CHAPTER

12 Operations and Materials Management:

Managing the Production and Flow of Goods and Services

Learning Objectives

After studying this chapter, you should be able to:

1. Describe the nature of the operations and materials management process and explain how it can create a competitive advantage for a company.
2. Identify the five main components of operations and materials management costs and the methods companies use to reduce them.
3. Differentiate between the three major kinds of operating systems companies use to produce goods and services.
4. Understand the way total quality management can significantly improve both quality and productivity.
5. Describe three materials management methods companies use to improve the flow of resources into and out of production and increase operations efficiency.

WHY IS THIS IMPORTANT ?

Flour, eggs, sugar, baking powder, chocolate, and shortening don't create much excitement when they are in the kitchen cupboard. They create a lot more excitement when someone transforms them into a cake. Whether it's a cake, a computer, or a legal document, operations and materials management processes create value in a household or a company.

A company's operations require inputs such as raw materials or parts and the skilled people and equipment to transform them into useful products. After you read this chapter, you will understand why the management of a company's supply chain and transformation processes determine how much value it can create for customers.

A Question of Business

UTC Is on Top of Its Game

Why does UTC have such an efficient and effective operating system?

United Technologies Corp. (UTC), based in Hartford, Connecticut, is a *conglomerate*, a term used to describe a company that owns a wide variety of other companies that operate in different businesses and industries. Some of the companies in UTC's portfolio are better known than UTC itself, such as Sikorsky Aircraft Corporation, Pratt & Whitney, the aircraft engine and component maker, Otis Elevator Company, Carrier Transport Air Conditioning Inc., and Chubb Corporation, the security and lock maker.

In the 2000s, UTC has been one of the most profitable companies in the world. The reason, so its CEO George David claims, is that he has created a sophisticated business model for his company based on improving the operating and materials management systems in all its diverse businesses. To understand how David continually improves UTC's operating system, it is necessary to go look at how his career as a manager in many of UTC's different divisions has shaped his thinking.

David joined Otis Elevator as an assistant to its CEO in 1975, but within one year Otis was acquired by UTC during a decade when "bigger is better" ruled corporate America and mergers and acquisitions, of whatever kind, were seen as the best way to grow a company's profits. UTC sent David to manage its South American operations, and later gave him responsibility for the company's Japanese operations. Otis had formed an alliance with Matsushita to develop an elevator for

the Japanese market, but after being installed widely in Japanese buildings, the "Elevonic 401" proved to be a disaster. It broke down much more often than elevators made by other Japanese companies, and customers were concerned not

only about the reliability of the elevators but also about their personal safety.

Matsushita was extremely embarrassed by the elevator's failure and assigned one of its leading total quality management experts, Yuzuru Ito, to head a team of Otis engineers to find out why it performed so poorly. Under Itos's direction they created a set of "process" techniques, which involved all of the employees responsible for producing the elevator—managers, designers, and production workers—to analyze why the elevators were malfunctioning. This intensive study led to a total redesign of the elevator. When the new and improved version was launched worldwide, it met with great success, and Otis's share of the global elevator market increased dramatically.

David was subsequently named president of UTC in 1992. He was given the responsibility to cut costs across the entire company including its important Pratt & Whitney division. After he successfully reduced UTC's cost structure, the company's board of directors appointed him as CEO in 1994. Now responsible for all of UTC, David decided the best way he could work to increase UTC's profitability was to find ways to improve efficiency and quality of all its diverse businesses. He convinced Ito to move to Hartford to take responsibility for championing the kinds of improvements that had transformed the Otis division. Ito then began developing UTC's TQM system, which is known as *Achieving Competitive Excellence* or ACE.

ACE is a set of tasks and procedures used by all of a company's employees to analyze every aspect of the way a product is made. The goal is to find ways to improve quality and reliability, to lower the costs of making the products, and, in particular, to find ways to make future products better. David makes every employee in every one of the company's functions at every level take responsibility for achieving the incremental, step-by-step gains that can result in innovative products.

David calls these techniques "process disciplines." He has used them to improve the operating and materials management systems in all of UTC's companies. His success can be seen in the rising performance of UTC. In the decade since he took control, he has quadrupled UTC's earnings per share, and its stock price has boomed in the 2000s.

David and his managers believe that the gains that can be achieved from its process disciplines are never-ending because its own research and development groups continue to produce innovative products at a rapid rate, and the company has continued to improve its companywide operating systems. The company also continuously acquires other manufacturing companies that can benefit from its expertise. Once UTC's systems are put into place in its new companies they then perform much better. This, in turn, increases UTC's profitability and its future looks bright indeed.[1] •

Overview

UTC's ongoing efforts to increase quality, boost efficiency, and create new, innovative products suggest how important it is for companies to continually search for ways to improve the way they make and sell goods and services. In this chapter, we examine why operations and materials management are vital functions in a company's value chain. First, we define operations and materials management (OMM) and explain how it can be such an important source of a company's competitive advantage. Second, we look at the sources of OMM costs and their relationship to profitability. Third, we describe three important forms of operating systems a company can adopt to increase productivity and quality. Finally, we look at three important materials management techniques that a company can use to improve its performance and gain a competitive advantage. By the end of this chapter you will understand the crucial role operations and materials management play in terms of making better use of a company's resources and speeding goods and services to customers.

The Nature of Operations and Materials Management

The last two chapters discuss the vital role that marketing, product development, and sales play in discovering customer needs, developing products to meet those needs, and then getting them to customers. Once a company has chosen which products to make and sell to customers, the actual process of creating goods or providing services begins. **Operations**, or an operating system, are the value-creation activities that convert a company's inputs into finished goods and services. The interaction between members of a surgical team performing open-heart surgery, the cooperative efforts of assembly-line employees standing along a moving conveyor belt to make a car, and the coordinated behaviors of lawyers, a judge, detectives, and courtroom personnel involved in a criminal trial are all examples of different kinds of operations and operating systems. In each case, value is being created by the specific activities used to bring about change and create value, for example, to cure a patient, assemble a car, try a legal case, or make a high-quality doughnut.

Manufacturing companies such as General Motors, Boeing, and Dell create value by using their operating systems to turn inputs into outputs—products such as cars, aircraft, and PCs.

Materials management is the set of activities that control the flow of resources *into* and *out of* the operating system. For a manufacturing company, materials management activities on the *input* side include the activities necessary to find and purchase high-quality raw materials or low-cost components and get them to the firm's operational units as efficiently as possible. For a service organization, input activities include controlling the flow of patients into a hospital or diners into a restaurant, for example. Materials management activities at the *output* side include (1) controlling the inventory of finished goods, (2) ensuring enough employees are available to provide high-quality customer service in banks or stores at busy times, and (3) distributing goods and services to customers.

operations A company's system of value-creation activities used to transform inputs into finished goods and services.

materials management The set of activities that control the flow of resources into and out of a firm's operating system.

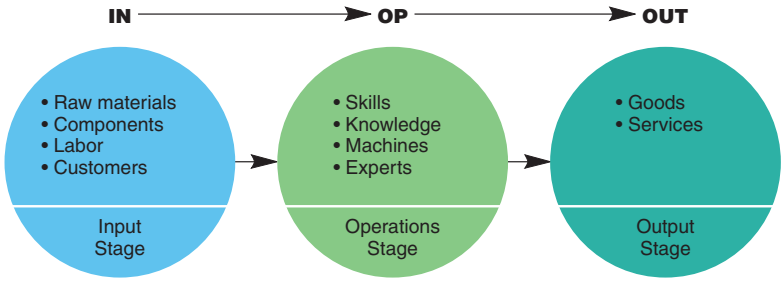
The Operations and Materials Management Process

The functional activities involved in operations and materials management are usually viewed as a three-stage process illustrated in Figure 12.1. Value creation takes place at all three stages: input, operations, and output.

At the input stage, a company's materials management expertise determines how much value the company creates for customers. For example, Amazon uses its materials management expertise to keep the books, CDs, and electronics in inventory that most appeal to customers. Similarly, McDonald's works with hamburger bun manufacturers and beef and egg producers to make sure the fast food it produces is as fresh as possible. If Amazon's customers were unable to find the popular new books they want on the company's Web site, or McDonald's customers found the company's hamburger buns were always stale, these companies would be doing a poor job at the input stage.

It's not just the quality of inputs that are important at this stage, however. It's also their flow–how well they move into and out of the company. Amazon's success, for example, depends critically on how quickly it can ship its books and other products to customers. To further speed up delivery, Amazon has formed alliances with companies such as Circuit City. Customers who order products stocked by Circuit City on Amazon's site can now pick up the products in their local Circuit City stores instead of having to wait for the products to be mailed to their homes. Likewise, a fast-food company's ability to deliver customers tasty fast food quickly is critical to its success.

Figure 12.1
The Operations and Materials Management Process



Amazon.com	• Customer-friendly online storefront	• Development and use of state-of-the-art software	• High-quality customer service and a satisfying shopping experience
McDonald's	• Alliances with suppliers and ownership of supplies of inputs	• Innovations in production methods and work procedures	• Speeding flavorful fast food to customers

The way a company combines the skills and knowledge of its employees with its machinery and computer systems to change inputs into outputs also determines how much value the company creates at the operations stage. A good operations process ultimately creates products that satisfy customers. A few years ago, McDonald's managed to create a fast-cooking burger machine and installed it in its stores. Unfortunately, the burgers didn't taste as good. In 2003, McDonald's announced it was changing its cooking operations to restore the charbroiled flavor its customers wanted. Likewise, although Amazon's online storefront is considered the best in the business, the company's success still depends heavily on the ability of its employees to develop even better software to track the changing needs of customers.

A company uses the revenue it earns from the sale of goods and services to customers to purchase more inputs and resources, such as new raw materials, new computer software, or additional highly skilled employees. Then, the value-creation cycle begins again. A company that continues to satisfy people will find that its sales revenues increase steadily over time. This, in turn, allows the company to buy additional and better resources to create even more value for customers–and profit for itself.

