

# Introduction to Operations and Supply Chain Management



Christopher Fatcher/Getty Images

## LEARNING OBJECTIVES

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**After reading this chapter, you will be able to:**

- Describe what the operations function is and how it relates to other business functions.
- Discuss the key factors that have contributed to the evolution of operations and supply chain management.
- Discuss how and why businesses operate globally, and the importance of globalization in supply chain management.

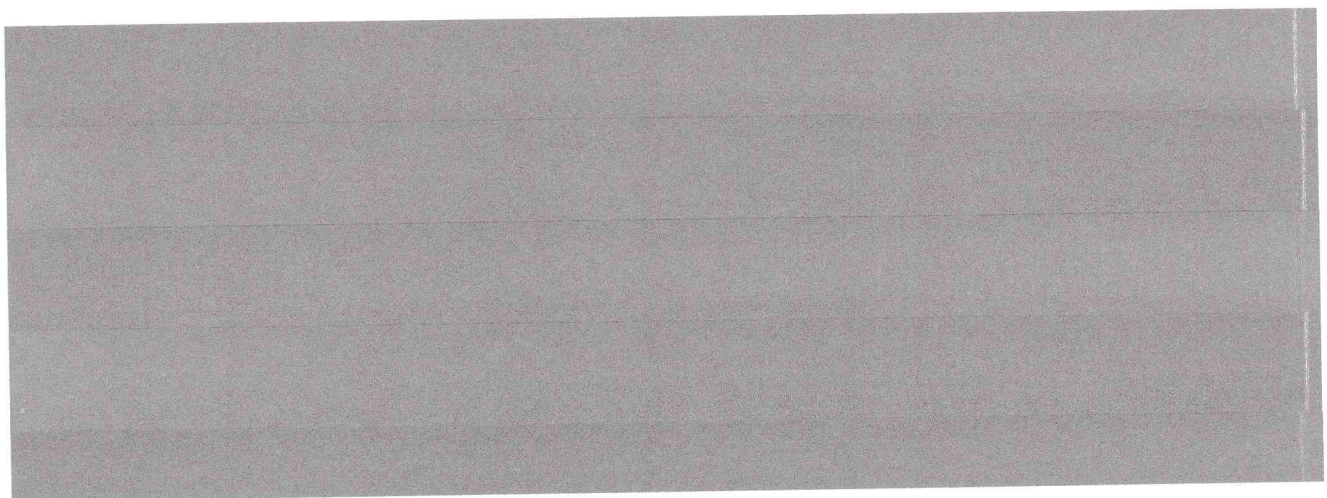
- Calculate and interpret productivity measures used for measuring competitiveness.
  - Discuss the importance of operations and supply chain management to a firm's strategy, and the process of developing, aligning, and deploying strategy.
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## The Cell Is the Thing

What is the most important product in your life? I'm betting most of you would say your smartphone. Smartphones (see photo) allow us to communicate with our friends, our family, and the world. They organize our lives and tell us where to go and what to do. They connect us to each other and share what is important, what is trending, who is who, and how we can participate. We will be following the design, manufacture, use and re-use of cell phones in this book as background for decisions in operations and supply chain management. Our journey will take us from the desert sands, through the most advanced and automated factories on the planet, across oceans to massive assembly lines of workers, and through high-tech design centers and logistics hubs. We will crisscross the world several times before landing in a retail store or website and arriving at your door. And when the next latest and greatest technology is available and you opt for an upgrade, we'll follow the disposal, recycling, and reuse of your old unit and muse about what might be next on the horizon.

**Operations management** designs, operates, and improves productive systems—systems for getting work done. Operations managers are found in banks, hospitals, factories, and government. They design systems, ensure quality, produce products, and deliver services. They work with customers and suppliers, the latest technology, and global partners. They solve problems, reengineer processes, innovate, and integrate. Operations is more than planning and controlling; it's doing. Whether it's superior quality, speed-to-market, customization, or low cost, excellence in operations is critical to a firm's success.

**Operations management** The design and operation of productive systems.



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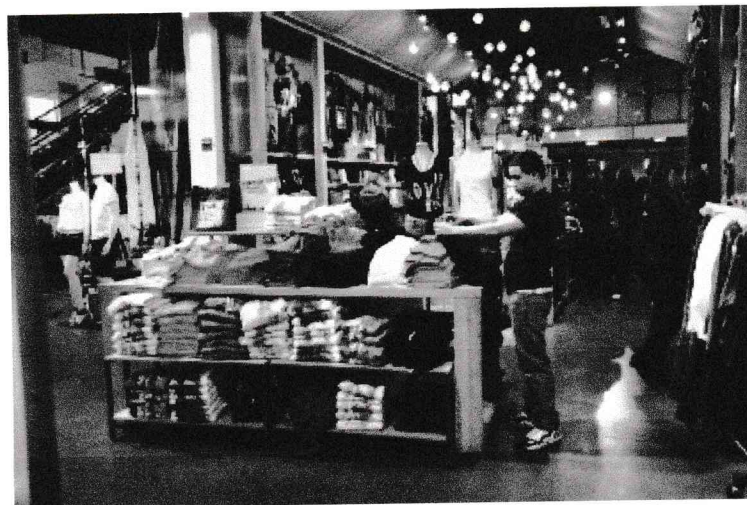
## Along the Supply Chain

### What Do Operations and Supply Chain Managers Do?

Operations and supply chain managers are the *improvement people*, the realistic, hard-nosed, make-it-work, get-it-done people; the planners, coordinators, and negotiators. They perform a variety of tasks in many different types of businesses and organizations.



Jim Cragmyle/Getty Images



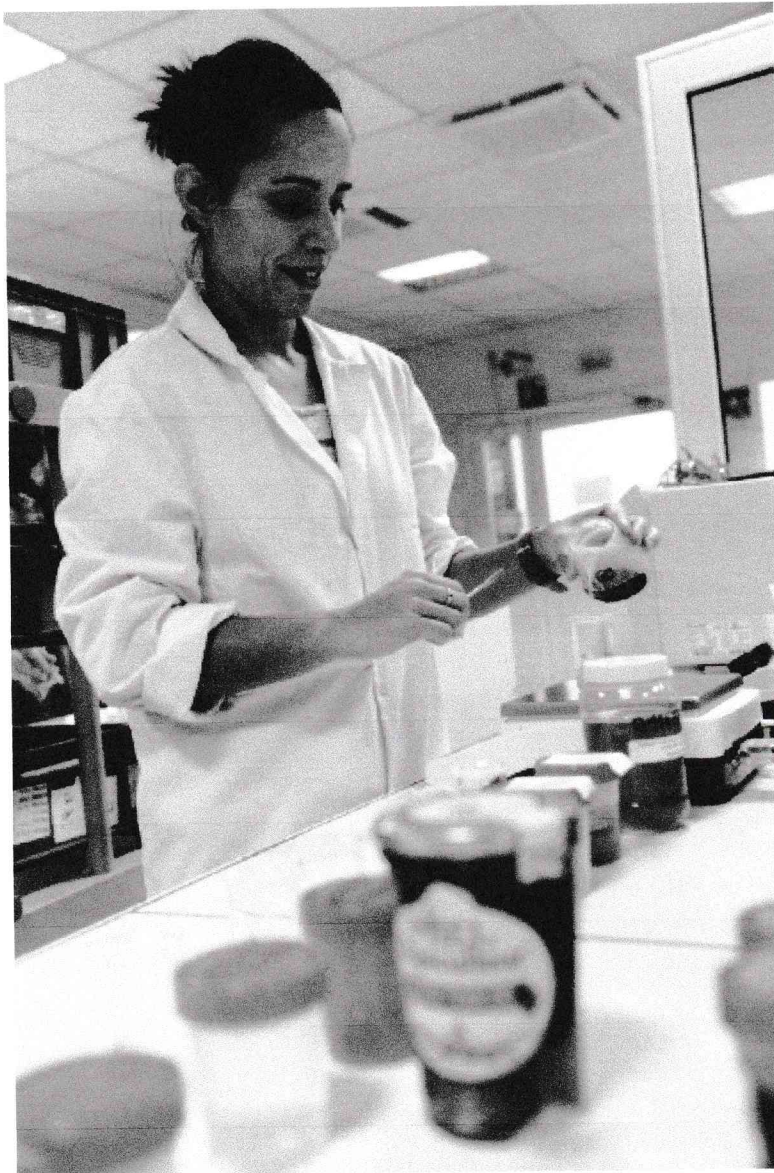
SUZANNE DECHILLO/The New York Times

Let's meet Claire Thielen, director of informatics for a healthcare system; Ada Liu,

division manager for Li & Fung Trading Company; and Erin Hiller, food technologist at a major branded food manufacturer.

