapter 2

CHAPTER ONE

Introduction to Operations Management

CHAPTER OUTLINE

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. Describe the operations function and the nature of the operations manager's job.
4. Differentiate between design and operation of production systems.
5. Provide a general description of the different types of operations.
6. Compare and contrast service and manufacturing operations.
7. Briefly describe the historical evolution of operations management.
8. Describe the key aspects of operations management decision making.
9. Identify some of the current trends in business that impact operations management.

In the late 1970s, Wal-Mart was a niche marketer, with about 200 stores, mostly in the South. At the time, Sears, JC Penney, and Kmart dominated the retail market. Over the years, Wal-Mart gained market share at the expense of the previous market leaders, and it has now become the largest and most profitable retailer in the world!

In the 1990s, the Boeing Company ran into trouble when it could not meet production deadlines. As a result, Boeing lost some orders, which had a negative impact on earnings and its stock price.

Why do some companies thrive while others struggle or fail? There are a variety of reasons, to be sure. However, an important key in a company's success or failure is its *operations management*. This is the subject of this book.

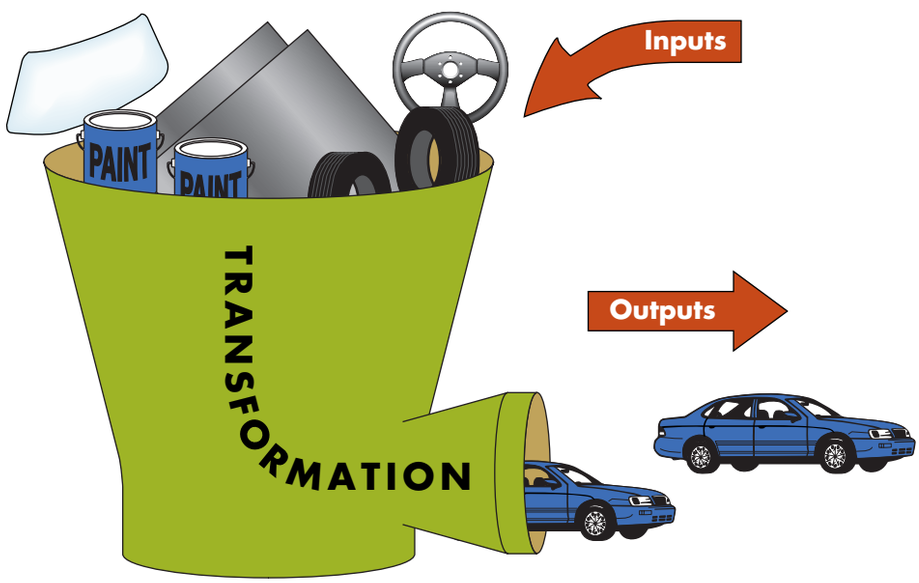
This book is about operations management. The subject matter is fascinating and timely: productivity, quality, e-business, global competition, and customer service are very much in the news. All are part of operations management. This first chapter presents an introduction and overview of operations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

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

Introduction

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

Operations Management is the management of processes or systems that create goods and/or provide services. It encompasses 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 an operations system. The system consists of the airplanes, airport facilities, and maintenance facilities, sometimes spread out over a wide territory. Most of the activities performed by management and employees fall into the realm of operations management:

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

Capacity planning, essential for the airline to maintain the 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.)

The Pipian Bike factory in Havana employs nearly 700 people and produces 15,000 bicycles annually. Parts for the bikes come from all over, including Russia, India, China, and Spain.

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. Also 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.

Employee motivation and training in all phases of operations.

Location of 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 might also do some of the *fabrication* work itself, forming frames, making the gears and chains, and buy mainly raw materials and a few parts and materials such as paint, nuts and bolts, and tires. Among the key management tasks in either case are scheduling production, deciding which components to make and which to buy, ordering parts and materials, deciding on the style of bicycle to produce and how many, purchasing 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 of 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.

Why Study Operations Management?

You may be wondering why you need to study operations management. Actually, there are a number of very good reasons. One is that operations management activities are at the core of *all* business organizations, regardless of what business they are in. Second, 50 percent or more of all jobs are in operations management–related areas—such areas as customer service, quality assurance, production planning and control, scheduling, job design, inventory management, and many more. Third, activities in all of the other areas of business organizations, such as finance, accounting, human resources, logistics, management information systems (MIS), marketing, purchasing, as well as others are all interrelated

with operations management activities. So it is essential for people who work in these areas to have a basic understanding of operations management.

Business processes involve systems that extend across functional boundaries. For example, accountants need to know about inventory management, work measurement and labor standards, and processing systems in order to estimate costs, conduct audits, and prepare financial reports. Those working in finance also need to understand inventory management, but they must also be able to forecast financial needs and cash flow and understand the rationale for make-or-buy decisions, the need for funds for updating equipment, investing in new technology, investing in upgrading employee skills, and providing funds for expansion or relocation. Marketing and operations are closely linked. Included in those areas are product planning and forecasting. Moreover, in most service operations, production and marketing occur concurrently, so there is considerable overlap between marketing and operations. Those working in MIS need to understand operations management because much of their work will directly or indirectly involve operations. And, of course, those who have or want to have their own businesses will need to have a thorough knowledge of operations management.

Beyond all of this is the reality that operations management is about *management,* and *all managers* need to possess the knowledge and skills in the content areas you will learn about here. Among them are productivity, strategy, forecasting, quality, inventory control, and scheduling. Also, you will learn how to use a range of quantitative tools that enhance managerial decision making.

CAREERS IN OPERATIONS MANAGEMENT

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

www.apics-stlouis.com/
www.apics-houston.org/
www.apicsaustin.com/

American Production and Inventory Control Society (APICS)
500 West Annandale Road, Falls Church, Virginia 22046-4274

American Society for Quality (ASQ)
230 West Wells Street, Milwaukee, Wisconsin 53203

www.napm.org

National Association of Purchasing Management (NAPM)
2055 East Centennial Circle, Tempe, Arizona 85284

www.infoanalytic.com/asm/

Association for Systems Management
P.O. Box 38370, Cleveland, Ohio 44130-0307

www.informs.org

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

www.poms.org

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

www.pmi.org

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

APICS and NAPM both 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).

Functions within Business Organizations

Organizations are formed to pursue goals that are achieved more efficiently by the concerted efforts of a group of people than by individuals working alone. Business organizations are devoted to producing goods and/or providing services. They may be for-profit or nonprofit organizations. Their goals, products, and services may be similar or quite different. Nonetheless, their functions and the way they operate are similar.