Video Small Business in Action

Mom-preneurship: Stroller Strides

This NBC segment, as shown on your Student DVD, introduces Lisa Druxer, the founder of the company "Stroller Strides." Druxer is a new mother who left a full-time career in fitness services to become a full-time mom. With her experience in the fitness industry, a new child, and plenty of time and energy, she found herself exercising while taking her daughter for a walk in the stroller. Druxer is creative and talented with considerable drive and energy. This gave rise to an innovation that combined full-time motherhood with her former career in fitness. The new business start-up integrates mothers spending time with their children with a physical fitness work-out. While new-business start-ups are a high-risk venture, Druxer had the full support of her husband even though she had never run a business before.

Today, Stroller Strides is a successful venture with over 100 sites nationwide. Her advice to individuals contemplating a new business startup includes: remaining flexible, having a sense of humor and to cut revenue projections by 50% while increasing by a factor of 2, projected expenses.

Discussion Questions

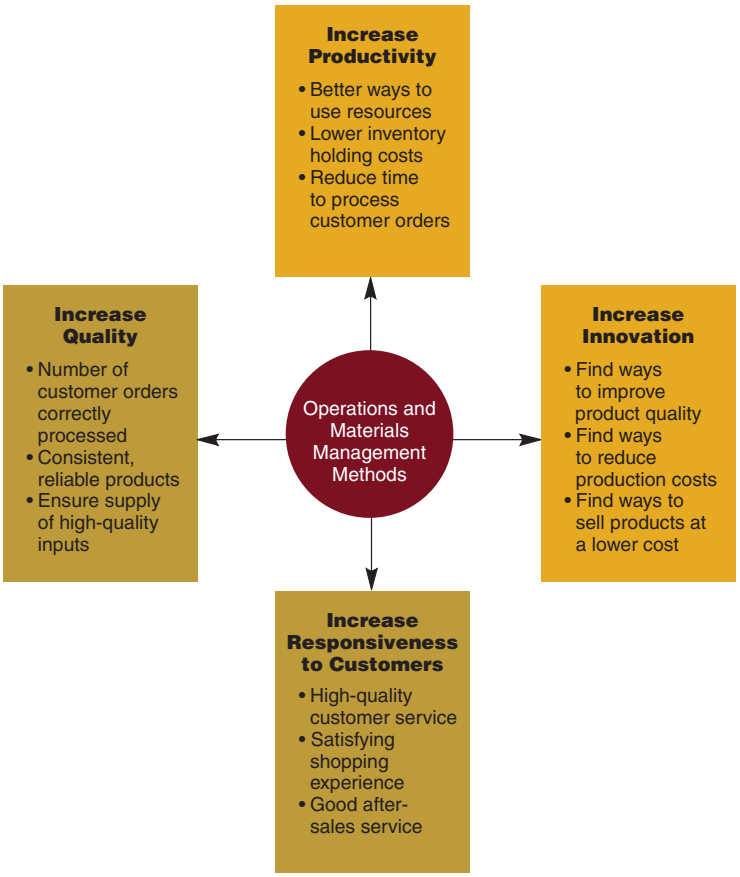
1. Using Stroller Strides as a model, explain how its operations add value that change inputs into outputs of goods and/or services.
2. What are the main sources of operating costs for Stroller Strides?
3. Would total quality management be relevant for Stroller Strides?

Amazon is a good example. The company has found that the number of its repeat customers continues to grow–as have its revenues. Likewise, McDonald's enjoyed enormous success throughout the 1990s. The company's combination of low prices and fast service created customer loyalty. In the 2000s, the growing perception that McDonald's food was not only less flavorful but also fattening lowered its appeal to health-conscious customers, who switched to fast-food chains like Subway sandwiches. In response, in 2003 McDonald's announced that it intended to change its operations. Not only would its new cooking methods result in better tasting food, it was also introducing new lines of healthy foods to its menu, such as a line of premium salads using grilled chicken. Many analysts are expecting McDonald's to introduce a new line of sandwiches as soon as it has developed the operational proficiency needed to do this efficiently. However, it will require extensive changes be made to McDonald's operating system. The company's thousands of restaurant managers, for example, will have to be retrained, and they will then have to retrain all of McDonald's crews.

Using Operations and Materials Management to Gain a Competitive Advantage

How well a company controls its operations and materials management activities will have a big impact on the overall profitability of its business model and its ability to create a competitive advantage for itself. Recall from Chapter 4 that the four building blocks necessary to gain a competitive advantage are superior productivity, quality, innovation, and responsiveness to customers. Figure 12.2 shows how this relates to operations and materials management.

Figure 12.2
Operations, Materials Management, and Competitive Advantage



Productivity

To continue with our example of Amazon and McDonald's, to achieve superior *productivity* both companies must continually search for better ways to use their resources to create value for customers. Amazon can increase its productivity by reducing the time it takes to process customers' orders. McDonald's has installed clocks in some of its restaurants that show customers and employees the time it takes to complete an order–and to encourage speedy service, of course.

Amazon's early business model assumed that the Internet would give it a competitive advantage because the costs of operating an online storefront are a fraction of the costs needed to operate a national chain of bricks-and-mortar bookstores such as Border's. Once Amazon's business started to grow, however, the company found that it needed to invest over $10 billion to build the five huge warehouses necessary to serve its U.S. operations. These high costs resulted in huge operating losses in the early 2000s, but the major gains in productivity it derived from the new warehouses subsequently allowed Amazon to return to profitability by 2004.

QUALITY For both Amazon and McDonald's the number of customer orders that are accurately processed is a major indicator of product quality. When customers return books or fast food because it is not what they ordered, operating costs rise and reduce the company's profitability. In fact, studies show that companies that can reduce the number of incorrectly processed orders from 3% to less than 1% can significantly increase their profitability. Of course, the quality of a product can only be as good as the quality of the inputs that go into making it. Cars and computers, for example, are only as reliable as the components used to make them. Ensuring that the firm has a reliable supply of high-quality, low-cost inputs is therefore crucial. (We discuss more about the quality of components later in the chapter.)

INNOVATION Innovation not only involves creating new and improved products, but also finding new and better methods to make them–methods that will increase product quality or reduce operating costs. McDonald's has long been a leader in making innovative kitchen equipment to speed up the production of fast food. Indeed, Ray Kroc, the entrepreneur who built the McDonald's chain, got his start by selling state-of-the-art machines that could make six milkshakes at a time. A major operating challenge facing McDonald's is to create a burger-cooking method that simultaneously improves flavor and keeps costs low. As we discussed earlier in the chapter, the company found a way to speed up the cooking process, but flavor suffered. Introducing innovative new lines of salads and sandwiches also means McDonald's will have to purchase and ship a wider range of products to its thousands of restaurants–and salad is one of the most perishable of all foods.

Amazon faces several OMM innovation challenges, too. The company has already spent hundreds of millions of dollars to install and develop innovative new IT systems, such as SAP's ERP system, to meet its materials management needs. That said, it needs to continually upgrade its storefront IT to create an increasingly better shopping experience for its customers. Amazon also needs to adopt new methods to allow it to control the way it acquires, stocks, and ships the thousands of products it currently sells. Radio frequency tags could be the answer. Radio frequency tags allow a firm to "earmark," or track, each product that goes into and out of its warehouses.

Did You Know?

Henry Ford popularized the assembly line but did not invent it. Mechanized assembly lines were used in milling and baking and in packing houses over 200 years before Ford.[2]

RESPONSIVENESS TO CUSTOMERS Finally, OMM plays a major role in creating competitive advantage by increasing responsiveness to customers. Customers, for example, prefer quick service to slow service, and good not poor after-sales support. Good OMM facilitates this. In Amazon's case, good OMM practices help ensure that books are always in

stock when customers request them and that "hot" new books are added to Amazon's title list when customers begin demanding them.

Similarly, it is vital that McDonald's rapidly change the kinds of fast food it offers when customer tastes change. The physical setting in which the company serves food is also important to customers. McDonald's has invested billions of dollars to upgrade and refurbish its older restaurants to improve their appeal to today's more sophisticated customers. It is also installing WiFi in many of its restaurants.

BALANCING COSTS VERSUS REVENUES It is important to note that a company must pay attention to all four competitive-advantage sources. A company that puts all its efforts into reducing costs to increase efficiency, for example, can easily lose sight of the fact that this might lead to lower quality, lower innovation or lower responsiveness to customers–which will reduce the demand for its products, revenues, and profitability. For example, operating costs often rise as the range of products a company designs, makes, and sells increases. McDonald's provides us with yet another example here: Some analysts believe the chain was slow to offer a wider variety of food because it was too focused on reducing its operating costs. McDonald's wanted to keep its costs low so it could keep prices low, of course. But, when the company's sales plummeted along with its profitability, McDonald's managers realized they had to find low-cost ways to offer customers new kinds of meals.

Gateway provides another example. Gateway became concerned about the high costs associated with providing after-sales service to its PC customers. To reduce costs, it ordered its customer service representatives *not* to help customers when they installed software on their new PCs that conflicted with Gateway's installed software. Customers became infuriated. Within months, news of Gateway's poor customer service spread, and sales of its computers plummeted. Not surprisingly, the PC maker's top managers have since reversed this order.

Some analysts believe that McDonald's was slow to change its food offerings because it was too focused on reducing its operating costs.

In both these cases, the attempt to reduce costs led to reduced revenues because Gateway and McDonald's were not providing customers with what they wanted–innovative, quality products, and/or good customer service. As we discuss in other chapters, investing capital to improve a product or customer service can increase operating costs. This is not a problem, however, as long as the investment maintains or increases the company's revenues. Moreover, if revenues do increase more than costs–something that normally happens if managers have made the right choices–a company's profitability will also increase. The success of a company's business model is based on increasing revenues through skillful marketing and product development, for example, and on reducing operating costs through well-designed operations and materials management methods.