Claire Thielen is a healthcare professional who specializes in decision support, process improvement, and organizational performance. She facilitates interdisciplinary teams as they pursue continuous quality improvement projects and analyzes methods and systems for managing information. Her projects include determining staffing patterns and workflow for computerized scheduling systems; consolidating policies, procedures, and practices for hospital mergers; developing and implementing balanced scorecards and benchmarking reports; designing clinical studies of new medication effectiveness; and conducting training sessions on process mapping and analysis (see photo). Claire Thielen improves quality, productivity, and information in the healthcare industry.

Ada Liu is a division manager for Li & Fung, a global sourcing company. She coordinates global production and distribution for major players in the garment industry (see photo). For one particular trouser order, she had the fabric woven in China (for their unique dyeing process), chose fasteners from Hong Kong and Korea (for their durability), and sent the raw materials to Guatemala for sewing (for their basic skills, low cost, and proximity to the United States). If problems should arise, Liu can reroute the order to one of its 7500 suppliers in 37 countries. Ada Liu is a supply chain expert for Li & Fung.



GAIZKA IROZ/Getty Images, Inc.

Erin Hiller is a food technologist at a major branded food manufacturer. She works in research and development (R&D) devising, developing, and testing new products, as shown in the photo. For part of her job, she travels to manufacturing plants across the country to monitor the ramp-up of production for consumer food products with new formulas or ingredients. She verifies that correct procedures are being followed, samples and tests output for quality and consistency, and revises formulaic recipes as required. She also evaluates new and emerging technologies and determines whether they would be beneficial to the product lines and manufacturing operations. Erin Hiller brings fresh designs to the market, keeps operations up to date, and ensures the safety and quality of the foods you eat every day.

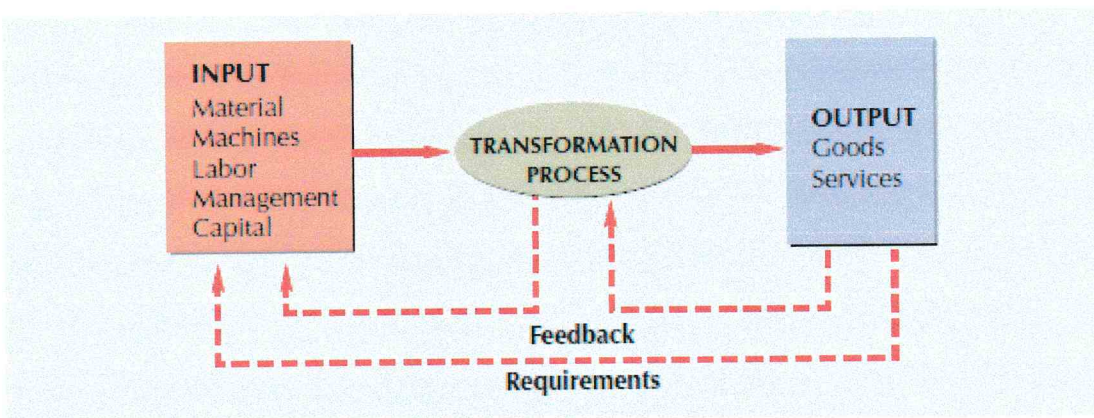
Sources: Claire Theilen, LinkedIn, accessed January 10, 2010; Joanne Lee-Young, "Furiously Fast Fashions," *The Industry Standard Magazine*, (June 22, 2001); Interview with Erin Hiller (January 3, 2013).

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**Operations** is often defined as a transformation process. As shown in **Figure 1.1**, inputs (such as material, machines, labor, management, and capital) are transformed into outputs (goods and services). Requirements and feedback from customers are used to adjust factors in the transformation process, which may in turn alter inputs. In operations management, we try to ensure that the transformation process is performed efficiently and that the output is of greater *value* than the sum of the inputs. Thus, the role of operations is to create value. The transformation process itself can be viewed as a series of activities along a **value chain** extending from supplier to customer.

**Operations** A function or system that transforms inputs into outputs of greater value.

**Value chain** A series of activities from supplier to customer that add value to a product or service.



**FIGURE 1.1 Operations as a Transformation Process**

The input–transformation–output process is characteristic of a wide variety of operating systems. In an automobile factory, sheet steel is formed into different shapes, painted and finished, and then assembled with thousands of component parts to produce a working automobile. In an aluminum factory, various grades of bauxite are mixed, heated, and cast into ingots of different sizes. In a hospital, patients are helped to become healthier individuals through special care, meals, medication, lab work, and surgical procedures. Obviously, “operations” can take many different forms. The transformation process can be

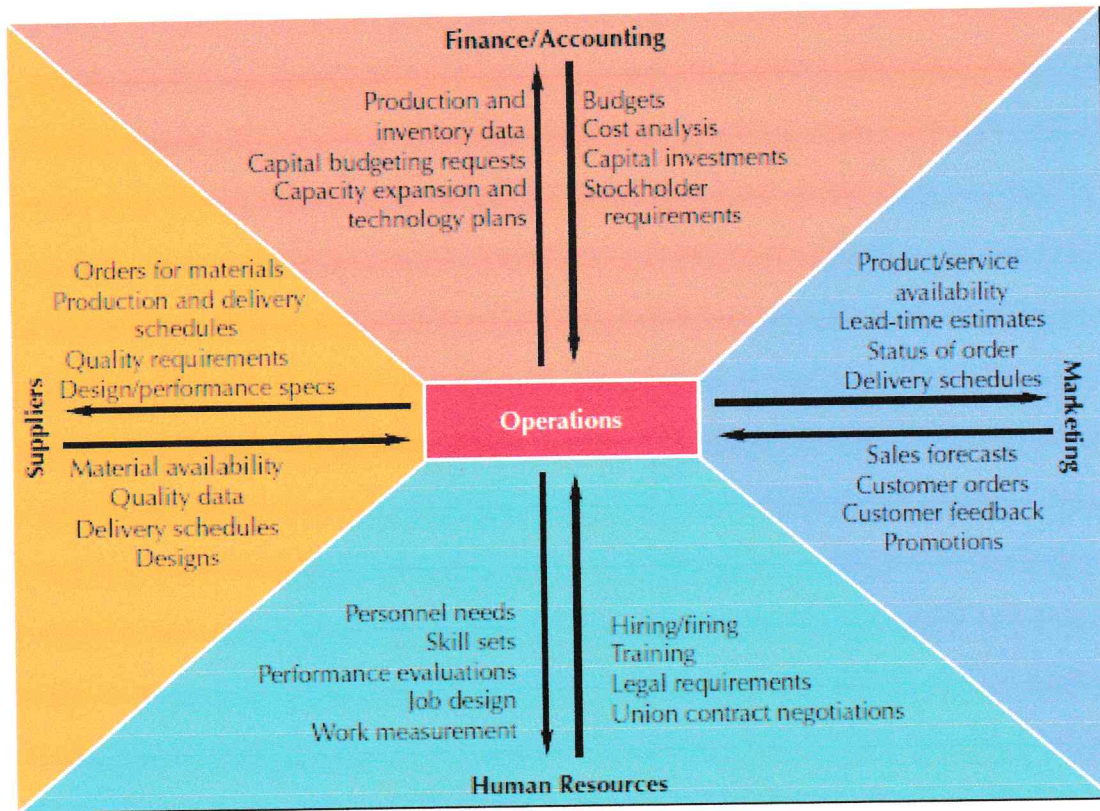
<i>physical,</i>	as in manufacturing operations;
<i>locational,</i>	as in transportation or warehouse operations;
<i>exchange,</i>	as in retail operations;

<i>physiological,</i>	as in healthcare;
<i>psychological,</i>	as in entertainment; or
<i>informational,</i>	as in communication.