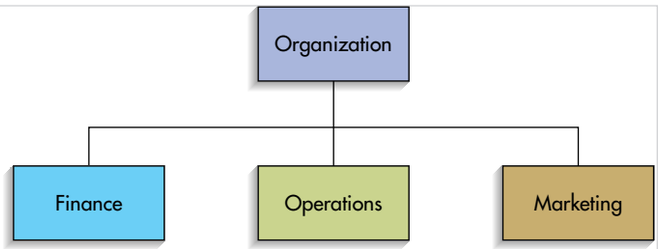


FIGURE 1–1
The three basic functions of business organizations

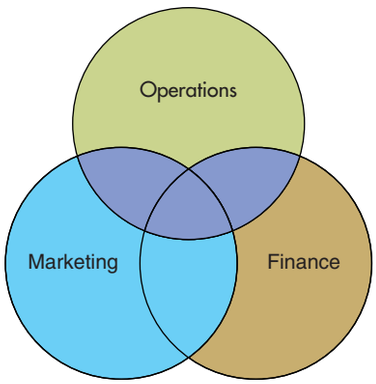


FIGURE 1–2
The three major functions of business organizations overlap

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

TABLE 1–1
Examples of types of operations

A typical business organization has three basic functions: finance, marketing, and operations (see Figure 1–1). These three functions, and other supporting functions, perform different but *related* activities necessary for the operation of the organization. The interdependency of the major functions is depicted by overlapping circles in Figure 1–2. The functions must interact to achieve the goals and objectives of the organization, and each makes an important contribution. Often the success of an organization depends not only on how well each area performs but also on how well the areas *interface* with each other. For instance, unless operations and marketing work together, marketing may promote goods or services that operations cannot profitably deliver, or operations may turn out goods or services for which there is no demand. Similarly, unless finance and operations people work closely, funds for expansion or new equipment may not be available when needed.

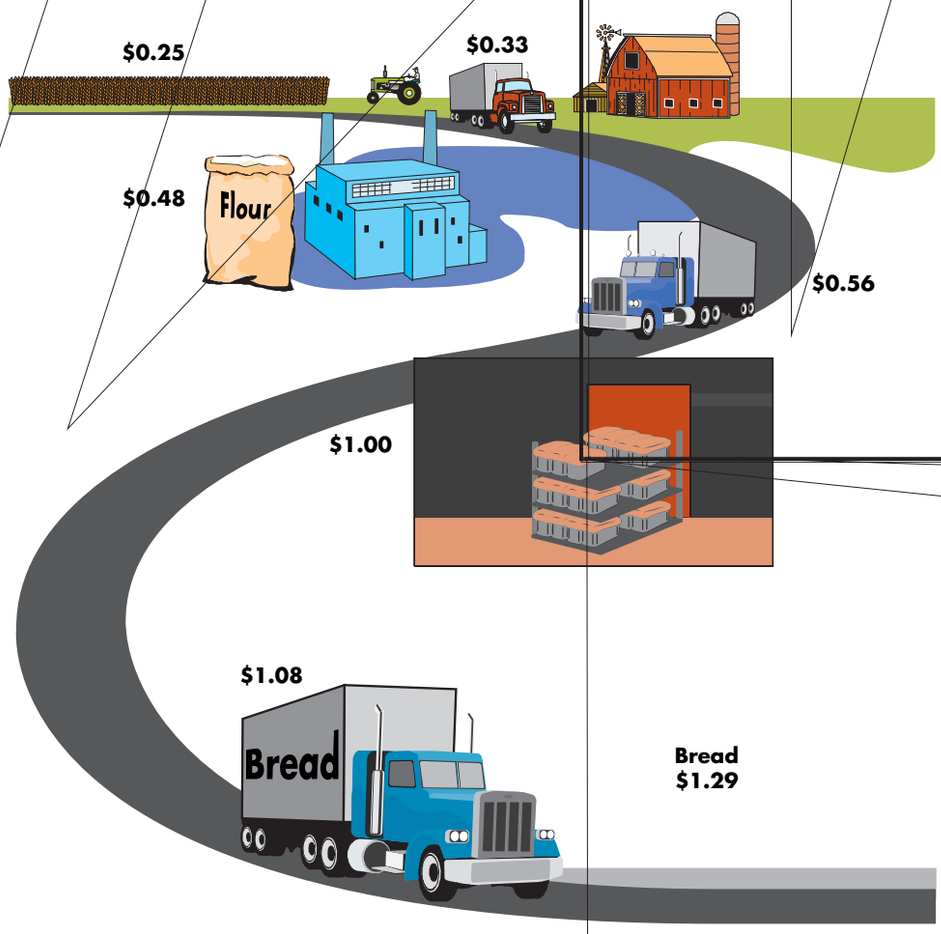
Let's take a closer look at these functions.

OPERATIONS

The operations function consists of all activities *directly* related to producing goods or providing services. Hence, it exists both in manufacturing and assembly operations, which are *goods-oriented,* and in areas such as health care, transportation, food handling, and retailing, which are primarily *service-oriented.* Table 1–1 provides illustrations of the diversity of operations management settings.

The operations function is the core of most business organizations; it is responsible for the creation of an organization's goods or services. Inputs are used to obtain finished goods or services using one or more *transformation processes* (e.g., storing, transporting, cutting). To ensure that the desired outputs are obtained, measurements are taken at various points in the transformation process (*feedback*) and then compared with previously established standards to determine whether corrective action is needed (*control*). Figure 1–3 shows the conversion process.

Table 1–2 provides some examples of inputs, transformation processes, and outputs. Although goods and services are listed separately in Table 1–2, it is important to note that goods and services often occur jointly. For example, having the oil changed in your car is a service, but the oil that is delivered is a good. Similarly, house painting is a service, but the paint is a good. The goods-service package is a continuum. It can range from primarily goods, with little service, to primarily service, with few goods. Figure 1–4 illustrates this continuum.