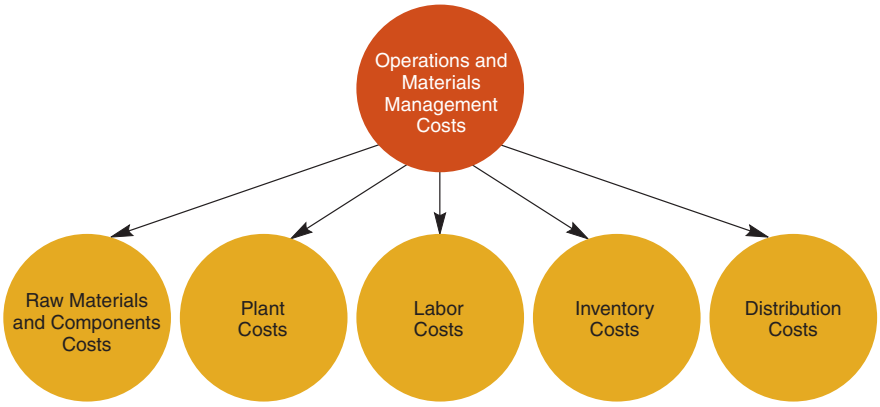
Operations and Materials Management Costs

Let's now review the sources of operating costs involved in OMM activities to understand their impact on a company's profitability. The five main sources of operating costs affected by OMM activities are the costs of (1) raw materials and components, (2) plant, (3) labor, (4) inventory, and (5) distribution. These costs are outlined in Figure 12.3.

Raw Materials and Component Costs

Inputs such as raw materials and component parts comprise a significant percentage of companies' total operating costs, particularly companies that makes physical products

Figure 12.3
Five Major Components of OMM Costs



such as cars, aircraft, aluminum cans, computers, furniture, or hamburgers. A firm's materials management function is responsible for finding companies that supply high-quality, low-cost raw materials and components. As we discussed in Chapter 4, companies are now searching around the world for these inputs, so global outsourcing has become commonplace. To remain competitive, most multinationals now buy their component parts in countries where they can be acquired inexpensively.

Other companies go so far as to purchase the companies that supply them with their raw materials and components. This gives them greater control over the supply of inputs they receive, which can be especially important for critical inputs. Purchasing its suppliers can also help a company lower the cost of its inputs and increase their quality. McDonald's, for example, purchased vast cattle ranches in South America to allow it to obtain low-cost, high-quality beef. Similarly, Dole owns huge banana and pineapple plantations in the Caribbean and Hawaii. For Dole, the need to maintain control over the quality of the bananas it sends to U.S. supermarkets–to ensure they are neither too green nor too ripe when sold–was a major consideration.

Plant Costs

Plant costs, the cost of the machinery, computers, tools, buildings, and equipment needed to transform inputs into finished products is the second component of OMM costs. When Intel decides to make a new kind of microprocessor, it knows it will cost $1 to 2 *billion* to build and equip a factory with the technology necessary to make the chip. One of the goals of OMM is to find ways to reduce plant costs. Companies also have the option to outsource their operations and contract with manufacturers abroad to make their products. Nike and The Gap, for example, do not make their shoes and clothes. Manufacturers abroad that can make these products at a lower cost do. Still other companies prefer to lease, rather than own, their plants, and even their headquarters and retail stores. This way they don't have to invest scarce capital in buildings and equipment or pay to maintain them.

Another way to avoid the high plant and capital costs associated with making and selling products is by franchising. Today, for example, it would cost a new company tens of billions of dollars to establish a nationwide chain of retail outlets. Few new companies can raise the capital needed to do this. By franchising, a young company can quickly increase its national presence and invest its capital in vital marketing and product development activities to grow its sales. Companies such as McDonald's, Subway, Midas Muffler, and Gold's Gym reduce their operating costs by making their franchisees invest the capital needed to open stores. This allows these companies to use their capital in other ways. The choice of how to use a company's capital to get the best return on its investment in buildings, machinery, and equipment is a complex materials management issue. Later in the chapter we discuss how companies design their operating systems to do this.

Many U.S. companies establish maquiladoras near the U.S.-Mexico border in order to take advantage of the low-wage rates there.

Labor Costs

The labor costs involved in making or providing goods and services are a third component of operating costs. For many companies, particularly service companies, labor is their biggest cost. The cost of labor is a function of (1) the number of employees needed to produce a given quantity of outputs and (2) the amount each employee must be paid–something which is often a function of the employee's skills, knowledge, and experience, (3) the health and social insurance benefits each employee is given. For many companies, benefits make up one-quarter to one-third of their total labor costs. The kind of technology a company uses also determines its labor costs, as we discuss later.

maquiladoras U.S. companies' manufacturing plants in cities along the Mexican border.

Today, to take advantage of the low cost of labor in countries overseas, companies often ship the machinery and computers they need to make their products to these countries and establish factories there. Many U.S. companies took this route to enter Mexico and establish **maquiladoras,** the name given to U.S. companies' manufacturing plants in cities along the Mexican border. In the last decade, China's low labor costs have made it the location of choice for most multinational companies.

The decision to set up manufacturing operations in a country abroad, rather than just contract with manufacturing companies in that country to make a product, often depends on the complexity and sophistication of the machinery and equipment needed to make the product. The machinery needed to make clothes and shoes, for example, such as cutting and sewing machines, is relatively simple. Hence, using a company overseas to make these products is often the lowest cost method. If GM decides to make cars in China, however, no Chinese carmaker possesses the knowledge and equipment needed to assemble cars to its specifications. GM must make the multibillion dollar investment needed to build and operate a factory there. This is, in fact, what GM has done. Because such a large investment is needed, multinationals try to locate countries that have a stable political and economic system to minimize their risks. (Companies obviously do not want their factories ravaged by war, a poor economy, or risk their being seized by corrupt national governments or lawless citizens.)

Frequently, labor costs increase when a company requires employees with more skills, knowledge, and experience to provide customers with services. A hospital is a good example. Hospitals need highly skilled nurses, doctors, radiographers, and other kinds of medical specialists to provide high-quality patient care. Since these people also work around the clock to deal with patient emergencies, high labor costs are associated with running a hospital–something that helps explain high health-care costs.

To reduce their labor costs, many service companies search for ways to redesign their production systems. Companies such as supermarkets, department stores, and fast-food restaurants have found many ways to have customers perform some of their own services. Today, we take for granted that we gas our own cars, scan our own groceries, and bus our own tables. But this wasn't so in decades past. If customers want better quality customer service today, they often have to pay extra for it–luxury food stores, department stores, and expensive restaurants pass their higher labor costs on to customers in the form of higher priced products.

The Internet has become an important labor-cost reducing tool for many companies. Checking and bill paying, buying and selling stocks, and planning and booking vacations online are now tasks many customers do for themselves–work previously handled by customer service reps. Customers also benefit, however, because they have the ability to easily access their banking or credit card records, brokerage records, and visually choose the seats they want on a flight, for example. Plus, they don't get put on hold waiting for a customer service rep to come on the telephone.

Inventory Costs

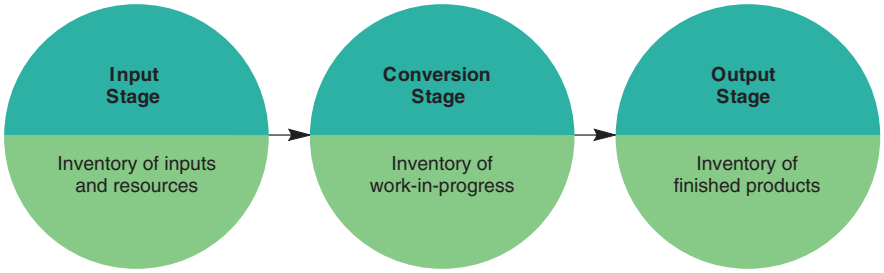
inventory The resources—materials, supplies, and goods—a company holds in stock.

work-in-process goods The semifinished goods and services that move through a company's production process.

Inventory is the quantity of resources–materials, supplies, and goods–a company has in stock. Inventory is held at three stages in the OMM process, which are shown in Figure 12.4. At the input stage, inventory consists of raw materials, component parts, repeat customers, and so on. At the operations stage inventory consists of **work-in-process goods,** semi-finished products moving through the production process, such as partially assembled computers and cars or patients being treated in hospitals. At the output side, inventory consists of the stock of finished products ready to distribute to customers.

Holding inventory at each of these stages is expensive for companies. A company's capital is tied up in these items and no return is received on them until revenues are generated from their sale. One way to reduce these costs is with IT. IT can help managers better forecast the inputs required to makes the inputs and finished products it needs to have on hand to meet demand in a certain period of time, a day or week, for example. Another way to reduce inventory costs is to shorten the time it takes to assemble or manufacture a product. The faster that inputs can be assembled into finished products and shipped out the door to customers, the lower the costs of holding these inputs in inventory is. Suppose, for example, a luxury carmaker currently spends two weeks to make a $60,000 car. The cost of the inputs needed to make the car increases every day until the car is gradually assembled–and then shipped and sold. If the firm's operations can be redesigned so the car can be made and sold in one week versus two, the cost of the company's inventory will be reduced by half.

Figure 12.4 Three Types of Inventory



Finally, at the output side a major inventory cost is the stock of finished products a company holds in inventory, such as an appliance maker that stores thousands of refrigerators in its warehouses, or a carmaker that has thousands of cars sitting in the parking lots surrounding its assembly plant. Ideally, a company would like to ship products to customers as soon as they are made–then it will receive the sales revenues from them as quickly as possible. Every day a car spends on the lot of a carmaker, and then on the lot of a car dealer, operating costs increase. A typical car dealership that carriers an inventory of 500 cars may have $10 million tied up in its stock of cars (assuming the average cost of each car is $20,000). This is why car dealers are so anxious to get them off the lot!