## The Operations Function

Activities in operations management (OM) include organizing work, selecting processes, arranging layouts, locating facilities, designing jobs, measuring performance, controlling quality, scheduling work, managing inventory, and planning production. Operations managers deal with people, technology, and deadlines. These managers need good technical, conceptual, and behavioral skills. Their activities are closely intertwined with other functional areas of a firm.

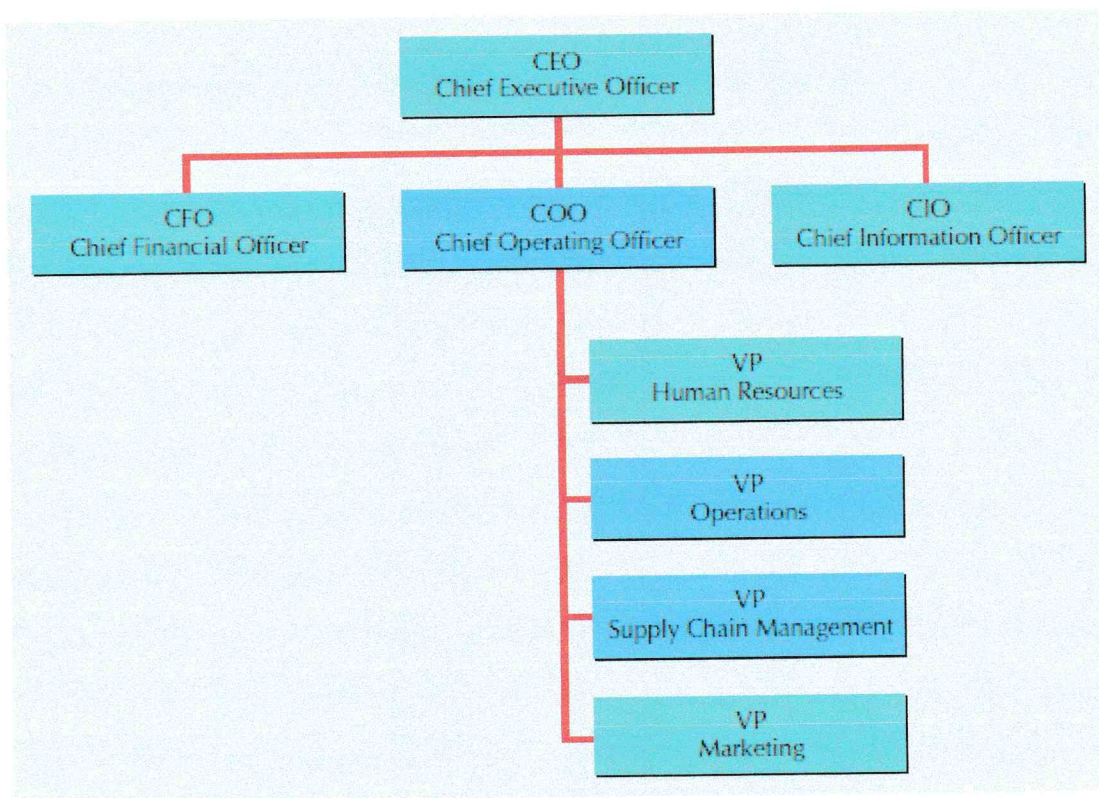
The four primary functional areas of a firm are marketing, finance, operations, and human resources. As shown in **Figure 1.2**, for most firms, operations is the technical core or “hub” of the organization, interacting with the other functional areas and suppliers to produce goods and provide services for customers. For example, to obtain monetary resources for production, operations provides finance and accounting with production and inventory data, capital budgeting requests, and capacity expansion and technology plans. Finance pays workers and suppliers, performs cost analyses, approves capital investments, and communicates requirements of shareholders and financial markets. Marketing provides operations with sales forecasts, customer orders, customer feedback, and information on promotions and product development. Operations, in turn, provides marketing with information on product or service availability, lead-time estimates, order status, and delivery schedules. For personnel needs, operations relies on human resources to recruit, train, evaluate, and compensate workers and to assist with legal issues, job design, and union activities. Outside the organization operations interacts with suppliers to order materials or services, communicate production and delivery requirements, certify quality, negotiate contracts, and finalize design specifications.



**FIGURE 1.2 Operations as the Technical Core**

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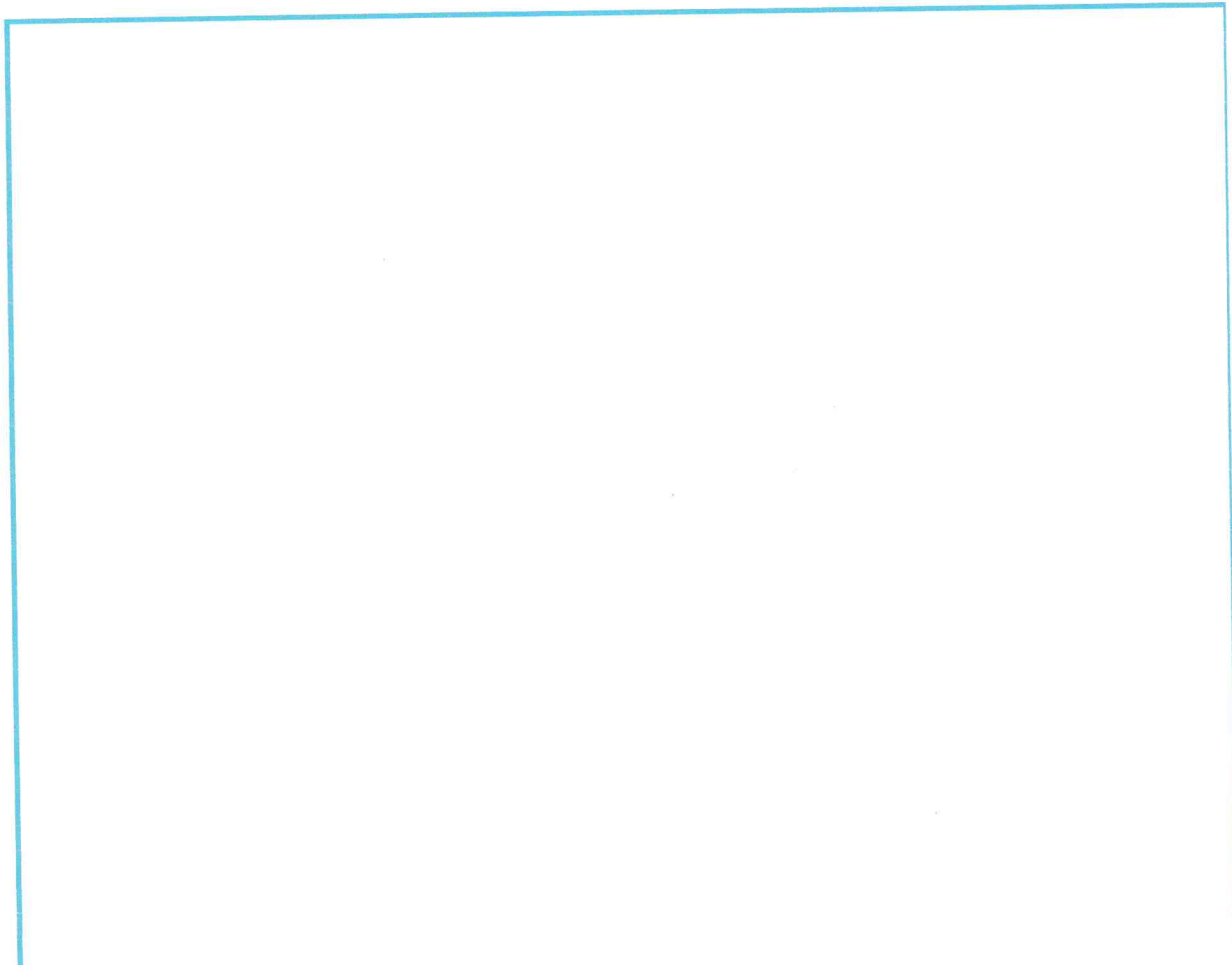
As a field of study, operations brings together many disciplines and provides an integrated view of business organizations. Operations managers are in demand in business, industry, and government. Chief operating officers (COOs) run major corporations as shown in **Figure 1.3**, Vice-presidents of Operations and Supply Chain Management oversee scores of departments, facilities, and employees. Typical jobs for new college graduates include business process analyst, inventory analyst, project coordinator, unit supervisor, supply chain analyst, materials manager, quality assurance specialist, production scheduler, and logistics planner. Even if you do not pursue a career in operations and supply chain management, you'll be able to use the ideas you learn in this course to organize work, ensure quality, and manage processes. Regardless of your major, you can apply some aspect of operations and supply chain management to your future career—as did Mark, Nicole, John, Vignesh, Margie, and Anastasia, who tell their stories in **Figure 1.4** and the OM Dialogues dispersed throughout the text.