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

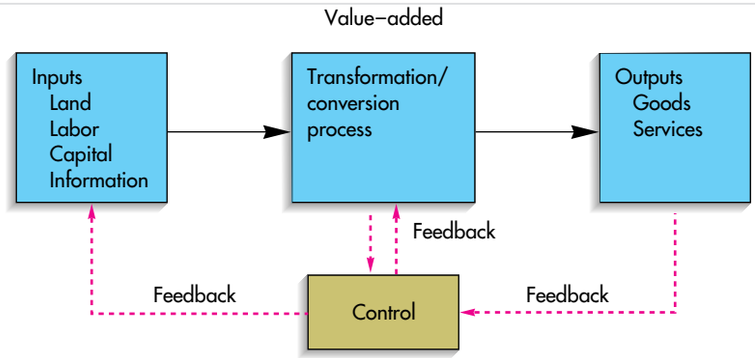


FIGURE 1–3

The operations function involves the conversion of inputs into outputs

Inputs	Transformation	Outputs
Land	Processes	Goods
Human	Cutting, drilling	Houses
Physical	Transporting	Automobiles
Intellectual	Teaching	Clothing
Raw materials	Farming	Computers
Energy	Mixing	Machines
Water	Packing	Televisions
Chemicals	Canning	Food products
Metals	Consulting	Textbooks
Wood	Copying, faxing	Magazines
Equipment		Shoes
Machines		CD players
Computers		Services
Trucks		Health care
Tools		Entertainment
Facilities		Car repair
Hospitals		Delivery
Factories		Gift wrapping
Offices		Legal
Retail stores		Banking
Other		Communication
Information		
Time		

TABLE 1–2

Examples of inputs, transformation, and outputs

One way that businesses attempt to become more productive is to examine critically whether the operations performed by their workers add value. Businesses consider those that do not add value wasteful. Eliminating or improving such operations decreases the cost of inputs or processing, thereby increasing the value-added. For instance, a firm may discover it is producing an item much earlier than the scheduled delivery date to a customer, thus requiring the storage of the item in a warehouse until delivery. In effect, additional costs are incurred by storing the item without adding to the value of the item. Reducing storage time would reduce the transformation cost and, hence, increase the value-added.

Table 1–3 provides some specific illustrations of the transformation process.

FINANCE

The finance function comprises activities related to securing resources at favorable prices and allocating those resources throughout the organization. Finance and operations management personnel cooperate by exchanging information and expertise in such activities as:

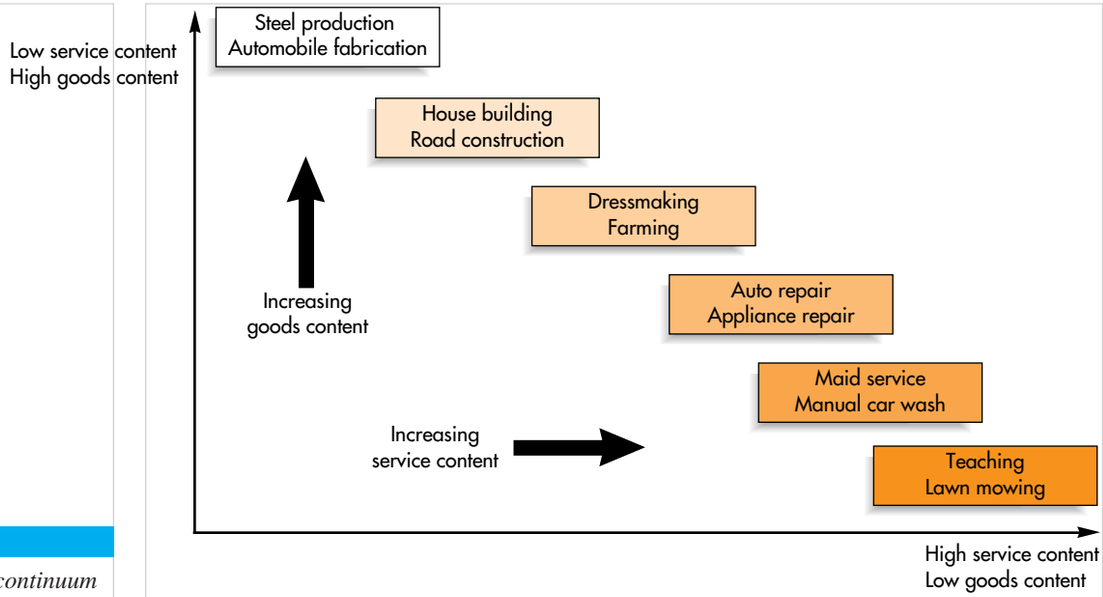


FIGURE 1–4

The goods–service continuum

TABLE 1–3

Illustrations of the transformation process

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

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. Most for-profit firms obtain the majority of their funds through the revenues generated by sales of goods and services.

MARKETING

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

FIGURE 1–5
Operations interfaces with a number of supporting functions

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 to successfully implement design changes and to develop and produce new products. Marketing can provide valuable insight on what competitors are doing. Marketing can also 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.

OTHER FUNCTIONS

There are a host of other supporting functions that interface with operations. Among them are accounting and purchasing. Also, depending on the nature of the organization, they may include personnel or human resources, product design and development, industrial engineering, and maintenance (see Figure 1–5).

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.

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.

The *personnel* or *human resource* 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.

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.

Many of these interfaces are elaborated on in later chapters.

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

The Scope of Operations Management

We have already noted that the operations manager is responsible for the creation of goods and services. This encompasses acquisition of resources and the conversion of those inputs into outputs using one or more transformation processes. That involves planning, coordinating, and controlling the elements that make up the process, including workers, equipment, facilities, allocation of resources, and work methods. It also includes product and/or service design, a vital, ongoing process that most organizations must do. Operations performs this activity in conjunction with marketing. Marketing people can be a source of ideas concerning new products and services, and improvements to existing ones. Operations people can also be a source of new ideas for improvements in the processes that provide the goods or services. From a practical standpoint, product and service design and the processes that provide them are the lifeblood of a competitive organization.

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. *System operation* involves management of personnel, inventory planning and control, scheduling, project management, and quality assurance. In many instances, the operations manager is more involved in day-to-day operating decisions than with decisions relating to system design. However, the operations manager has a vital stake in system design because *system design essentially determines many of the parameters of system operation.* For example, costs, space, capacities, and quality are directly affected by design decisions. Even though the operations manager is not responsible for making all design decisions, he or she can provide those decision makers with a wide range of information that will have a bearing on their decisions. Table 1–4 provides additional details on the nature and scope of operations management.