On the other hand, suppose a company is cautious and decides to make only a small amount of a product to avoid having high inventory-holding costs. But if the product becomes extremely popular, the company won't have enough of it on hand. Most customers don't like to wait for products; frequently they will buy a rival's product instead. If this happens, the firm will lose a large amount of sales revenues–surely more than it saves on inventory-holding costs.

When a company makes just enough of a product to satisfy customer demand, it is maximizing sales revenues while minimizing its inventory costs. But this is a difficult thing to accomplish. Companies frequently make too much or too little of a particular product. Companies that make too much of a product often have to sharply discount their price to sell them. This reduces their profitability and can result in major losses. Due to overproduction, Dial, the soap company, was once forced to sell soap at such a deep discount that it lost an astonishing $300 million.

By contrast, good forecasting and inventory management practices are hallmarks of Dell. Dell has become the market leader by driving down operating costs–including its inventory-holding costs. Dell involves its suppliers in the component design process; informs them months in advance of its future requirements; and makes its suppliers establish warehouses close to its assembly operations so they, rather than Dell, bear the costs of holding inventory. Because Dell has the lowest operating costs of any PC maker it can offer its customers lower prices while still earning a 20% profit on each PC sale. None of its competitors can match its prices and make this same level of profit because their OMM costs are higher.

Distribution Costs

distribution costs The cost of getting products to customers.

The fifth major component of operating costs is **distribution costs,** the costs of getting products to customers. Transporting a car to a dealership costs hundreds of dollars. BMW, in fact, directly bills its customers about $650 per automobile to have their cars shipped. Similarly, when it is not offering free shipping, Dell charges $65 to ship a PC to a customer's home. Dell and BMW's delivery charges are visible to customers, but often delivery costs are built into the price of products, so consumers can't tell readily what they are. In 2003, Amazon reported a record increase in its revenues after it began to offer customers free shipping on orders over $50. Internet customers are sensitive to paying the extra cost of shipping. By building the shipping cost into the price of its products so it wouldn't be apparent, Amazon boosted its sales significantly.

Because high delivery and shipping costs increase the price customers have to pay for a product, companies, of course, try to find ways to reduce these costs. Cases of soft drinks are heavy and expensive to transport, for example, so to reduce shipping costs, Coca-Cola and PepsiCo just ship their syrups to regional and local bottlers and fast-food restaurants. The companies Coke and Pepsi ship to then mix the syrups with water and locally distribute the soft drinks produced. This keeps distribution costs to a minimum.

To reduce the high costs associated with shipping and distributing products abroad, multinationals often establish manufacturing operations abroad or contract with companies in countries overseas to make their products for them. Dell, for example, opened a large manufacturing plant in Ireland to supply countries within the European Union with its PCs, and a plant in Malaysia to serve the Asian region. Chemical and plastics makers such as DuPont, Shell, and Monsanto license the rights to manufacture many of their heavy, bulky products to companies around the world. This is more profitable than making these products in the United States and then shipping them elsewhere.

A major distribution decision companies have to make is whether to distribute their products themselves or outsource the task to other companies. Some companies, such as Anheuser-Busch, Dillard's, and Wal-Mart own their own trucking fleets and perform their own distribution activities. But many smaller companies contract with specialized trucking companies such as Hunt, Knight, and Yellow Freight to handle the shipping of their products because this reduces their costs. To grow their profits, both UPS and FedEx are becoming increasingly involved in not only the distribution of different companies' products but *all* of their materials management activities, including their inputs. Because UPS and FedEx are so efficient at what they do, they can perform materials management activities at a lower cost than these companies can. This lowers the multinationals' operating costs and frees up capital to invest in value-chain activities that generate more profit–by increasing global marketing, for example.

To grow their profits, FedEx and UPS are contracting with multinationals to take control of their materials management activities. This involves managing both the flow of inputs into their operation systems as well as distributing their finished products.

Of course, the Internet has changed the way companies transport their products to customers, too. Hundreds of millions of transactions take place each year between customers and company that have virtual storefronts. Now companies no longer have to ship their products to wholesalers or bricks-and-mortar stores, which boosts their profitability. The growth of the Internet has been a major source of revenue for companies like UPS and FedEx, which have seen the volume of packages they handle soar. In turn, this has allowed them to find ways to reduce their own operating costs and pass the savings on to their customers.

Types of Operating Systems

Now that we have discussed how OMM activities affect a company's operating costs and competitive advantage, we can take a close look at the different ways in which goods and services are produced. In other words, we are going to examine the different types of operating systems that are used to make goods and services. The three types of operating system we discuss below are small-batch production, mass production, and flexible production. (See Figure 12.5.) Then, we discuss how techniques like Total Quality Management (TQM) are used to improve operational efficiency and effectiveness.

Small-Batch Production

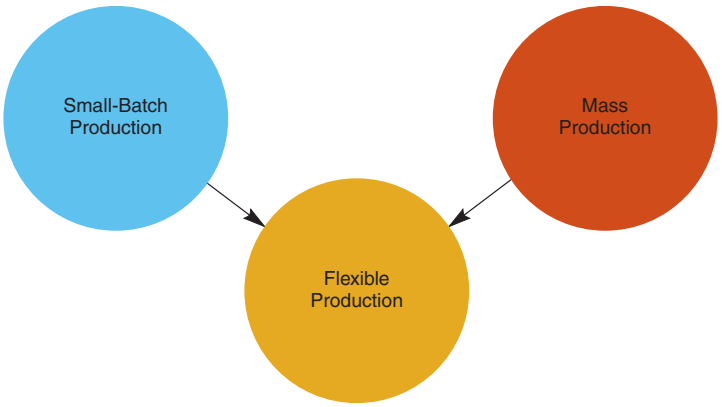
small-batch production An operating system designed to make one-of-a-kind or small quantities of customized products.

customized products Products designed to match the needs of individual customers.

Companies like Krispy Kreme that use **small-batch production** make one-of-a-kind or small quantities of customized products. **Customized products** are products that are designed and made to more closely match the needs of individual users–like a doughnut lover's desire for freshly made, Bavarian-cream filled doughnuts topped with fresh raspberries and Belgium chocolate. Other examples of companies that use small-batch production include a specialty furniture maker that makes chairs designed according to customers' specifications; a team of surgeons and nurses who are experts in heart transplant surgery; and software consultants who can modify ERP software to suit the needs of companies in the pharmaceutical industry.

In small-batch production, the operating methods used depend heavily on the judgment of employees about how and when to use machines and equipment. A custom furniture maker, for example, uses an array of tools–including lathes, hammers, planes, and saws–to transform boards into a chair. However, which tools are used, and the order in which they are used, depends on how the furniture maker chooses to build the chair. Likewise, as Business in Action suggests, Krispy Kreme employees have to decide how to utilize the machines needed to make doughnuts. The employees have to decide how and when to reconfigure the machines to make exactly the type and quantity of doughnuts that are in most demand, for example.

Figure 12.5
Three Types of Operating Systems



Business in Action

How Krispy Kreme Makes Doughnuts

Founded in 1937 in Winston-Salem, North Carolina, Krispy Kreme has grown to become a leading U.S. specialty retailer of premium quality, yeast-raised doughnuts. Krispy Kreme's doughnuts have a broad customer following and command a premium price because of their unique taste and quality. Although it only had 100 stores in 1999, by 2004 it had over 300. As it has expanded rapidly, Krispy Kreme has gone to great lengths to develop and use advanced operating and materials management methods to maintain the high quality of its doughnuts and increase its responsiveness to customers. Krispy Kreme calls its store operations "doughnut theatre" because the physical layout of its stores is designed so that customers can see and smell the doughnuts coming out of its impressive, company-built, doughnut-making machines.

What are the OMM elements of Krispy Kreme's business model? The story starts with the 65-year- old company's secret doughnut recipe that is kept locked up in a vault. None of its franchisees know the recipe for making its dough. The company sells the ready-made dough and other ingredients to its stores where they are changed or converted into the finished product–doughnuts. Even the machines used to make the doughnuts are company-designed and produced so no doughnut maker can imitate its unique cooking methods and thus create a similar, competing product.

The doughnut-making machines are designed to produce a wide variety of different kinds of doughnuts in small quantities. Each store makes between 4,000 and 10,000 dozen doughnuts per day that are sold in the store and it outlets such as supermarkets and convenience stores. Krispy Kreme is constantly refining its operating system to improve efficiency. For example, in 2003 it redesigned its doughnut machine to include a high-tech extruder that uses air pressure to force doughnut dough into row after row of rings or shells. Employees used to have to manually adjust the air pressure as the dough load lightened. Now, however, this is all done automatically. A new doughnut icer tips finished pastries into a puddle of chocolate frosting. Before the machine was invented and installed, employees had to dunk the doughnuts two at a time by hand. Although these innovations may seem "small," across hundreds of stores and millions of doughnuts they add up to significant gains in productivity.

To operate its small-batch production system efficiently, Krispy Kreme must have the different ingredients on hand just when they are needed so the doughnuts are fresh. Krispy Kreme therefore developed a state-of-the-art materials management method to control the supply and quality of its inputs. The company uses SAP software, for example, and developed an online portal called mykrispykreme.com. Franchisees can log on to mykrispykreme.com and order exactly what supplies of ingredients they need, when they need them. Second, the OMM information franchisees need to operate their stores, such as how to make a new kind of doughnut or repair a broken machine, is also available at mykrispykreme.com via streamed video. Franchisees even have access to predictive modeling software that helps them forecast how many doughnuts they should make each day due to changes in the weather and other factors. (More doughnuts are sold on cold, rainy days, for instance.)