**FIGURE 1.3 Sample Organizational Structure**

 <p><b>MARKETING</b> Mark: "How can you do a good job marketing a product if you're unsure of its quality or delivery status?"</p>	 <p><b>MANAGEMENT</b> Margie: "We use so many things you learn in an operations class—scheduling, lean production, theory of constraints, and tons of quality tools."</p>	 <p><b>ACCOUNTING</b> Vignesh: "As an auditor you must understand the fundamentals of operations management."</p>
 <p><b>INFORMATION TECHNOLOGY</b> Nicole: "IT is a tool, and there's no better place to apply it than in operations."</p>	 <p><b>FINANCE</b> John: "Most of our capital budgeting requests are from operations, and most of our cost savings, too."</p>	 <p><b>ECONOMICS</b> Anastasia: "It's all about processes. I live by flowcharts and Pareto analysis."</p>

**FIGURE 1.4** How Is Operations Relevant to My Major?



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may or may not provide the most cost-effective alternative. A lean production system provides low costs through disciplined operations.

**Competing on Speed** More than ever before, speed has become a source of competitive advantage. The Internet has conditioned customers to expect immediate response and rapid product shipment. Service organizations such as McDonald's, LensCrafters, and FedEx have always competed on speed. Now manufacturers are discovering the advantages of *time-based competition*, with build-to-order production and efficient supply chains. In the fashion industry where trends are temporary, Gap's six-month time-to-market can no longer compete with the nine-day design-to-rack lead time of Spanish retailer Zara.

**Competing on Quality** Most companies approach quality in a defensive or reactive mode; quality is confined to minimizing defect rates or conforming to design specifications. To compete on quality, companies must view it as an opportunity to please the customer, not just a way to avoid problems or reduce rework costs.

To please the customer, one must first understand customer attitudes toward and expectations of quality. One good source is the American Customer Satisfaction Index compiled each year by the American Society for Quality and the National Quality Research Center. Examining recent winners of the Malcolm Baldrige National Quality Award and the criteria on which the award are based also provides insight into companies that compete on quality.

The Ritz-Carlton Hotel Company is a Baldrige Award winner and a recognized symbol of quality. The entire service system is designed to understand the individual expectations of more than 500,000 customers and to "move heaven and earth" to satisfy them. Every employee is empowered to take immediate action to satisfy a guest's wish or resolve a problem. Processes are uniform and well defined. Teams of workers at all levels set objectives and devise quality action plans. Each hotel has a quality leader who serves as a resource and advocate for the development and implementation of those plans.



Virtual Tours

**Competing on Flexibility** Marketing always wants more variety to offer its customers. Manufacturing resists this trend because variety upsets the stability (and efficiency) of a production system and increases costs. The ability of manufacturing to respond to variation has opened up a new level of competition. **Flexibility** has become a competitive weapon. It includes the ability to produce a wide variety of products, to introduce new products and modify existing ones quickly, and to respond to customer needs.

**Flexibility** In operations, the ability to adjust to changes in product mix, production volume, or product and process design.

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Mark Jackson

## Marketing Manager for Pizza Hut



Roberta Russell

As regional marketing manager for Pizza Hut, I'm responsible for 21 stores. It's my job to make sure each store is operating properly and, when new products come out, to see that they are given the attention they deserve. I also coach managers and employees about their job and their relationship with the customer.

You would think that a marketing manager's job would be concerned solely with advertising, special promotions, store signage, customer service, and the like. But we also deal with quality, forecasting, logistics, and other operational issues. Marketing and operations are almost inseparable in services. We can come out with a new product and spend megabucks advertising it, but if the product is not made or delivered properly, all is lost.

The most important aspect of quality is consistency—so that the customer gets the same pizza at any Pizza Hut from whichever cook happens to be on shift. We have exact standards and specifications for our products, and it's important that operating procedures be followed.

Scheduling is somewhat of a headache because of staff turnover and individual limitations on working hours. Some of that is alleviated in our new system where we allow employees to request days off up to six months in advance. They can put requests into the system when they clock in each day, and they can view upcoming schedules.

Our forecasting system keeps historical data on sales by hour and day of the week five years back. Forecasts are weighted averages of past demand—usually 60% of the past two weeks' sales and 40% of the past six weeks' sales. A manager can *freeze* the forecast and make manual adjustments, such as increasing demand during a home football game weekend or when a local festival is under way. Managers can also enter notes into the system when unusual occurrences affect demand, like a snowstorm. When the forecast is set, it generates a labor plan for the week, along with prep plans for salad, dough, breadsticks, and so forth. The labor plan just specifies the number of workers needed; it is up to the manager to

do the detailed scheduling of individuals.

After quality, it's all about speed of delivery—whether to the customer's table or to the customer's home. We have initiatives such as *Ready for Revenue* where we pre-sauce and pre-cheese in anticipation of customer orders, and *Aces in Their Places* where we make sure the best people are scheduled and ready to go for peak demand periods. As for delivery, we keep track of percent of deliveries under 39 minutes and percent of deliveries to promise. We found we could significantly reduce the number of drivers needed (and keep the same customer satisfaction numbers) by promising delivery within 39 minutes rather than 30. We also are more efficient now that dispatching divides our delivery areas into delivery pods and uses computerized estimates of transit time.



**Interchangeable parts** The standardization of parts initially as replacement parts; enabled mass production.

Advances in technology continued through the 1800s. Cost accounting and other control systems were developed, but management theory and practice were virtually nonexistent.

In the early 1900s an enterprising laborer (and later chief engineer) at Midvale Steel Works named Frederick W. Taylor approached the management of work as a science. Based on observation, measurement, and analysis, he identified the best method for performing each job. Once determined, the methods were standardized for all workers, and economic incentives were established to encourage workers to follow the standards. Taylor's philosophy became known as **scientific management**. His ideas were embraced and extended by efficiency experts Frank and Lillian Gilbreth, Henry Gantt, and others. One of Taylor's biggest advocates was Henry Ford.

**Scientific management** The systematic analysis of work methods proposed by Frederick Taylor in the early 1900s.

Henry Ford applied scientific management to the production of the Model T in 1913 and reduced the time required to assemble a car from a high of 728 hours to 1½ hours. A Model T chassis moved slowly down a conveyor belt with six workers walking alongside it, picking up parts from carefully spaced piles on the floor and fitting them to the chassis<sup>1</sup>. The short assembly time per car allowed the Model T to be produced in high volumes, or "en masse," yielding the name **mass production**.