Decision Area	Basic Questions	Chapter
Forecasting	What will demand be?	3
Design		
Product and service design	What do customers want? How can products and services be improved?	4
Process selection	What processes should the organization use?	6
Capacity (long range)	How much capacity will be needed? How can the organization best meet capacity requirements?	5
Layout	What is the best arrangement for departments, equipment, work flow, and storage in terms of cost, productivity?	6
Design of work systems	What is the best way to motivate employees? How can productivity be improved? How to measure work? How to improve work methods?	7
Location	What is a satisfactory location for a facility (factory, store, etc.)?	8
Operation		
Quality	How is quality defined?	9
Quality control	Are processes performing adequately? What standards should be used? Are standards being met?	10
Total quality management	How are quality goods and services achieved and improved?	11
Aggregate planning	How much capacity will be needed over the intermediate range? How can capacity needs best be met?	14
Inventory management	How much to order? When to reorder? Which items should get the most attention?	13, 15
Materials requirements planning	What materials, parts, and subassemblies will be needed, and when?	15
Scheduling	How can jobs best be scheduled? Who will do which job? Which equipment to use?	17
Project management	Which activities are the most critical to the success of a project? What are the goals of a project? What resources will be needed, and when will they be needed?	18
Waiting lines	What capacity is appropriate?	19

TABLE 1–4

Design and operating decisions

Differentiating Features of Operations Systems

A number of features differentiate operations systems. A brief discussion of some of these features will help you to develop a better understanding of the nature and scope of operations management. The three described are degree of standardization, type of operation, and production of goods versus service operations.

DEGREE OF STANDARDIZATION

The output of production systems can range from highly standardized to highly customized. *Standardized output* means that there is a high degree of uniformity in goods or services. Standardized goods include radios, televisions, computers, newspapers, canned foods, automobile tires, pens, and pencils. Standardized services include automatic car washes, televised newscasts, taped lectures, and commercial airline service. *Customized output* means that the product or service is designed for a specific case or individual. Customized goods include eyeglasses, custom-fitted clothing, window glass (cut to order), and customized draperies. Customized services include tailoring, taxi rides, and surgery.

Systems with standardized output can generally take advantage of standardized methods, less-skilled workers, materials, and mechanization, all of which contribute to higher volumes and lower unit costs. In custom systems, on the other hand, each job is sufficiently different so that workers must be more skilled, the work moves slower, and the work is less susceptible to mechanization.

TYPE OF OPERATION

The degree of standardization and the volume of output of a product or service influence the way a firm organizes production. On one end of the scale is a single, large-scale product or service such as the launching of a space shuttle (service) or the construction of a skyscraper (product). On the other end is a continuous process, such as oil refining. Between these extremes are customized individual units of output, such as custom-made furniture, special-purpose machines, and auto repair; batches, such as paint and food products; and mass production, such as automobiles, personal computers, and appliances.

You will learn more about these different types of operations in later chapters.

PRODUCTION OF GOODS VERSUS SERVICE OPERATIONS

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

Government (federal, state, local).

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

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

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

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

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

Education (schools, colleges, etc.).

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

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

1. Customer contact
2. Uniformity of input
3. Labor content of jobs
4. Uniformity of output
5. Measurement of productivity
6. Simultaneous production and delivery
7. Quality assurance

Let us consider each of these differences.

1. Often, by its nature, service involves a much higher degree of customer contact than manufacturing. The performance of a service often occurs at the point of consumption. For example, repairing a leaky roof must take place where the roof is, and surgery requires the presence of the surgeon and the patient. On the other hand, manufacturing allows a separation between production and consumption, so that manufacturing may occur away from the consumer. This permits a fair degree of latitude in selecting work methods, assigning jobs, scheduling work, and exercising control over operations. Service operations, because of their contact with customers, can be much more limited in their range of options. Moreover, customers are sometimes a part of the system (e.g., self-service operations such as gas stations, shopping), so tight control is impossible. In addition, product-oriented operations can build up inventories of finished goods (e.g., cars, refrigerators),

enabling them to absorb some of the shocks caused by varying demand. Service operations, however, cannot build up inventories of *time* and are much more sensitive to demand variability—banks and supermarkets alternate between lines of customers waiting for service and idle tellers or cashiers waiting for customers.

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

3. Services often require a higher labor content whereas manufacturing, with exceptions, can be more capital-intensive (i.e., mechanized).

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

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

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

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

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

Table 1–5 gives an overview of the differences between production of goods and service operations.

Although it is convenient to think in terms of systems devoted exclusively to goods or services, most real systems are a blend of both. For instance, maintenance and repair of equipment are services performed by virtually every manufacturing firm. Similarly, most service organizations typically sell goods that complement their services. Thus, a lawn care firm usually sells goods such as weed killers, fertilizers, and grass seed. Hospitals

TABLE 1–5

Typical differences between goods and services

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

dispense medical and surgical supplies along with health services. Restaurants sell food. Movie theaters sell popcorn, candy, and beverages.

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. Moreover, the number of people working in services is increasing, while the number of people working in manufacturing is not. (See Figure 1–6.) More and more the U.S. economy is becoming a service economy.

The Operations Manager and the Management Process

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. In every case, the operations manager must coordinate the use of resources through the management process of planning, organizing, staffing, directing, and controlling.

Examples of the responsibilities of operations managers according to these classifications are given in Table 1–6.

FIGURE 1–6

Manufacturing versus service employment, 1940–2000

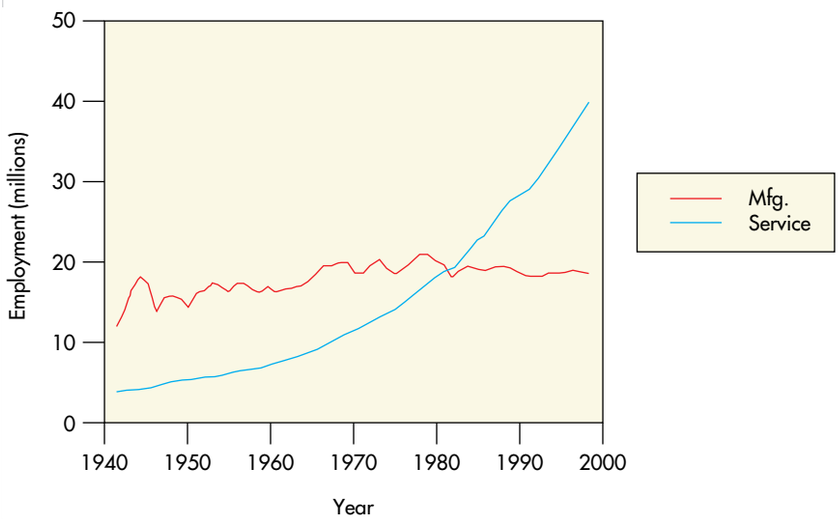


TABLE 1–6

Responsibilities of operations managers

Planning	Organizing
Capacity	Degree of centralization
Location	Subcontracting
Products and services	Staffing
Make or buy	Hiring/laying off
Layout	Use of overtime
Projects	Directing
Scheduling	Incentive plans
Controlling	Issuance of work orders
Inventory control	Job assignments
Quality control	

Operations Managers and Decision Making

The chief role of an operations manager is that of planner and decision maker. In this capacity, the operations manager exerts considerable influence over the degree to which the goals and objectives of the organization are realized.