Krispy Kreme calls its operations "doughnut theatre." The physical layout of its stores is designed so that customers can see and smell the doughnuts coming out of its doughnut-making machines.

Krispy Kreme's sweet rise to success was followed by an equally dramatic sour fall in 2004, however. Its company-wide inventory and operating costs had become bloated; lower profitability resulted, and the company's stock price plummeted. In the future, Krispy Kreme will have to tighten up its belt to remain competitive.[3]

The advantage of small-batch production is that the operating system is flexible–employees can change their work procedures and adapt their techniques to suit the orders of individual customers. This gives a company the ability to produce a wide range of products that can be customized. Small-batch technology allows a custom furniture maker, for example, to satisfy the customer's request for a certain style of table made from a certain kind of wood. For similar reasons, high-fashion designers and makers of products like fine perfumes, custom-built cars, and specialized furniture use small-batch production.

OPERATING COSTS As Krispy Creme's story suggests, small-batch production is an expensive operating system and results in higher operating costs. Costs are higher when only small quantities of a particular product are made. In addition, a lot of time and effort is spent in fine-tuning a product and then finding the best kinds of inputs to make it–so raw materials and labor costs tend to be higher, too. As a result, the goods and services that small-batch production creates command higher prices. Specialized health care, custom software installations, Krispy Kreme doughnuts, or a Rolls-Royce car are examples of products you will have to pay more for because small-batch production processes were used to produce them. However, the price *has* to be very high if the company making the product is to profit.

Mass Production

mass production An operating system based on the use of automated machines and standard operating procedures to make work routine and create a large number of standardized products.

standardized products Products that are identical.

Mass production is an operating system based on the use of automated machines and standard operating procedures (SOPs). SOPs have been worked out in advance, which makes the work easy, or routine, so much less employee judgment is needed on a day-to-day basis. Companies that operate mass production systems manufacture large quantities of **standardized products,** that is, products that are identical, such as a razor blade, aluminum can, or hamburger. Instead of a group of skilled employees using hand tools to make a piece of custom furniture, for example, employees positioned along a production line use high high-speed saws and lathes to cut and shape boards into uniform components that are then assembled into thousands of identical tables or chairs. Each employee follows a standard operating procedure to perform one of the specific tasks needed to complete the final product.

Effective materials management is a crucial requirement for mass production systems to operate efficiently. The raw materials and component parts used to assemble a product must be made to a consistent quality and specifications to prevent problems from arising during the assembly process. To make a standardized product you must have standardized components–so the task facing materials management is to find reliable suppliers or to ensure a company can make its own high-quality inputs.

Instead of a group of skilled employees using hand tools to make a piece of custom furniture, employees on a mass production line use high-speed saws and lathes to cut and shape boards into uniform components that are then assembled into thousands of identical tables or chairs.

To increase their efficiency, service organizations like fast-food restaurants, airlines, and discount stores have imitated the mass production methods used by manufacturers. McDonald's, for example, devoted its energies to creating machines and SOPs that would allow its employees to make its food as quickly and inexpensively as possible. Similarly, Southwest Airlines decided to use only one kind of plane, the Boeing 737, to standardize its operations. This maximizes the ability of its employees to efficiently operate and service its fleet.

OPERATING COSTS Mass production is a highly efficient operating system that results in low operating costs. Costs are lower because when large, often millions, of units of the same product are made, companies *learn* how to reduce costs, and they design machines and technology to make the process more efficient. The costs of making a product such as a table, PC, or car fall dramatically when mass production processes are used.

Because its operating costs are lower, a mass producer can reduce the price of its products. This will substantially increase customer demand. Recall that Henry Ford changed manufacturing history when he pioneered the assembly of the Model-T car using mass production methods (replacing the old small-batch method). His use of a moving conveyor belt, uniform car components, and employees who each did a specific task in sequence increased productivity and manufacturing efficiency a thousand times over. By shrinking operating costs, Ford was able to lower the cost of a Model-T and create a mass market for his cars. Similarly, McDonald's, Southwest, and Wal-Mart have all created mass markets for their products.

As you can see, mass production is essentially the opposite of small-batch production. It allows a company to achieve a competitive advantage via high productivity, low operating costs, and low product prices. The downside of mass production is that it is hard to be responsive to customers and provide them with products that better fit their needs. A customer has to select from what is on McDonald's menu, for example, or from what shirts Wal-Mart chooses to carry, or what colors Ford chooses to offer on its car models.

Flexible Production

Suppose an entrepreneur creates a new form of operating system and founds a new company that can achieve the advantages of both small-batch *and* mass production. Now, it can make small batches of a wide range of customized products at little or no extra cost than a company that uses mass production methods. This will attract more customers because the company can rapidly introduce new products that incorporate innovative features and the latest design trends. This gives the company a competitive advantage.

Many companies today are attempting to do just this. They are searching for new ways to design their operating systems to make them flexible enough to respond to changing customer needs but also to keep costs to a minimum. These new developments in OMM have resulted in what is known as **flexible production**, an advanced, computer-based operating system that allows mass production to achieve the benefits of small-batch production but at a lower cost. Computer-integrated manufacturing and flexible employees and work teams are integral elements of flexible production.

flexible production An advanced operating system that combines the benefits of mass production with the benefits of small-batch production.

computer-integrated manufacturing A manufacturing technique that controls the changeover of machines from one operation to another via computer software.

COMPUTER-INTEGRATED MANUFACTURING In flexible production, a more complicated sequence of operations is needed to make a wide variety of customized products. The key to preventing costs from increasing in such a system is to use **computer-integrated manufacturing** (CIM). CIM is a manufacturing technique that controls the changeover from one operation to another by means of the commands given to machines through computer software. A CIM system eliminates the need to physically retool machines to produce different or customized products. The operating system is composed of a series of computer-controlled machines or robots, each capable of performing a range of different production operations. A master computer schedules the movement of products by a series of robots. Unlike a dedicated machine, a robot can be reprogrammed instantly to perform a number of different tasks. The robots can "behave" flexibly, in other words, unlike a dedicated machine. As a result, they can be used to create many different kinds of products. Besides being so flexible, this type of an operating system also results in lower costs: The cost of reprogramming a robot instantly to act differently is much less than the cost of retooling or changing

Did You Know?

Willis Carrier designed his first air conditioning system in 1902 for a New York printer who struggled with temperature and humidity affecting his paper and ink. Carrier solved a variety of production problems by applying chilled air to the manufacturing of razor blades, tobacco, soap, and bread, before taking it to stores and theaters and airplane repair in hot climates. Sixty years later, air conditioning was popularized for home use.[4]

over a dedicated machine, or buying and installing an entirely new one. Motorola's cellular phone and pager factory illustrates many of the operational advantages of robots and flexible production.

Business in Action

Motorola's Factory of the Future

Motorola is one of America's oldest consumer electronics organizations. The company developed the world's first car radio in 1930 and quickly entered the home audio and television market. Today, Motorola is a global leader in digital and wireless communications technology and a leading producer of cell phones. Nonetheless, it faces intense competition from companies such as Samsung and Nokia.

To compete effectively, Motorola created a "factory of the future" that is able to customize products, such as cell phones, to the individual needs of customers within hours. At its futuristic factory at Boynton Beach, Florida, Motorola can make a customized phone in just two hours.

This is how the customization process works: A salesperson in the field takes the customer's order for a cell phone designed to operate on a specific frequency range and have one of a number of customized features, such as a particular type of digital camera. The salesperson electronically relays this information as a bar code to the factory. There the CIM system scans the specifications and creates the circuit board design for the pager.

The production process is then handled by a series of computer-controlled robots. As the cell phone passes down the production line, each robot reads the bar code and performs the necessary operations. Each cell phone in the line can be made to order because the CIM system automatically selects the sequence of operations needed to assemble it to a customer's specifications. The finished products are then electronically scanned, tested, and shipped to the customer. Not surprisingly, customers like Motorola's ability to provide them with customized products, and demand has soared.[5]

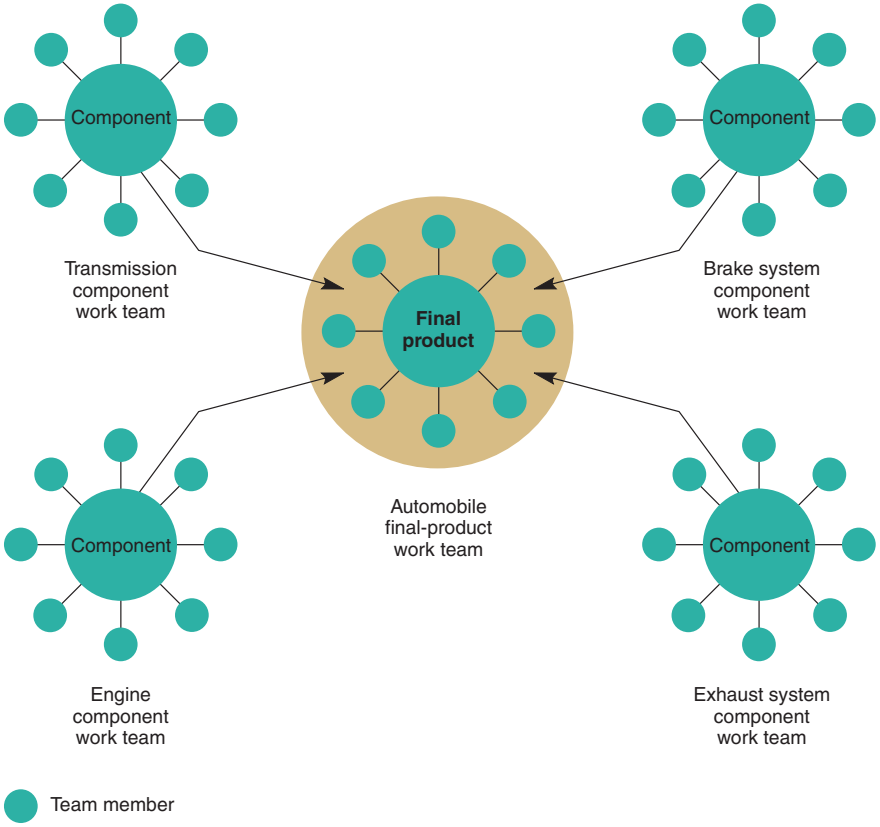
FLEXIBLE EMPLOYEES AND WORK GROUPS Flexible production is not only achieved through computers and machines, however. It is also achieved by the way employees are organized and controlled. In mass production, employees learn only the specific work procedures necessary to complete a single operating task. Moreover, because employees perform their tasks in sequence, any alteration in the task of one employee directly impacts the performance of all the others. This makes it difficult or impossible to change the design of the product coming off the assembly line.