**Mass production** The high-volume production of a standardized product for a mass market.

American manufacturers became adept at mass production over the next 50 years and easily dominated manufacturing worldwide. The human relations movement of the 1930s, led by Elton Mayo and the Hawthorne studies, introduced the idea that worker motivation, as well as the technical aspects of work, affected productivity. Theories of motivation were developed by Frederick Herzberg, Abraham Maslow, Douglas McGregor, and others. Quantitative models and techniques spawned by the operations research groups of World War II continued to develop and were applied successfully to manufacturing and services. Computers and automation led still another upsurge in technological advancements applied to operations. These events are summarized in [Table 1.1](#).

**TABLE 1.1 Historical Events in Operations Management**

ERA	EVENTS/CONCEPTS	DATES	ORIGINATOR
Industrial Revolution	Steam engine	1769	James Watt
	Division of labor	1776	Adam Smith
	Interchangeable parts	1790	Eli Whitney
Scientific Management	Principles of scientific management	1911	Frederick W. Taylor
	Time and motion studies	1911	Frank and Lillian Gilbreth
	Activity scheduling chart	1912	Henry Gantt
	Moving assembly line	1913	Henry Ford
Human Relations	Hawthorne studies	1930	Elton Mayo
	Motivation theories	1940s	Abraham Maslow
		1950s	Frederick Herzberg
		1960s	Douglas McGregor
Operations Research	Linear programming	1947	George Dantzig
	Digital computer	1951	Remington Rand
	Simulation, waiting line theory, decision theory, PERT/CPM	1950s	Operations research groups
	MRP	1960s	Joseph Orlicky, IBM, and others
	EDI, CIM	1970s	Auto industry, DARPA

Quality Revolution	JIT (just-in-time)	1970s	Taiichi Ohno (Toyota)
	TQM (total quality management)	1980s	W. Edwards Deming, Joseph Juran
	Strategy and operations		Wickham Skinner, Robert Hayes
	Reengineering	1990s	Michael Hammer, James Champy
	Six Sigma	1990s	GE, Motorola
Internet Revolution	Internet, WWW	1990s	ARPANET, Tim Berners-Lee
	ERP, supply chain management		SAP, Oracle, Dell, Apple
	E-commerce, social networking	2000s	Amazon, Yahoo, eBay, Google, Facebook, YouTube, Twitter, etc.
Globalization	World Trade Organization	1990s	GATT
	European Union		Europe
	Global supply chains	2000s	China, India
	Outsourcing		Emerging economies
Sustainability	Global warming Carbon footprint Green products	2010s, Today	Numerous companies, scientists, statesmen and governments
	Corporate social responsibility (CSR)		World Economic Forum, Kyoto Protocol
	UN Global Compact		United Nations
Digital Revolution	Big data, Internet of Things (IoT), 3D printing, Smart cities,	Today	Google, Apache, P&G, MIT, NSF, Amazon,

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Now that you are aware of how operations might relate to your interests, let's take a brief look at how the field of operations and supply chain management (OSM) has evolved to its present state.

## The Evolution of Operations and Supply Chain Management

Although history is full of amazing production feats—the pyramids of Egypt, the Great Wall of China, the roads and aqueducts of Rome—the widespread production of consumer goods—and thus, operations management—did not begin until the Industrial Revolution in the 1700s. Prior to that time, skilled craftspersons and their apprentices fashioned goods for individual customers from studios in their own homes. Every piece was unique, hand-fitted, and made entirely by one person, a process known as **craft production**. Although *craft production* still exists today, the availability of coal, iron ore, and steam power set into motion a series of industrial inventions that revolutionized the way work was performed. Great mechanically powered machines replaced the laborer as the primary factor of production and brought workers to a central location to perform tasks under the direction of an “overseer” in a place called a “factory.” The revolution first took hold in textile mills, grain mills, metalworking, and machine-making facilities.

**Craft production** The process of handcrafting products or services for individual customers.

Around the same time, Adam Smith's *Wealth of Nations* (1776) proposed the **division of labor**, in which the production process was broken down into a series of small tasks, each performed by a different worker. The specialization of the workers on limited, repetitive tasks allowed them to become very proficient at those tasks and further encouraged the development of specialized machinery.

**Division of labor** Dividing a job into a series of small tasks each performed by a different worker.

The introduction of **interchangeable parts** by Eli Whitney (1790s) allowed the manufacture of firearms, clocks, watches, sewing machines, and other goods to shift from customized one-at-a-time production to volume production of standardized parts. This meant the factory needed a system of measurements and inspection, a standard method of production, and supervisors to check the quality of the worker's production.

**Interchangeable parts** The standardization of parts initially as replacement parts; enabled mass production.

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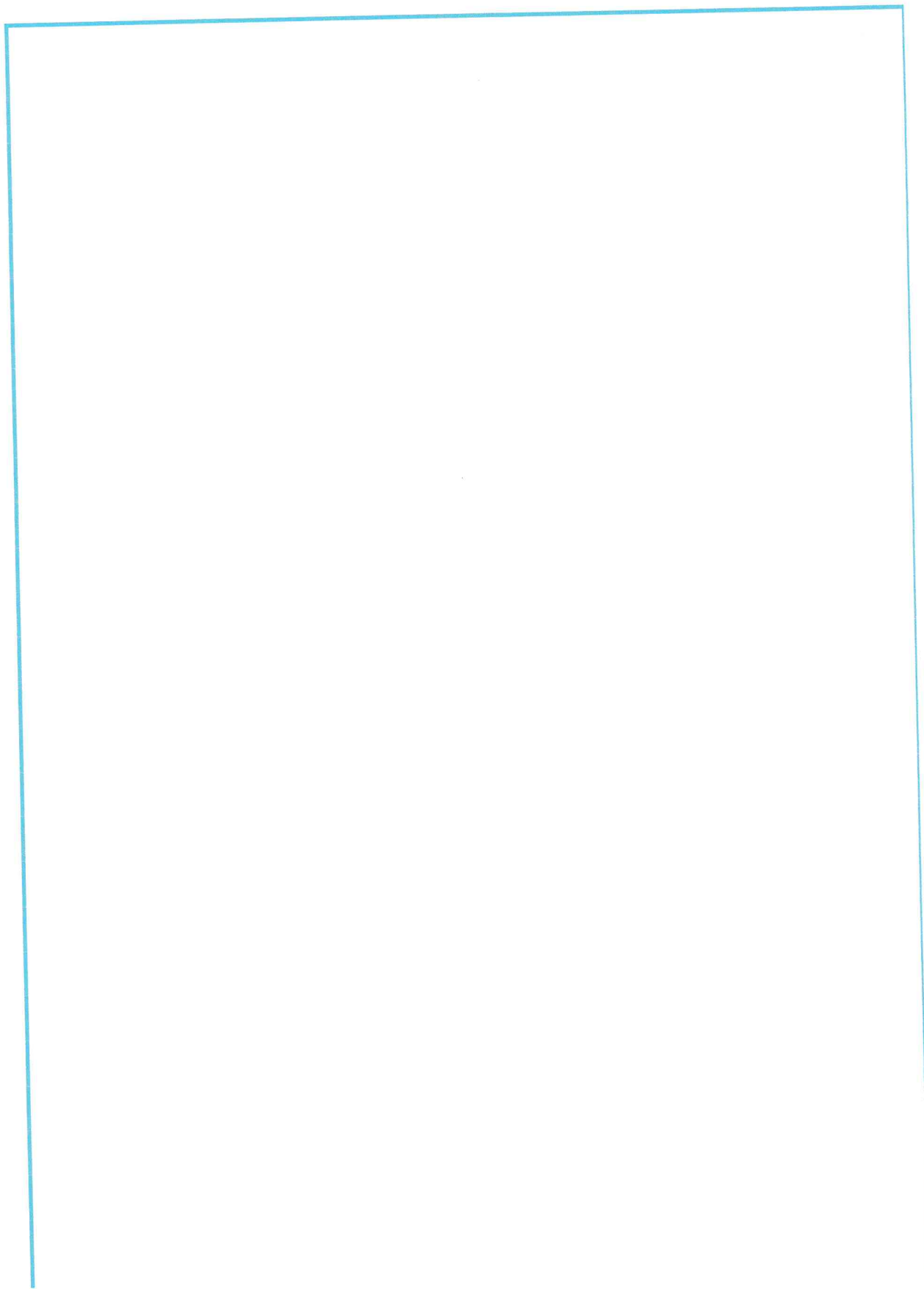
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Sustainability	Global warming Carbon footprint Green products	2010s, Today	Numerous companies, scientists, statesmen and governments
	Corporate social responsibility (CSR)		World Economic Forum, Kyoto Protocol
	UN Global Compact		United Nations
Digital Revolution	Big data, Internet of Things (IoT), 3D printing, Smart cities,	Today	Google, Apache, P&G, MIT, NSF, Amazon,