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, and the systems approach.

MODELS

A **model** is an abstraction of reality, a simplified version 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.

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

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, ranging from the simple to the exotic; some are very crude, others extremely elegant. 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 ignore the unimportant details so that attention can be concentrated on the most important aspects of a situation, thus increasing the opportunity to understand a problem and its solution.

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

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

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. Provide a systematic approach to problem solving.
4. Increase understanding of the problem.
5. Enable managers to analyze "what if?" questions.
6. Require users to be specific about objectives.
7. Serve as a consistent tool for evaluation.
8. Enable users to bring the power of mathematics to bear on a problem.
9. Provide a standardized format for analyzing a problem.

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

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 grounded in mathematics 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.

QUANTITATIVE APPROACHES

Quantitative approaches to problem solving often embody an attempt to obtain mathematically optimum solutions to managerial problems. Although quantitative techniques have traditionally been associated with production and operations management, it was not until World War II that major efforts were made to develop these techniques. In order to handle complex military logistics problems, interdisciplinary teams were assembled (e.g., psychologists, mathematicians, economists) to combine efforts in search of workable solutions. These efforts continued and expanded after the war, and many of the resulting techniques were applied to operations management. *Linear programming* and related mathematical techniques are widely used for optimum allocation of scarce resources. *Queuing techniques,* which originated around 1920 in the telephone industry but remained dormant until the 1950s and 1960s, are useful for analyzing situations in which waiting lines form. *Inventory models,* also popular after some early work, went through a long period of low interest but are now 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 areas of decision making) have been accepted because of the introduction of calculators and the availability of high-speed computers capable of handling the required calculations. Computers have had an enormous influence on the practice of operations management, particularly in scheduling and inventory control. Because they are capable of rapid, error-free computations and keeping track of thousands of bits of information with instantaneous retrieval, computers have had a major impact on operations management. Moreover, the growing availability of software packages covering virtually every quantitative technique has greatly increased management's use of the computer. Many heretofore impractical techniques, such as multiple regression analysis and linear programming, can now be handled with ease.

Because of the emphasis on quantitative approaches in operations management decision making, it is important not to lose sight of the fact that managers typically use a

combination of qualitative and quantitative approaches, and many important decisions are based on qualitative approaches.

ANALYSIS OF TRADE-OFFS

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

Throughout this book you will be presented with decision models that reflect these kinds of trade-offs. Managers 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, managers 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. An example of this is the factor-rating approach described in the chapter on facilities location.

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 subsystems), which in turn are composed of lower subsystems. The systems approach emphasizes interrelationships among subsystems, but its main theme is that *the whole is greater than the sum of its individual parts.* Hence, from a systems viewpoint, the output and objectives of the organization as a whole take precedence over those of any one subsystem. An alternative approach is to concentrate on efficiency within subsystems and thereby achieve overall efficiency. But that approach overlooks the fact that organizations must operate in an environment of scarce resources and that subsystems are often in direct competition for those scarce resources, so that an orderly approach to the allocation of resources is called for.

system A set of interrelated parts that must work together.

One undesirable result of the use of quantitative techniques is that many of the techniques tend to produce solutions that are optimal in a narrow sense but may not be optimal in a broader sense (e.g., in terms of a department, plant, division, or overall organization). Consequently, managers must evaluate "optimal" solutions produced by quantitative techniques in terms of the larger framework, and perhaps modify decisions accordingly.

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.

ESTABLISHING PRIORITIES

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

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

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

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

Obviously, certain parts of an automobile are more critical to its operation than others. The same concept applies to management. By recognizing this and setting priorities, a manager will be in a position to deal more effectively with problems as they arise and to prevent many others from arising at all.

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

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

ETHICS

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

- 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: don't hire under 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 worker problems quickly and fairly.

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 Historical Evolution of Operations Management

Systems for production have existed since ancient times. The Great Wall of China, the Egyptian pyramids, the ships of the Roman and Spanish empires, and the roads and aqueducts of the Romans provide examples of the human ability to organize for production. Even so, most of these examples could be classified as "public works" projects. The production of goods for sale, at least in the modern sense, and the modern factory system had their roots in the Industrial Revolution.

THE INDUSTRIAL REVOLUTION

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

Then, a number of innovations changed the face of production forever by substituting machine power for human power. Perhaps the most significant of these was the steam engine, made practical by James Watt around 1764, because it provided a source of power to operate machines in factories. James Hargreave's spinning jenny (1770) and Edmund Cartwright's power loom (1785) revolutionized the textile industry. Ample supplies of coal and iron ore provided materials for generating power and making machinery. The new machines, made of iron, were much stronger and more durable than the simple wooden machines they replaced.

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

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

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

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

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

SCIENTIFIC MANAGEMENT

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

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

www.ford.com

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

During the early part of the twentieth 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.*

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

Among Ford's many contributions was the introduction of **mass production** to the automotive industry, a system of production in which large volumes of standardized goods are produced by low-skilled or semiskilled workers using highly specialized, and often costly, equipment. Ford was able to do this by taking advantage of a number of important concepts. Perhaps the key concept that launched mass production was **interchangeable parts,** sometimes attributed to Eli Whitney, an American inventor who applied the concept to assembling muskets in the late 1700s. The basis for interchangeable parts is 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.

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

division of labor Breaking up a production process into small tasks, so that each worker performs a small portion of the overall job.

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 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 Hertzberg refined in the 1950s. Douglas McGregor added Theory X and Theory Y in the 1960s. These theories represented the two ends of the spectrum of how employees view work. Theory X, on the negative end, assumed that workers do not like to work, and have to be controlled—rewarded and punished—to get them to do good work. This attitude was quite common in the automobile industry and in some other industries, until the threat of global competition forced them to rethink that approach. Theory Y, on the other end of the spectrum, assumed that workers enjoy the physical and mental aspects of work and become committed to work. The Theory X approach resulted in an adversarial environment, whereas the Theory Y approach resulted in empowered workers and a more cooperative spirit. In the 1970s, William Ouchi added Theory Z, which combined the Japanese approach, with such features as lifetime employment, employee problem solving, and consensus building, and the traditional Western approach that features short-term employment, specialists, and individual decision making and responsibility.