With flexible production, employees' tasks are more complex because SOPs continually change depending on which customized product is next up for assembly. Employees must develop the different skills needed to assemble different products. Generally, an employee first develops the skills needed to accomplish one operating task and then over time is trained to perform all the other tasks that need to be done to make a product. Employees can then be moved when and where they are most needed.

flexible work team A team of self-managed employees who assume responsibility for performing the operating tasks necessary to make a part, or all, of a product.

Flexible work teams are a hallmark of flexible production. A **flexible work team** is a group of employees who assume responsibility for performing the operating tasks necessary to make a part, or all, of a product. A flexible work team is self-managed: The team members jointly assign tasks and decide which employees should perform which tasks as necessary. So, production line employees who were used to being assigned to perform one specific task along the assembly line are now placed in work groups that are given the responsibility for managing all of the operations needed to make a part, or all, of a product.

Figure 12.6
The Use of Flexible Work Teams to Assemble Cars



At a Ford plant, for example, one work team might be responsible for all the operations involved in the assembly of the car's transmission. This team then sends the work-in-process to the body assembly area, where another team takes over and fits the transmission into the car body. Figure 12.6 illustrates the way in which flexible work teams perform their activities. Separate teams assemble different components and turn those components over to the final-product work team that completes the finished product.

Globe Metallurgical, which makes specialty steel products is a leader in the use of flexible production, something that has allowed it to surpass its competitors in product quality, sales, and profit growth. Globe began experimenting with flexible, self-managed work teams when ten managers and thirty-five salaried employees were charged with the task of increasing the productivity of two of Globe's furnaces. They began to experiment with ways to reorganize operations to increase the efficiency of work operations. All the old work SOPs were abandoned, and different ways to sequence tasks were tested. It soon became clear that productivity could be increased if welders, crane operators, furnace operators, forklift operators, stokers, furnace tappers, and tapper assistants worked cooperatively in teams.

By trial and error, managers discovered that a flexible work team of seven employees, who could each perform all the others' jobs, could efficiently operate one furnace. Each team was put under the supervision of a team leader who took the responsibility of coordinating the team's work schedule with those of the

Did You Know?

One study showed that the value stream for a can of soft drink–creating the can, the cardboard box, and the drink itself–required 319 days, but all but 3 hours of that time, the product was waiting for the next stage of processing. The Japanese call this *muda* or "waste" in the production process.[6]

other teams. Every day brought new suggestions, and after several months Globe found that by using flexible work teams it could operate its furnaces with only one-third of the employees that were previously necessary.

production layout The way teams of employees are physically grouped into work cells or pods to assemble a product.

Another way in which flexible work teams can be organized to increase productivity is by experimenting with new **production layouts**, that is, the way employees are physically grouped into work cells or pods to assemble a product. For example, Bayside Controls, a small gearhead manufacturer in Queens, New York, converted its thirty-five person assembly line into a four-cell design where seven to nine employees form a cell. The members of each cell perform all the measuring, cutting, and assembly operations involved in making the gearheads. Bayside's managers say that the average production time it takes to make a gear has dropped to two days from six weeks, and it now makes 75 gearheads a day–up from 50 before the change.

Improving Operations Quality: Total Quality Management

total quality management An operations technique used to continuously improve the production process, increase the quality of products, and help companies lower their operating costs.

Flexible production and the use of flexible teams and CIM are not only directed at improving productivity but also at increasing product quality. The members of flexible work teams, for example, are also responsible for controlling the quality of their performance, and the finished products that result. Increasingly, companies are adhering to the principles of total quality management. **Total quality management** (TQM) is an operations technique aimed at continuous improvement–improvement in product quality and the reduction of production time and waste. The idea behind TQM is to *empower* employees to find ways to improve the work process as UTC (discussed in the opening case) has done.

One important TQM step is to solicit suggestions from lower-level employees about how to improve the quality of the organization's products.

A company that introduces TQM often begins by *benchmarking* some other company that does a particular functional activity extraordinarily well. The company then seeks to match that company's performance. Achieving this objective becomes similar to achieving a stretch goal, discussed in Chapter 6–it is a challenging objective that managers and employees work hard to do. Let's look at a couple of examples. To improve quality, Daimler-Chrysler benchmarked Lexus's low defect rate as the standard it sought to achieve. Similarly, UPS used FedEx's guarantee of overnight delivery as a benchmark when designing its own overnight delivery service. In fact, UPS searched so relentlessly for ways to achieve this benchmark that some analysts today think its overnight operations are now even more efficient than FedEx's.

In addition to establishing benchmarks, other important steps in TQM include:

- Identify defects. Trace them back to their sources, and fix quality problems.
- Design products that are easy to assemble.
- Identify customer needs. Translate those needs into quality requirements, and see that these quality requirements shape the production system of the organization.
- Work to break down the barriers between functional departments to get the cooperation needed among them to improve operating methods.
- Solicit suggestions from lower-level employees about how to improve the quality of the organization's products.

Employees in a TQM system are expected to make suggestions that improve all aspects of the work process. They then share their ideas with their managers so that it

quality control circles Team meetings in which production employees discuss ways to improve operating quality and productivity

can be communicated throughout a company. New ideas often originate in **quality control circles,** meetings in which production employees discuss ways to improve operating quality and productivity. Research shows that the many small, incremental changes to work operations that a company's employees and managers make over time add up and pay off.

Advanced Materials Management Methods

Managing the flow of resources in to and out of the operating system is a complex functional activity. Earlier, we discussed how materials management methods such as outsourcing, licensing, and ownership of manufacturing operations abroad can reduce operating costs. Next, we discuss three other materials management methods that are often used to build competitive advantage: computer-aided materials management, global supply chain management, and just-in-time inventory systems.

Computer-Aided Materials Management

computer-aided materials management A technique that relies on computers to manage the flow of raw materials and component parts into and out of a company's operating system.

Computer-aided materials management (CAMM) is used to manage the flow of raw materials and component parts into and out of the operating system. The ways CAMM can increase efficiency is illustrated by the difference between the *push and pull* approaches to materials management.

Traditional mass production uses the "push" approach. Raw materials and components are pushed into the operating system according to a previously determined plan–a plan based on some forecast of how many units of product need to be made and which therefore might be accurate or not. Computer-aided materials management, by contrast, uses the "pull" approach. The flow of inputs is not governed by a mere forecast, but by real-time customer orders for a particular product. The inputs needed to make the product are pulled into the operating system in response to the output stage (the demand of customers) not a push from the input stage (sales forecasts).

VF Inc., the manufacturer of Wrangler and Lee jeans, meets customer demand using the pull approach. As VF's jeans sell out in stores, the stores issue requests by computer for VF to make jeans with the appropriate styles or sizes. VF's OMM functions then pulls in raw materials, such as cloth, zippers, and thread, from suppliers as they are needed. If VF used the push approach, its master plan might say, "Make 30,000 pairs of style XYZ in May"; and at the end of the summer 25,000 pairs might remain unsold in the warehouse because of lack of demand. The pull system means that specific products are produced when they are needed.

Computer-Based Global Supply Chain Management

global supply chain management The coordination of the flow of raw materials, semifinished goods, and finished products around the world.

Earlier in the chapter we talked about how companies are searching globally for supplies as well as searching for new ways to deliver their products around the world. **Global supply chain management** is the coordination of all of these activities. Coordinating the flow of resources, components, and final products becomes more complex as multinationals expand their operations abroad to take advantage of national differences in operations and materials management costs. To deal with global coordination problems, companies have increasingly adopted CAMM systems to manage their global supply chains. The system used by Bose Corporation, profiled in the following Business in Action illustrates how a CAMM works.

Business in Action

Bose's Global Supply Chain

Bose Corporation, based near Boston, Massachusetts, manufactures some of the world's best-known high-fidelity speakers. Bose purchases most of the components that go into its speakers from independent suppliers. About 50% of its purchases are from foreign suppliers, the majority of which are in the Far East.

The challenge for Bose is to coordinate this globally dispersed supply chain to minimize its inventory and transportation costs. Minimizing these costs requires that component parts arrive at Bose's assembly plants just in time to enter the production process and not before. Bose also has to remain responsive to customer demands. This means that the company has to respond quickly to increases in demand for certain kinds of speakers, such as outdoor speakers in the summer. Failure to respond quickly can cause the loss of a big order to competitors. Since Bose does not want to hold extensive inventories at its Massachusetts plant, the need to remain responsive to customer demands requires that Bose's suppliers be able to respond rapidly to its changing demand for components.

The responsibility for coordinating its global supply chain to simultaneously minimize inventory and transportation costs *and* respond quickly to customer demands belongs to Bose's logistics managers. These managers have contracted with W.N. Procter, a Boston-based freight forwarder and customs broker. W.N. Procter uses a CAMM called "ProcterLink" to provide Bose with real-time information on the flow of components and its finished products, as they move through the global supply chain.