Autonomous vehicles, Drones

and others



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## Along the Supply Chain

### Feeding America

Each year, the Feeding America network helps provide food to more than 46 million people facing hunger in the United States, including 12 million children and 7 million seniors. Through 61,000 food pantries, 200 food banks, and innumerable community meal programs, the Feeding America network provides more than 3.7 billion meals to individuals and families in need. The non-profit accomplishes its goals by working closely with manufacturers, retailers, communities and farmers across the nation. The logistics of collecting, sorting and distributing donated food (with limited shelf life) to a widespread base of needy customers is challenging. To respond to this challenge, Feeding America has created several online connection tools to match donors and recipients, such as Produce MatchMakers and Online Marketplace (funded by Google), and has partnered with the Food Waste Reduction Alliance to divert 2.6 billion pounds of food headed to landfills to more than 2 billion meals for people in need. Feeding America has further partnered with organizations and government programs such as Kids Café and Summer Food Service Programs, School Backpack programs, the Rural Child Hunger Capacity Institute, and the Child Hunger Corps to distribute food to children in need. A peer-to-peer benchmarking report prepared by a store chain spurred a 14% increase in retail donations over the previous year.

Feeding America also provides monetary grants to local food pantries to support storing and distributing food, processing applicants, and educating recipients on how to prepare and serve the food in healthy ways. The group seeks to build the capacity of food banks to prepare for and respond to natural disasters and to aid in stabilizing communities post-disaster. For example, thousands of pounds of supplies were positioned along Hurricane Sandy's path to provide immediate access to food and water at food pantries, emergency shelters, and soup kitchens. Feeding America operates a high-volume, sophisticated food distribution network through its food banks with advanced technology and food distribution software from eSoftware Professionals. Even so, donor and recipient operations are staffed by more than 2 million volunteers in communities across the nation.

Feeding America excels on both the supply and demand side—exploring new food sourcing models and finding innovative ways to distribute the food where and when it is needed. The organization works with professional staff, volunteers, corporations, and community centers to source and deliver a better life to its constituents. This is an example of how operations and supply chain management tools can be used to alleviate major societal problems.

1. Is there a food bank for students in your community? Find out what challenges the group faces, and how food is collected and distributed.
2. What is difficult about balancing supply and demand for this non-profit? Looking at the range of topics covered in the textbook, what skills in operations

and supply chain management would be useful?

3. Explore the software available for the food distribution industry. What kinds of data are kept on the warehoused food and food in transit? Why?
4. Explore how other organizations fight hunger across the globe. What is the scope of their efforts? How do they connect supply and demand? What innovative methods are used for food distribution? How is success measured?

Source: Feeding America Annual Report, 2015, [www.feedingamerica.org](http://www.feedingamerica.org) (accessed January 4, 2016); “Feeding America Harnesses Food Distribution Software to Help Victims of Hurricane Sandy,” <http://www.erpsoftwareblog.com>, November 1, 2012 (accessed January 5, 2016).

From the Industrial Revolution through the 1960s, the United States was the world’s greatest producer of goods and services, as well as the major source of managerial and technical expertise. But in the 1970s and 1980s, industry by industry, U.S. manufacturing superiority was challenged by lower costs and higher quality from foreign manufacturers, led by Japan. Several studies published during those years confirmed what the consumer already knew—U.S.-made products of that era were inferior and could not compete on the world market. Early rationalizations that the Japanese success in manufacturing was a cultural phenomenon were disproved by the successes of Japanese-owned plants in the United States, such as the Matsushita purchase of a failing Quasar television plant in Chicago from Motorola. Part of the purchase contract specified that Matsushita had to retain the entire hourly workforce of 1000 persons. After only two years, with the identical workers, half the management staff, and little or no capital investment, Matsushita doubled production, cut assembly repairs from 130% to 6%, and reduced warranty costs from \$16 million a year to \$2 million a year. You can bet Motorola took notice, as did the rest of U.S. industry.

The **quality revolution** brought with it a realization that production should be tied to consumer demand. Product proliferation, shortened product lifecycles, shortened product development times, changes in technology, more customized products, and segmented markets did not fit mass production assumptions. Using a concept known as just-in-time, Toyota changed the rules of production from mass production to **lean production**, a system that prizes flexibility (rather than efficiency) and quality (rather than quantity).

**Quality revolution** An emphasis on quality and the strategic role of operations.

**Lean production** An adaptation of mass production that prizes quality and flexibility.

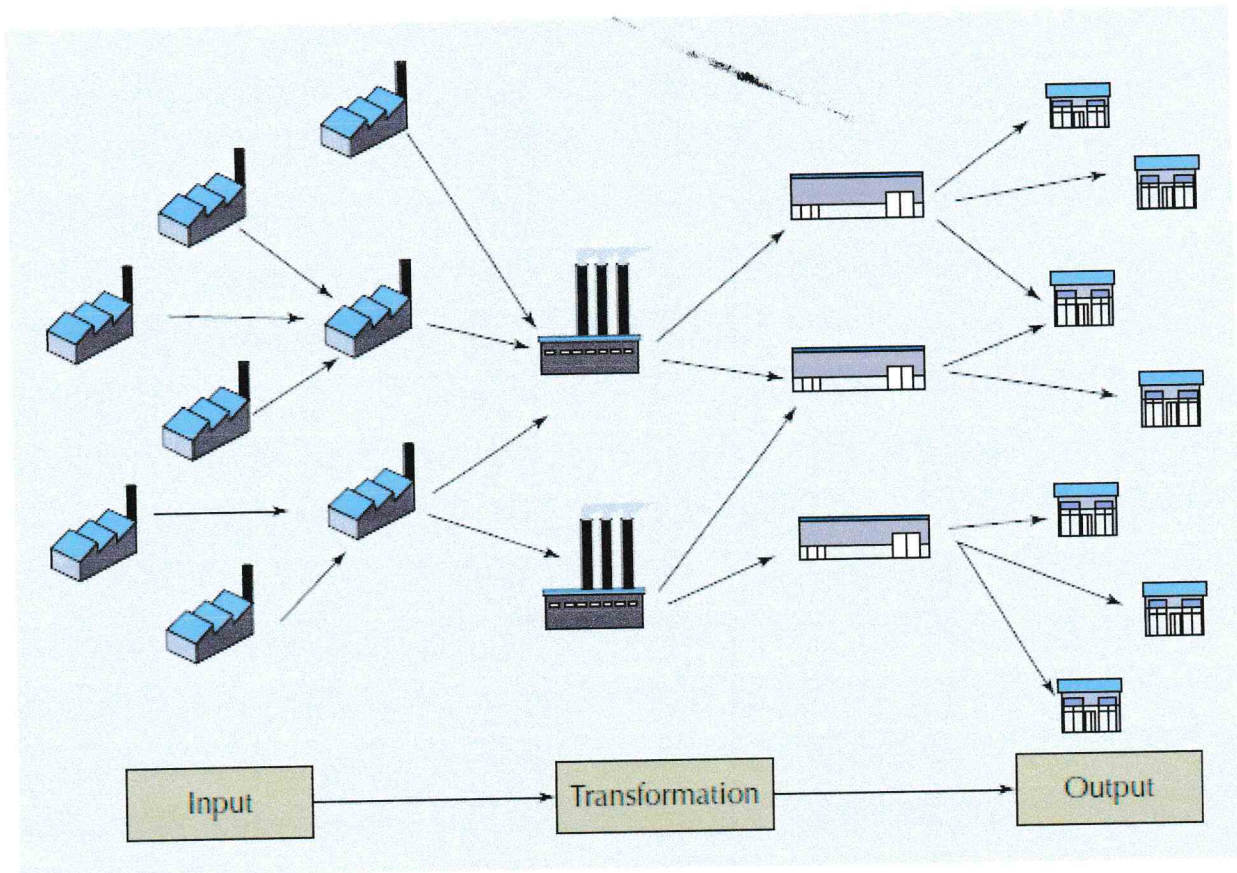
The renewed emphasis on quality and the *strategic importance* of operations made some U.S. companies competitive again. Others continued to stagnate, buoyed temporarily by the expanding economies of the Internet era and globalization. Productivity soared as return on