DECISION MODELS AND MANAGEMENT SCIENCE

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

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

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

THE INFLUENCE OF JAPANESE MANUFACTURERS

A number of Japanese manufacturers developed or refined management practices that increased the productivity of their operations and the quality of their products. This made them very competitive, sparking interest in their approaches by companies outside Japan. Their approaches emphasized quality and continual improvement, worker teams and empowerment, and achieving customer satisfaction. The Japanese can be credited with spawning the "quality revolution" that occurred in industrialized countries, and with generating widespread interest in time-based management (just-in-time production).

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

Table 1–7 provides a chronological summary of some of the key developments in the evolution of operations management.

TABLE 1–7

Historical summary of operations management

Approximate Date	Contribution/Concept	Originator
1776	Division of labor	Adam Smith
1790	Interchangeable parts	Eli Whitney
1911	Principles of scientific management	Frederick W. Taylor
1911	Motion study; use of industrial psychology	Frank and Lillian Gilbreth
1912	Chart for scheduling activities	Henry Gantt
1913	Moving assembly line	Henry Ford
1915	Mathematical model for inventory management	F. W. Harris
1930	Hawthorne studies on worker motivation	Elton Mayo
1935	Statistical procedures for sampling and quality control	H. F. Dodge, H. G. Romig, W. Shewhart, L. H. C. Tippett
1940	Operations research applications in warfare	Operations research groups
1947	Linear programming	George Dantzig
1951	Commercial digital computers	Sperry Univac
1950s	Automation	Numerous
1960s	Extensive development of quantitative tools	Numerous
1975	Emphasis an manufacturing strategy	W. Skinner
1980s	Emphasis on quality, flexibility, time-based competition, production	Japanese manufacturers, especially Toyota, and Taiichi Ohno
1990s	Internet, supply chains	Numerous

Trends in Business

Business must constantly monitor new trends and take them into account in their strategies and operations management. In this section we touch on some of the key trends that are occurring in businesses around the world.

RECENT TRENDS

Two fairly recent trends are having tremendous impact on business operations:

1. The Internet and e-business.
2. Supply chain management.

e-business Use of the Internet to transact business.

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 are 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.

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

A **supply chain** is the sequence of organizations—their facilities, functions, and activities—that are involved in producing and delivering a product or service. The sequence begins with basic suppliers of raw materials and extends all the way to the final customer, as seen in Figure 1–7. Facilities might include warehouses, factories, processing centers, offices, distribution centers, and retail outlets. Functions and activities include forecasting, purchasing, inventory management, information management, quality assurance, scheduling, production, distribution, delivery, and customer service.

These trends are having a major influence on business (including accounting, finance, international business, marketing, and MIS), as well as on operations management. Their impact on operations management is discussed throughout the book, as well as in a chapter on supply chain management.

FIGURE 1–7
A simple product supply chain

CONTINUING TRENDS

A number of continuing trends that influence business and operations management.

1. *Quality and process improvement*. Given a boost by the "quality revolution" of the 1980s and 1990s, quality is now ingrained in business. Where once quality was a criterion for being an "order winner," it has now become a criterion for being an "order qualifier." 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, replenish supplies, and fill orders 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 processing, information retrieval, product design, and the response to customer complaints. 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 day, at a savings of $82 million.

2. *Technology*. Technological advances have led to a vast array of new products and processes. Undoubtedly the computer has had—and will continue to have—the greatest impact on business organizations. It has revolutionized the way companies operate. Applications include product design, product features, processing technology, information processing, and communication. Technological advances in new materials, new methods, and new equipment have also made their mark on operations. Technological changes in products and processes can have major implications for production systems, affecting competitiveness and quality, but unless technology is carefully integrated into an existing system, it can do more harm than good by raising costs, reducing flexibility, and even reducing productivity. Advancements in *information technology* are having an impact on operations management. These advances began in the early 1960s using mainframe computers. Among the applications were planning and scheduling or resources. In the late 1970s, personal computers made computing power more accessible to workers and were easier to use. Applications included word processing and spreadsheet analysis. In the middle to late 1980s, network computing began to increase, with applications such as electronic data interchange (EDI) and the ability to instantaneously receive point-of-sale data. In the mid-1990s, the Internet began to play a major role in business operations.

3. *Globalization*. Global competition, global markets, global supply chains, and international operations are having a growing impact on the strategies and operations of businesses large and small around the world. The General Agreement on Tariffs and Trade (GATT) of 1994 reduced tariffs and subsidies in many countries, expanding world trade.

4. *Operations strategy*. 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.

5. *Environmental issues*. Pollution control and waste disposal are key issues managers must contend with. There is increasing emphasis on reducing waste, using less toxic chemicals (e.g., lawncare services shifting to environmentally friendly approaches), recycling, making it easier for consumers to recycle products (e.g., including a shipping container for returning used laser printer cartridges), and designing products and parts that can be reused (remanufacturing products such as copying machines). The term *environmentally*

Headquartered in Battle Creek, Michigan, Kellogg Company is one of the world's leading producers of ready-to-eat cereals and grain-based convenience foods. This display of a popular Kellogg cereal is in a grocery store in Tokyo, Japan.

responsible manufacturing is sometimes used to describe these policies. Regulations are increasing in number and complexity, and penalties for pollution and inadequate control of wastes can be severe. While this has place an added burden on some industries, society should reap tremendous benefits in cleaner air and water, and less damage to the environment in general. Some of the consequences of *not* paying attention to environmental issues can be seen in the industrialized cities of the former Soviet Union and its East European satellites, where years of neglect have resulted in catastrophic damage to the environment, which will require many years and enormous amounts of money before recovery. Waste disposal regulation has led to the creation of opportunity for businesses that specialize in waste management and recycling.

6. *Corporate downsizing.* Squeezed by competition, lagging productivity, and stockholders calling for improved profits and share prices, many corporations have responded by reducing their labor forces. This has meant that operations managers often have to find ways to produce more with fewer workers.