When a shipment leaves a supplier, it is logged into ProcterLink. From that point on, ProcterLink can track the flow of components as they move across the globe toward Massachusetts, where Bose has its operations. This system allows Bose to fine-tune its production scheduling so that supplies enter the assembly process exactly when they are needed.

The challenge for Bose is to coordinate its globally dispersed, supply-chain activities to minimize its inventory and transportation costs. What are some ways Bose can do this?

How well this system works was shown when one of Bose's Japanese customers suddenly doubled its order for the company's speakers. Bose had to gear up its manufacturing in a hurry, but many of its components were stretched out across long distances. Using ProcterLink, Bose was able to locate the needed parts in its supply chain. It then broke them out of the normal delivery chain and moved them by airfreight to get them to the assembly line in time for the accelerated schedule needed to meet the customer's request.[7]

As the Bose example suggests, the use of computer-based global supply chain management allows a company to improve its responsiveness to customers, minimize its costs, and build competitive advantage. UPS and FedEx have expanded their outsourcing operations to serve the needs of global companies by establishing huge warehouses in countries around the world. They now manage a company's global inventory and coordinate the transfer of inputs and outputs to wherever they are needed around the world. This service is particularly important for companies that manufacture high-value, high-price products such as computer components and software, cell phones, and digital and electronic devices which generate higher sales revenues the faster they are delivered to customers.

Just-in-Time Inventory Systems

just-in-time inventory system An inventory management system whereby inputs are delivered to the firm just when they are needed rather than being purchased and warehoused prior to their use.

Another advanced materials management technique is the just-in-time inventory system. Developed from the Japanese kanban system (a *kanban* is a card), a **just-in-time inventory** (JIT) **system** requires that the inputs and components needed to assemble a product be delivered to the operating system *just* as they are needed–neither earlier nor later–so that inventory can be kept to a minimum. In other words, when a JIT inventory system is used, components enter the production system immediately; they are not warehoused for days or weeks before being used.

Components are kept in bins, and as they are used up, the empty bins are sent back to suppliers with a request on the bin's card (kanban) for more components. CAMM is necessary for a JIT system to work because computerized linkages make possible the rapid transfer of information between a company and its suppliers. Just-in-time systems were originally developed in Japan during the 1950s and 1960s, as Business in Action illustrates.

Business in Action

The Kanban System in Japan

The Japanese *kanban* system of just-in-time inventory was originally developed at Toyota during the 1950s by a mechanical engineer, Taiichi Ohno. Ohno was a middle manager in charge of one of Toyota's component factories. Ohno was trying to achieve two goals: First, he wanted to reduce the costs associated with stockpiling inventory before it was used in the assembly process. Second, he wanted to improve the quality or car components to improve the quality of Toyota's cars.

At the time, vast amounts of component parts were produced at once and then stored in a warehouse until they were needed. Ohno saw a major problem with this approach. He reasoned that if there was a defect in a part, it would not be discovered for weeks or months, when the part was needed in the assembly process. Ohno decided to experiment with a new component operating and delivery system. He began to produce and send component parts in small quantities from his factory to the assembly line in a small, wheeled container known as a *kanban* just as they were needed. Assembly-line employees emptied the *kanban,* and the return of the *kanban* container was treated as the signal to produce another small-batch of component parts. So, the process repeated itself.

The system worked well, Ohno was able to get rid of most of the warehouse space needed to store inventory. Moreover, short production runs meant that defects in parts showed up at the assembly line almost immediately, which helped enormously to identify and eliminate the source of a defect. As a result, Ohno's machine shop quickly gained a reputation for quality within Toyota. Over the years, Ohno was repeatedly promoted for his efforts and was given the authority to spread his *kanban* innovation, first within Toyota and then to Toyota's suppliers.

During the 1970s, other Japanese companies copied Toyota's revolutionary *kanban* system. Much of the subsequent success of Japanese companies globally during the 1980s can be attributed to the improvements in product quality that were brought about by the wide-scale adoption of the *kanban* system in Japan, a full decade before managers in Western companies imitated the idea.[8]

A JIT system can extend beyond components to raw materials. A company may supply Toyota or Ford with taillight assemblies, for example. The taillight supplier, however, assembles taillights from components (screws, plastic lenses, bulbs) provided by yet other manufacturers. So, to reduce costs and increase quality, the taillight supplier also operates a JIT system with *its suppliers*, which in turn operate JIT

Figure 12.7
Just-in-Time Inventory Systems

systems with their suppliers, and so on. Figure 12.7 illustrates a just-in-time inventory system that goes from the customer, to the store, and then back through the manufacturer and original suppliers.

JIT systems are crucial for efficient flexible production operations. The ability to order components as they are needed allows a company to rapidly change the design of the products it makes to respond to changing customer needs. The company is not forced to carry on making an unpopular product simply because it has a large inventory of parts that need to be used up.

Summary of the Chapter

Operations and materials management are some of the most important and interesting functional activities that take place within a company. Today, changes in global competition and advances in IT are making OMM one of the most challenging tasks facing companies, managers, and employees. This chapter made the following major points:

1. Operations are the value-creation activities that transform inputs into outputs, or goods and services.
2. Materials management is the control of the flow of resources into and out of a company's operating system.
3. The functional activities involved in operations and materials management take place at three stages: the input, operations, and output stages.
4. How well a company controls its OMM activities is an important determinant of the profitability of a company's business model.
5. The five main sources of operating costs are the costs of raw materials and components, plant, labor, inventory, and distribution.
6. Three main types of operating system are small-batch production, mass production, and flexible production.
7. Small-batch production is an operating system designed to make one-of-a-kind or small quantities of customized products that closely match the needs of individual users.
8. Mass production is an operating system based on the use of machines and standard operating procedures to control the work process. Companies that use mass production systems are able to reduce their operating costs and lower their product prices.
9. Flexible production is an advanced, computer-based operating system that combines the benefits of mass production and small-batch production. This is achieved by the use of computer-integrated manufacturing and flexible employees and work teams.
10. Total quality management is an operations technique whose goal is the continuous improvement of a company's operating system to increase quality and reduce costs.
11. Three other materials management methods often used to create a competitive advantage are computer-aided materials management, global supply chain management, and just-in-time inventory systems.

Developing Business Skills

QUESTIONS FOR DISCUSSION AND ACTION

1. How do OMM activities create value and a competitive advantage at the input, operations, and output stages?

2. What are the three types of inventory costs, and why is it important for a company to reduce its inventory-holding costs?

3. How does small-batch production differ from mass production?

4. How would a fast-food restaurant operate differently if it used small-batch production compared to mass production?

5. In what ways can flexible production and the use of flexible work teams help create competitive advantage?

6. *Action.* Find a manager responsible for some aspect of a company's operations. Talk to the manager about the way the company handles its input, operations, and output processes.

7. What is TQM, and why is it important for a company to improve the quality of its products?

8. What are the alternative ways in which a company can manage its global supply chain activities?

9. *Action.* How does a just-in-time inventory system operate? Go to Dell's Web site and analyze the way it manages its JIT system.

ETHICS IN ACTION

Changing Operating Systems

Advanced operations and materials management techniques often lead to new work arrangements that dramatically reduce the number of employees needed to operate the production process. Consider the following quote from Jerry Miller, a former employee of US West, whose team of billing clerks lost their jobs after the company began to use flexible work teams. "When we first formed our teams, the company came in talking teams and empowerment and promised that we wouldn't lose any jobs. It turns out all this was a big cover. . . . We showed them how to streamline the work, and now 9,000 people are gone. It was cut-your-own-throat."

Using the ethical principles discussed in Chapter 5, think of the issues involved in changing the nature of a company's operating system and answer the following questions:

- When a company needs to change its work procedures to increase productivity, what ethical guidelines should it follow? For example, what kinds of information should it provide employees, and what kinds of guarantees should they be given?
- If employees begin to do different kinds of tasks and work in self-managed teams, what kinds of work and pay procedures should be introduced to ensure they are fairly treated?

SMALL GROUP EXERCISE

How to Operate a Computer Store?

Read the following and then break up into groups of three or four people and discuss the issues involved. Be prepared to share your discussion with the rest of your class.

You are the operations managers of a company planning to open a chain of large computer stores in major cities. You plan to offer small businesses a range of hardware, including servers, PCs, and cell phones, and software applications that work on both the Windows and Linux platforms. Your business model is to offer small businesses "one stop shopping." Your designers, salespeople, installers, and service and maintenance

employees will be expected to provide a solution that matches each customer's specific needs.

You are meeting to decide how to design your operations and materials management processes to provide the best quality solutions at the lowest possible cost.

1. Analyze the problems, issues, and tasks employees will have to solve to best provide such a service to customers.

2. Based on this analysis, what kind of work methods and procedures will be needed to achieve your goals? In particular, what kind of operating system–small-batch, mass, or flexible production–will you use?

3. How will you organize employees and coordinate their activities?

4. What kinds of materials management techniques will you need to develop to control OMM costs and yet provide excellent customer service?

DEVELOPING GOOD BUSINESS SENSE

Why Do Operating Systems Differ?

Many people take the way goods and services are provided to them for granted. They do not think about the nature of the operating system that produces the goods and services they receive. To improve your understanding of how OMM processes work, complete the following assignment.

1. Choose three companies and observe how employees do their tasks. These can be three different fast-food restaurants or three entirely different types of companies, such as a fast-food restaurant, a department store, or the emergency room of a hospital.

2. Think about the differences in the operations involved in the input, operations, and output stages of these companies. Try to identify the nature of their operating systems. Are employees organized in different ways? If so, why? If possible, talk to the managers and employees in these operations to further your analysis.