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investment in information technology finally came to fruition. New types of businesses and business models emerged, such as Amazon, Google, and eBay, and companies used the Internet to connect with customers and suppliers around the world. The inflated expectations of the dot-com era came to an end and, coupled with the terrorist attacks of 9/11 and their aftermath, brought many companies back to reality, searching for ways to cut costs and survive in a global economy. They found relief in the emerging economies of China and India, and began accelerating the outsourcing of not only goods production, but services, such as information technology, call centers, and other business processes. The outsourcing of business processes brought with it a new awareness of business-to-business (B2B) services.

With more and more activities taking place outside the enterprise in factories, distribution centers, offices and stores overseas, managers needed to develop skills in coordinating operations across a global supply chain. The field of **supply chain management** was born to manage the flow of information, products, and services across a network of customers, enterprises, and supply chain partners. In [Figure 1.1](#), we depicted operations as a transformation process. Extending that analogy in [Figure 1.5](#), supply chain management concentrates on the input and output sides of transformation processes. Increasingly, however, as the transformation process is performed by suppliers who may be located around the world, the supply chain manager is also concerned with the timeliness, quality, and legalities of the supplier's operations.

**Supply chain management** Managing the flow of information, products, and services across a network of customers, enterprises, and supply chain partners.



**FIGURE 1.5 Supply Chain Management**

The era of globalization was in full swing in 2008 when a financial crisis brought on by risky loans, inflated expectations, and unsavory financial practices brought the global economy to a standstill. Operations and supply chain management practices based on assumptions of growth had to be reevaluated for declining markets and resources. Companies began to reassess the value of their business, their customers, and their suppliers with an eye toward focusing on the most critical factors to sustain their business through the downturn.

Thus began the *era of sustainability*, in which countries, companies, and industries evaluate what it takes to sustain the health of their enterprise or people in the long term. This is especially important in light of climate change, natural and man-made disasters, scarcity of resources, and the competitive landscape. Nike CEO Mark Parker calls sustainability the “defining issue for our generation.”

A concept related to sustainability is **resilience**, the ability to bounce back, change, or adapt in response to a disaster, failure, or disruption. Globalization has increased the risk of

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disruptions in operations and supply chain activities, but it has also provided more flexibility in responding to disruptions. Building resilient systems is key to achieving sustainability.

**Resilience** The ability to bounce back, change, or adapt in response to a disaster, failure, or disruption.

In the midst of a global concern about sustainability comes dramatic new technology ushering in a *digital revolution*. Smart materials, smartphones, smart appliances, smart cars, even smart cities contain sensors that collect data, connect with networks, and have the ability to control processes and affect behavior. This explosion of the Internet of Things (IoT) is accompanied by new platforms for consuming products and services, the immediacy of which raises expectations and amps up innovation. Wearable technology, 3D printing, the sharing economy, and autonomous vehicles are just some of the results. This is indeed an exciting time for innovation and technology.

We discuss technology at length later in the text. In the next section, we delve more deeply into the effect of globalization on operations and supply chain management.

## Globalization

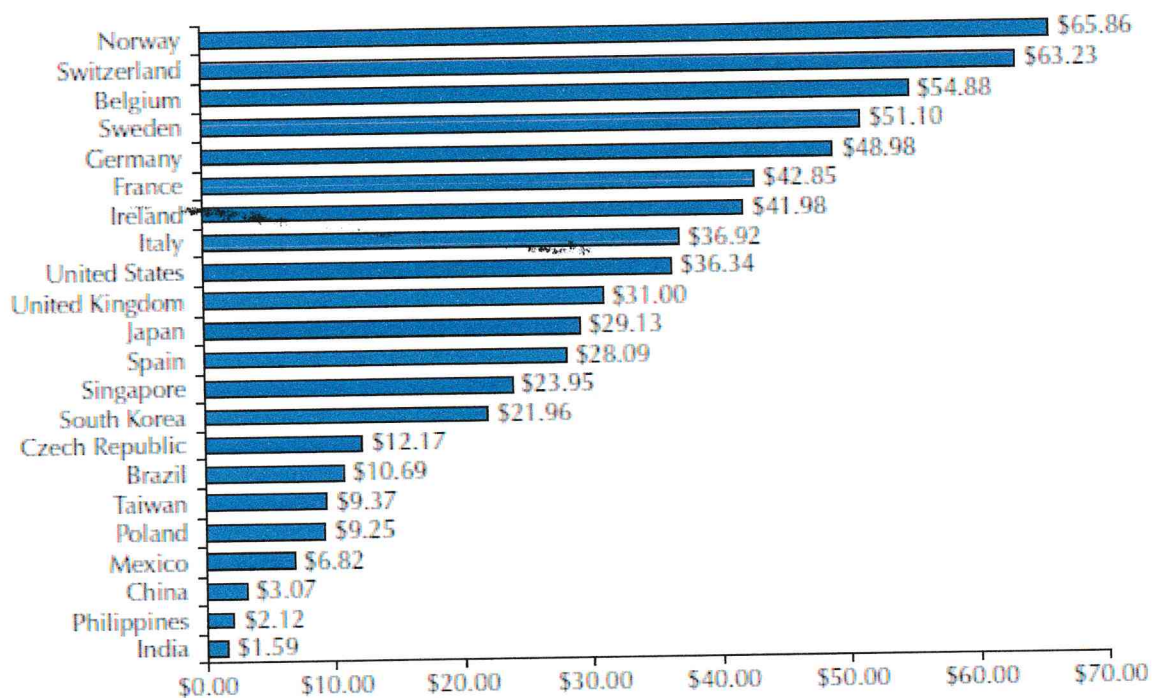
Two thirds of today's businesses operate globally through global markets, global operations, global financing, and global supply chains. Globalization can take the form of selling in foreign markets, producing in foreign lands, purchasing from foreign suppliers, or partnering with foreign firms. Companies "go global" to take advantage of favorable costs, to gain access to international markets, to be more responsive to changes in demand, to build reliable sources of supply, and to keep abreast of the latest trends and technologies.

Falling trade barriers and the Internet paved the way for globalization. The World Trade Organization (WTO) has opened up the heavily protected industries of agriculture, textiles, and telecommunications, and extended the scope of international trade rules to cover services, as well as goods. The European Union (EU) requires that strict quality and environmental standards be met before companies can do business with member countries. Strategic alliances, joint ventures, licensing arrangements, research consortia, supplier partnerships, and direct marketing agreements among global partners have proliferated.



**Figure 1.6** shows the hourly wage rates (including benefits) in U.S. dollars for production workers in 15 selected countries. Wage rates in Norway are the highest at \$66 an hour, with comparable rates in Switzerland. The average wage rate in the United States is \$36 an hour. China, the Philippines, and India exhibit the lowest wage

rates of \$3.07, \$2.12, and \$1.59 an hour. Rising wage rates in China are sending low-cost manufacturers to Asian neighbors Vietnam, Cambodia, and Malaysia. Other manufacturers are returning home in a phenomenon called *near shoring*, which we will discuss later in the text.