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

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

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

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

Because lean production systems operate with lower amounts of inventory, additional emphasis is placed on anticipating when problems might occur *before* they arise, and avoiding those problems through careful planning. Even so, problems still occur at times, and quick resolution is important. Workers participate in both the planning and correction stages. Technical experts are still used, but more as consultants rather than substitutes for workers. The focus is on designing a system (products and process) so that workers will be able to achieve high levels of quality and quantity.

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

READING

Agile Manufacturing

John Holusha

www.ford.com

Agile manufacturers emphasize flexibility of operations and speed to gain a competitive edge. An example of agile manufacturing can be found in Ford Motor Company's electronic components plant in Landsdale, Pennsylvania. The plant produces about 124,000 engine controllers, antilock brake sensors, and speed control units a day. And because each product has between 400 and 500 parts, this means that there are more than 5 million individual parts to keep track of daily. Nonetheless, according to the plant manager, when an order to change a product is received, the changed units can usually be shipped within 24 hours! The plant is able to respond to change orders quickly because it has highly flexible automated equipment, computer software that has been designed to accommodate changes, and lean inventories that don't have to be worked off before changed units can be shipped.

This agile philosophy of being able to switch quickly—and economically—from one design to another, with little disruption, is being implemented throughout the Ford Motor Company. It is also being implemented in many other companies, both large and small, as they shift away from more traditional mass production methods that have heavy emphasis on volume and cost reduction into production methods that emphasize speed and flexibility. This dramatic shift in the way things are made reflects a growing trend as American companies strive to compete with foreign companies.

Perhaps central to the process of agile manufacturing is the rapid collection and processing of information. For instance, extensive use of bar codes provides information on the status of each product for Ford managers at the plant in Landsdale. Moreover, if defects are discovered, there is an electronic audit trail to trace the defect back to the exact spot in the process where it occurred, enabling management to focus efforts on correcting the cause of the problem.

Questions

1. What is an agile manufacturer?
2. What is the value of being an agile manufacturer?
3. How could the managers at the plant keep track of the five million parts each day?
4. What are the keys to being an agile manufacturer?

Source: Adapted from "Agile Manufacturers Put Premium on Speed, Flexibility" by John Holusha, the New York Times Company, 1994.

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.

Unions often oppose conversion from a traditional system to a lean system because they view the added responsibility and multiple tasks as an expansion of job requirements without comparable increases in pay. In addition, workers sometimes complain that the company is the primary beneficiary of employee-generated improvements.

Table 1–8 provides a comparison of craft production, mass production, and lean production. Keep in mind that all three of these modes of production are in existence today.

fyi to PR/Client:
Table reference is here, but Table 1-8 will not fit until next page, which is within Summary. Please advise. Would it be better to move the Reading Box to next page (within summary)?
COMP

Summary

Operations management is that part of a business organization responsible for planning and coordinating the use of the organization's resources to convert inputs into outputs. The operations function is one of three primary functions of business organizations; the other two are marketing and finance.

The operations function is present in both service-oriented and product-oriented organizations. Operations decisions involve design decisions and operating decisions. Design decisions relate to capacity planning, product design, process design, layout of facilities, and selecting locations for facilities. Operating decisions relate to quality assurance, scheduling, inventory management, and project management.

The chapter provides a brief discussion of the historical evolution of operations management and recent trends in the field. Among those trends are e-business and supply chain management; global competition; increasing emphasis on quality; integrating technology into production systems; increasing worker involvement in problem solving and decision making, particularly through the use of teams; increasing emphasis on flexibility and time reduction; increasing attention to environmental issues; and lean production.

	Craft Production	Mass Production	Lean Production
Description	High variety, customized output, with one or a few skilled workers responsible for an entire unit of output.	High volume of standardized output, emphasis on volume. Capitalizes on division of labor, specialized equipment, and interchangeable parts.	Moderate to high volume of output, with more variety than mass production. Fewer mass production buffers such as extra workers, inventory, or time. Emphasis on quality. Employee involvement and teamwork important.
Examples of Goods and Services	Home remodeling and landscaping, tailoring, portrait painting, diagnosis and treatment of injuries, surgery.	Automobiles, computers, calculators, sewing machines, compact discs, mail sorting, check clearing.	Similar to mass production.
Advantages	Wide range of choice, output tailored to customer needs.	Low cost per unit, requires mostly low-skilled workers.	Flexibility, variety, high quality of goods.
Disadvantages	Slow, requires skilled workers, few economies of scale, high cost, and low standardization.	Rigid system, difficult to accommodate changes in output volume, product design, or process design. Volume may be emphasized at the expense of quality.	No safety nets to offset any system breakdowns, fewer opportunities for employee advancement, more worker stress, requires higher-skilled workers than mass production.

TABLE 1–8

A comparison of craft, mass, and lean production

Key Terms

craft production, 00
division of labor, 00
e-business, 00
interchangeable parts, 00
lead time, 00
lean production, 00
mass production, 00
models, 00
operations management, 00
Pareto phenomenon, 00
supply chain, 00
system, 00
value-added, 00

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 operation manager's job.
4. List five important differences between goods production and service operations.
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?
7. What are models and why are they important?
8. Can you think of a business that doesn't have operations management?
9. List the trade-offs you would consider for each of these decisions:
   a. Driving your own car versus public transportation.
   b. Buying a computer now versus waiting for an improved model.
   c. Buying a new car versus buying a used car.
   d. Speaking up in class versus waiting to get called on by the instructor.
10. Describe each of these systems: craft production, mass production, and lean production.

11. Why might some workers prefer not to work in a lean production environment? Why might some managers resist a change from a more traditional mode of production to lean production?
12. How has technological change affected you? Are there any downsides to technological change? Explain.
13. Identify some of the current trends in operations management and relate them to recent news items or to personal experience.
14. Why do people do things that are unethical?

Memo Writing Exercises

Memo writing exercises are intended to help you to strengthen your written communication skills while applying what you have learned to issues of managerial concern. The following memo provides information on writing good memos. Use it as a guide.

MEMORANDUM

To: Students using this book

From: W. Stevenson

Date: April 4, 2001

Subject: Memo writing exercises

The purpose of this memo is to introduce you to an important mode of business communication, and to provide you with information on how to write a memo.

Memos are often used to convey information within an organization, but they are also used to communicate with people outside the organization, such as suppliers, distributors, and sometimes, customers.

Memos tend to be less formal than letters. Memos should communicate business information in an organized, concise format. Even so, their length and degree of formality depend in part on the purpose of the memo, the amount of information to convey, and the intended audience. Thus, a memo reporting financial information to the chief executive officer would be more formal and probably longer than a memo to employees about the company picnic.