3. What are the main kinds of OMM costs companies have? How does this affect their OMM operations?

4. How do companies design their operating systems to give them a competitive advantage?

EXPLORING THE WORLD WIDE WEB

GE's Six Sigma

Go to GE's Web site (www.ge.com), click on "Our Company," and then "Company Information." Then click on "Six Sigma" and read about how GE is using Six Sigma to improve its OMM process. **For more Web activities, log on to www.mhhe.com/jonesintro.**

1. What is Six Sigma, and it what ways can it be used to reduce the costs of a company's OMM process?

2. In terms of a company's input, operations, and output stages, how can Six Sigma be used to create a competitive advantage?

BusinessWeek CASE FOR DISCUSSION

A China Price for Toyota

Five years ago, Toyota Motor Corp. stunned the auto world by embarking on a plan to slash costs 30% across the board for the car parts it buys–from air-conditioning ducts and door-assist grips to windshield wipers. The bold plan to squeeze its own network of traditional suppliers, known as a *keiretsu*, was designed to make sure the Toyota group would retain its competitive edge against a spate of global auto alliances such as DaimlerChrysler, which promised gigantic synergies from their bigger size.

DaimlerChrysler is still struggling to make its merger pay off. But Toyota's cost-cutting program–

dubbed CCC21, or Construction of Cost Competitiveness for the 21st Century–has been a remarkable success. With just one year to go, the plan is on track to save the auto maker some $10 billion over its five-year time frame. Not only is CCC21 sourcing components more cheaply but Toyota has also improved the parts' quality. The program has even bested archrival Nissan Motor Co., whose chief executive, Carlos Ghosn, kicked off the savings scramble in 1999 by pledging 20% cuts in procurement costs.

But where does Toyota go from here? Even after putting its supply network through the wringer, Japan's No. 1 carmaker can ill afford to rest easy. Toyota may be under more pressure now to cut costs than when it began CCC21. So the drive is on to replace expensive materials, benchmark Toyota's auto parts against Chinese-level pricing, and squeeze its Japanese suppliers further by relying more on non-*keiretsu* parts makers. "We need to adjust our cost-cutting drive to meet a whole new set of challenges," says Katsuaki Watanabe, 62, the executive vice president who helped devise and supervise CCC21. In a sign that streamlining is still a top priority, the company announced that Watanabe will take over as president of Toyota from Fujio Cho.

STEEL SHORTAGE

Watanabe is a demon at spotting costs that no one even knew existed and eliminating redundancies that few had noticed. Under his prodding, one Toyota CCC21 team disassembled the horns made by a Japanese supplier and found ways to eliminate six of 28 components, resulting in a 40% cost reduction. No part has been too mundane to escape the Watanabe squad's notice. His favorite example: interior assist grips above each door. There once were 35 different grips. Now, Toyota's entire 90-model lineup uses just three basic styles. Toyota gearheads call this process *kawaita zokin wo shiboru*, or "wringing drops from a dry towel." It's an unending, excruciating process, but essential to Toyota's bottom line.

But even Watanabe needs a new game plan to counter what's coming. Among the most pernicious threats: the surge in prices of crucial items such as sheet steel due to higher costs for raw materials like iron ore and coal. Blame China's voracious demand for steel and a shortage of Asian blast furnace capacity–factors that are unlikely to go away anytime soon. What's more, the strong yen means Toyota's reported profits from outside Japan come in lower, increasing the pressure to cut expenses.

These burdens come just as the automotive giant's latest cost-cutting push has started to run out of steam. The company acknowledged its cost cuts will likely total just $1.7 billion for the fiscal year ending in March, 15% short of its annual target, in large part because of the surge in sheet steel prices. Nikko Citigroup Ltd. notes that the pace of cost cuts has slowed to $388 million in the most recent quarter, down from $582 million a year earlier.

To cope, Watanabe is pushing Toyota to winnow down the number of steel parts it uses in an average vehicle from 610 to about 500, although it won't say by when or how much savings that will net. Toyota will probably turn to more steel substitutes such as aluminum and heavy-duty advanced plastics and resins. Moving away from steel goes hand-in-hand with the company's longer-term goal of cutting the weight of its vehicles to increase fuel efficiency and rust-proof durability.

That said, there's a limit to how many steel parts Toyota can replace. There's also no guarantee that prices of aluminum and petrochemicals won't skyrocket to the point where those materials are no longer cost-effective substitutes.

Something more is needed–and that's the China benchmark. Under CCC21, Watanabe's lieutenants identified about 180 key parts, then figured out who the world's most competitive suppliers of those parts were–companies like Robert Bosch of Germany, Delphi Corp., and the Toyota Group's own Denso Corp. The Toyota cost-cutters used this information as the "benchmark" against which Toyota's *keiretsu* suppliers had to compete. The *keiretsu* outfits must learn how to meet the benchmark–or risk losing the business. Toyota worked with affiliate Denso, for example, to consolidate production of air-conditioning vents to just four key styles, down from 27 previously. That resulted in a 28% cost reduction. Watanabe still wasn't happy: He had wanted just three.

Now the exercise goes to a whole new level. The boom in auto production in China is nurturing a car-parts industry–with both multinational suppliers and local companies–providing new data on how low prices can go. For now, that's mostly limited to commodity-type components such as assist grips, not high-end modules and core parts like brakes. Toyota officials say the rise of China has raised the bar for its *keiretsu* suppliers. They increasingly must push their prices toward the Chinese level to keep Toyota's business. "China has become an important new benchmark for us," says Watanabe.

This doesn't mean Toyota will soon start importing all its parts from China for use in its Japanese and U.S. factories. Analysts say it may be a decade before the parts makers in China can go toe-to-toe with components made in Japan, South Korea, and the United States The ultralow defect rates for parts made in Japan, for example, can be as important to cutting prices as cheap fixed costs. Even so, benchmarking against the Chinese price forces suppliers to come as close as possible to matching it without sacrificing quality. That involves rethinking everything,

from the number of designers assigned to making any one part, to the supply chain involved in sourcing components, to the utilization rates of equipment at a parts factory.

The China benchmark will increase the pressure on Toyota's traditional suppliers. But so will the company's efforts to court more non-Japanese suppliers to find the best price. And parts makers like Bosch and Delphi, which turn out everything from air bags to transmissions, are now more willing to meet demanding specifications. Bosch, for example, supplies the complete brake system for the Toyota Avensis sedan and the diesel-injection system for the Toyota Yaris subcompact, both made in Europe. Toyota won't say how much of its parts purchasing comes from its *keiretsu* versus outsiders, but non-Japanese suppliers are eager to win a bigger share. No wonder: The auto maker expects its global sales to hit 8.5 million vehicles by next year, about 1 million more than in 2004. That will put it on a par with General Motors Corp., the world's largest carmaker. "Toyota is an important customer for Bosch," says Bernd Bohr, chairman of the company's automotive group. "We maintain a close cooperative relationship with Toyota and in development projects."

Non-*keiretsu* suppliers see their best chance in markets where Toyota is expanding fastest, especially China, where the Japanese automaker is eager to catch up with established rivals like GM and Volkswagen. "This is a great opportunity for outside suppliers to increase their business with us," says Watanabe. Those suppliers would love ultimately to win orders on a global basis–including in Japan, where local suppliers account for all but a fraction of the auto giant's parts purchases.

PART OF THE FAMILY

To show the depth of its commitment, Delphi now sends technicians to Toyota headquarters in Toyota City to collaborate on the blueprints for new parts, and invites Toyota execs to tour its plants and offer suggestions for improving productivity and increasing quality. Although Delphi won't disclose how much business it does with Toyota, less than 10% of its roughly $1 billion in Asian revenue comes from the Japanese. The company, however, says it has high hopes for supplying more to Toyota from its 13 plants in China. "We are becoming part of Toyota's extended *keiretsu* family," says Choon T. Chon, president of Delphi's Asia Pacific unit. And part of Watanabe's ruthless drive to cut costs to the bone.

Source: Chester Dawson and Karen Nickel Anhalt, "A China Price for Toyota," *BusinessWeek Online,* February 21, 2005.

QUESTIONS

1. In what ways did Toyota's CCC21 plan improve the efficiency of its OMM process?

2. How is Toyota continuing to find ways to increase efficiency?

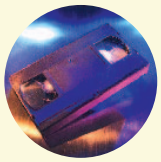
3. How is low-cost Chinese competition helping Toyota reduce its OMM costs?

BUILDING YOUR MANAGEMENT SKILLS

Know Thyself

Have you ever been to a Krispy Kreme Doughnut store or watched food being prepared at McDonald's or a large cafeteria? At Krispy Kreme stores you can observe the entire production process. The arrangement of equipment and people determines the speed of production, customer response time, and overall efficiency of the operation. The goal of process selection is to determine the most economical processes and sequences needed to transform inputs into the company's product or service. Do you think you could design an effective layout of people and equipment? The exercise on your Student DVD named "Facilities Layout" will explain more about it and let you apply your knowledge of facilities design.

CHAPTER VIDEO
Jet Blue



Jet Blue defines itself as a "customer service company." From its innovative mission statement to the teamwork displayed by its employees, Jet Blue is focused on its customers.

Rather than a traditional mission statement to guide it, Jet Blue has defined five (5) core values that serve to direct all activity: safety, caring, fun, passion, and integrity. There is a constant focus on ensuring that all details are correct; that courtesy is practiced at all levels. Their rapid success is attributed to their exclusive focus and emphasis on their customers.

Through 2002, Jet Blue achieved its efficiencies from Point to Point routes and flying only one type of aircraft. As of 2003, however, the company acquired 100 Brazilian made Embry Air jets which resulted in 800 new markets. Despite the new aircraft, the operating philosophy remains intact–focus on customers. Strong internal relations and training constantly reinforce these key principles. Whether the Jet Blue experience is a sustainable competitive advantage can only be judged by watching it perform into the future.

1. How does Jet Blue differentiate its service from that of its competitors?

2. What is the "marketing message" of Jet Blue?

3. Would you consider Jet Blue to be a product "brand"?