A variety of memo styles can be used. One style is illustrated by this memo, which is informational.

1. Use the first paragraph to state the purpose of the memo.
2. Use the second paragraph to provide major details of a proposal or major reasons for a decision or suggestion, or to indicate why you agree or disagree with a proposal or idea.
3. Use the third paragraph for minor details.
4. In a long memo, you may want to end by again stating your position on the subject.

1. Suppose that your boss, Tony Roman, who is the operations manager of your company, sends you a memo asking for your input on holding joint planning sessions with people from marketing and finance. A portion of that memo follows:

   Gail in Marketing and Jim in Finance have been bugging me lately about holding joint meetings. They're real gung-ho on this. But I'm a little concerned about agreeing to it. I don't want them to get the impression that they can come in here and tell us what to do. They don't really understand what it is we do or the kinds of problems we have. I'm sure they think we aren't doing as well as we could, but that's not any of their concern. I don't know why they just don't concentrate on what they do, and leave operations to us.

   Write a one-page memo that summarizes the potential benefits of holding joint planning meetings with Marketing and Finance.

2. Assume the role of a mid-level manager of a small company. The CEO, Rachael Barker, wants your views on a new computer network she is considering. The current network is adequate, but

the new one will provide much greater capabilities for managing files, word processing, and accessing the database.

Write a one-page memo in which you list (1) the key factors that you believe must be taken into account in making the decision, and (2) the trade-offs that must be considered.

3. Write a brief memo, responding to this one:

MEMORANDUM

To: (*Your name*), V.P. of Manufacturing

From: Deiter Smith, Production Supervisor, second shift

Date: Monday

Re: Accidental spill

We recently experienced an accidental discharge of mildly toxic chemicals into the creek that runs past one of our plants. Although there have been a few complaints of contamination from downstream property owners, I don't think that the spill can be traced back to our plant. Besides, other nearby companies have been getting away with more serious abuses for years, so let them take the heat.

I am confident that this is a one-time occurrence, so let's not blow the whole thing out of proportion. If we were to have to pay for a cleanup, this would have a big impact on quarterly profits, and our stockholders wouldn't like that one bit. Furthermore, in light of our recent efforts to promote an image of an environmental-friendly company, I say we should definitely keep quiet about this and let things die down.

What do you think?

4. Using your computer, load and then open the CD-ROM for this book. Click on What's on this CD-ROM? Write a half-page memo to your instructor on which of the items on the list you feel will be most helpful to you in this course.

CASE

Hazel

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 companywide 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 an important decision in her life. On a rainy Tuesday morning, she decided to go into business for herself—taking care of neighborhood lawns. She was relieved to give up the stress of job hunting, and she was excited about the prospect of being her own boss. But she was also fearful of being completely on her own. Nevertheless, Hazel was determined to make a go of it.

At first, business was a little slow, but once people realized Hazel was available, many asked her to take care of their lawns. Some people were simply glad to turn the work over to her; others switched from professional lawn care services. By the end of her first year in business, Hazel knew she could earn a living this way. She also performed other services such as fertilizing lawns, weeding gardens, and trimming shrubbery. Business became so good that Hazel hired two part-time workers to assist her and, even then, she believed she could expand further if she wanted to.

Questions

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

CASE

Total Recall

In mid-2000, the Firestone Tire Company issued a recall of some of its tires—those mounted on certain sport utility vehicles (SUVs) of the Ford Motor Company. This was done in response to reports that tire treads on some SUVs separated in use, causing accidents, some of which involved fatal injuries as vehicles rolled over.

At first, Firestone denied there was a problem with its tires, but it issued the recall under pressure from consumer groups and various government agencies. All of the tires in question were produced at the same tire plant, and there were calls to shut down that facility. Firestone suggested that Ford incorrectly matched the wrong tires with its SUVs. There was also the suggestion that the shock absorbers of the SUVs were rubbing against the tires, causing or aggravating the problem.

Both Ford and Firestone denied that this had been an ongoing problem. However, there was a public outcry when it was learned that Firestone had previously issued recalls of these tires in South America, but had not informed officials in other countries. Moreover, both companies had settled at least one lawsuit involving an accident caused by tread separation several years earlier.

This case raises a number of issues, some related to possible causes, as well as ethical issues.

Discuss each of these factors and their actual or potential relevance to what happended:

1. Product design.
2. Quality control.
3. Ethics.

OPERATIONS TOUR

Wegmans Food Markets

www.wegmans.com

Wegmans Food Markets, Inc., is one of the premier grocery chains in the United States. Headquartered in Rochester, New York, Wegmans operates over 70 stores, mainly in Rochester, Buffalo, and Syracuse. There are also a handful of stores elsewhere in New York State, New Jersey, and Pennsylvania. The company employs over 28,000 people, and has annual sales of over $2.0 billion. In addition to supermarkets, the company operates Chase-Pitkin Home and Garden Centers and an egg farm.

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. In fact, Wegmans is so good at what it does that

Each supermarket has an in-store bakery.

grocery chains all over the country send representatives to Wegmans for a firsthand look at operations.

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.

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 Cafe™ 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 will also 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 Cafes, 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, grilled salmon, Cajun tuna, and 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 during the lunch hour. 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 of 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

Market Café

Wegmans' "farm to market" allows local growers to deliver produce directly to stores.

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.

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, local circumstances (e.g., festivals, weather conditions) must all be taken into account. However, for seasonal periods, such as holidays, managers often check scanner records to learn what past demand was during a comparable period.

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

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

Inventory Management

Wegmans uses a companywide system to keep track of inventory. Departments take a monthly inventory count to verify the amount shown in the companywide system. Each department is responsible for ordering product. 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 be reflected in low profits for the department.

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. In a *Fortune* survey of employees on the best companies to work for in the United States, Wegmans ranked #16.

*(*Fortune, *January 12, 1998, p. 85.)*

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 department. 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.

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.

Selected Bibliography and Further Reading

Bounds, Gregory, H. Dobbins, and Oscar S. Fowler. *Management: A Total Quality Perspective.* Cincinnati: South-Western Publishing, 1995.

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

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

Hammer, Michael, and James Campy. *Reengineering the Corporation.* New York: Harper Business, 1993.

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

Owens, James. *Business Ethics*. Arlington, VA: Executive Publications, 1989.

Pfeiffer, Raymond S. *Ethics on the Job: Cases and Strategies*. Belmont, CA: Wadsworth Publishing Co., 1999.

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