**FIGURE 1.6 Hourly Compensation Costs for Production Workers (in U.S. Dollars)**

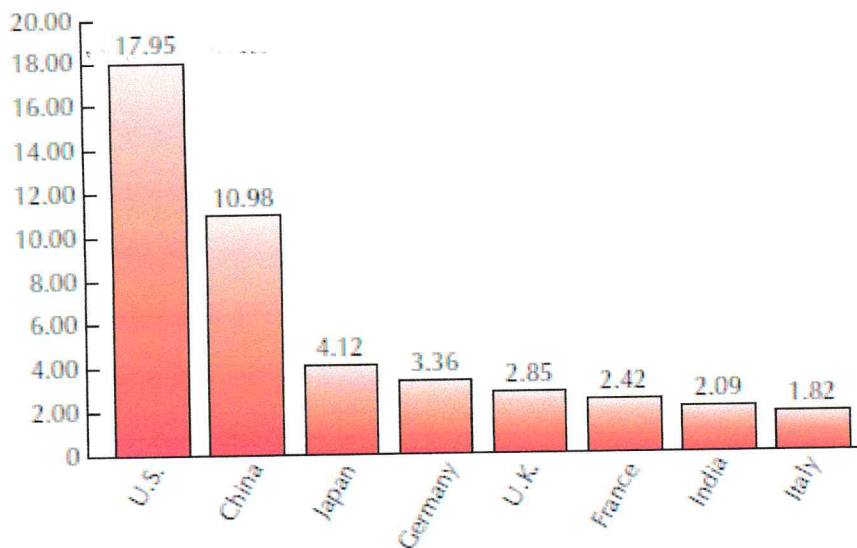
Source: The Conference Board, "International Comparisons of Hourly Compensation Costs in Manufacturing, 2013," New York: December 2014.

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China accounts for 20% of the world's population and is the world's largest manufacturer, employing more production workers than the United States, United Kingdom, Germany, Japan, Italy, Canada, and France combined. Its 1.3 billion people represent not only an immense labor market, but a huge consumer market as well. As China's industrial base multiplies, so does its need for machinery and basic materials, and as more companies move to China, so do their suppliers and their supplier's suppliers. Although initially the preferred location for the production of low-tech goods such as toys, textiles, and furniture, China has become a strategic manufacturing base for nearly every industry worldwide.

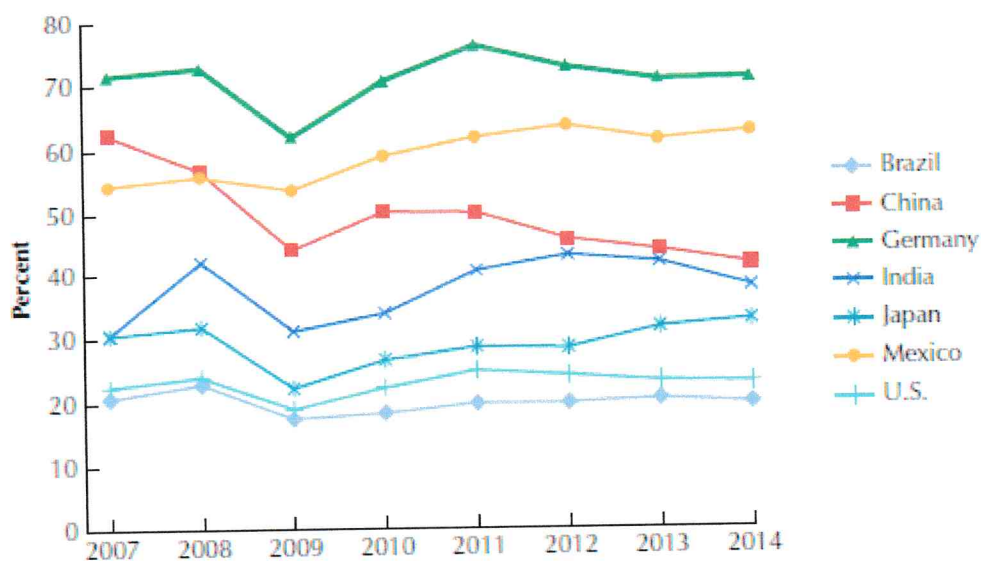
The scale of manufacturing in China is mind-boggling. For example, Foxconn (the trade name of Taiwan's Hon Hai Precision Industry Company) has several enormous industrial complexes in mainland China. The Guangdong Province site employs and houses approximately 270,000 workers, with its own dormitories, restaurants, hospital, police force, chicken farm, and soccer stadium. There are 40 separate production facilities "on campus," each dedicated to one of its major customers such as Apple, Dell, Motorola, Sony, Nintendo, and HP. Foxconn is the world's largest electronics manufacturer and China's largest exporter. It also represents a shorter supply chain because it *makes* components as well as *assembles* final products. Currently, Foxconn is expanding production into Mexico and Brazil to better serve the Americas.

Let's take a look at the health of the global economy in terms of GDP, trade in goods as a percent of GDP, and percentage manufacturing output by country. [Figure 1.7](#) shows the gross domestic product (GDP) for the largest economies in 2014. Note that China's GDP is more than twice that of Germany. However, Germany and Mexico beat out both China and the United States in trade as a percentage of GDP, as shown in [Figure 1.8](#). The United States, Brazil, and to some extent, Japan, are producing goods and services for their own markets, rather than exporting them.



**FIGURE 1.7 GDP, current prices (in \$US trillions), 2015**

Source: IMF World Economic Outlook (WEO), April 2015 (accessed June 22, 2016), <http://knoema.com/nwnfkne/world-gdp-ranking-2015-data-and-charts>.



**FIGURE 1.8 Trade in Goods as a Percent of GDP**

Source: The World Bank, Merchandise trade (% of GDP), <http://data.worldbank.org/indicator/TG.VAL.TOTL.GD.ZS>, accessed January 18, 2016.

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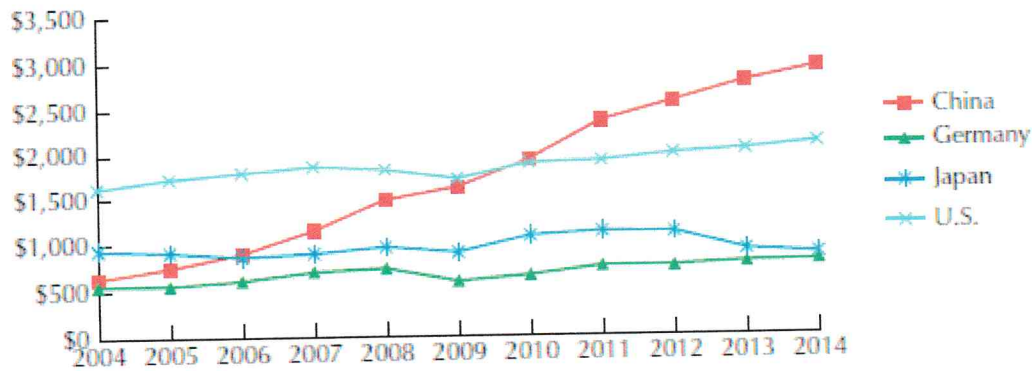
Trade dropped in all of the economies in 2009 as the recession hit and stores were no longer placing orders for goods. Most countries have returned to their pre-recession trade, with Germany and Mexico gaining orders, most likely from an increase in near-shoring at the expense of China. India has also recovered well. China's slowdown in trade could be attributed to a higher percent of its factory output filling domestic demand for goods. The predominance of global supply chains means that intermediate goods cross borders many more times than they did when products and their components were manufactured in one country. That explains why the volume of trade declines more sharply than GDP during downturns and why trade accelerates faster than GDP when the global economy picks up.

Finally, let's examine production output from 2004 to 2014 for the world's largest manufacturing economies, as shown in [Figure 1.9](#). In 2004, China held a slight edge over Germany as the world's third largest manufacturing economy. By 2006, China had surpassed Germany and was tied with Japan as the second largest manufacturer. Thus began a dramatic rise until 2010, where China edged ahead of the United States, producing 19.8% of the world's goods as compared to the United States' 19.4%. Then from 2011, China's manufacturing output soared. Prior to 2010, the United States had led world output in manufacturing since the 1930s. Prior to 2010, China's last number one ranking came in 1830, when it accounted for 30% of the world's production of goods. In 2014, China accounted for 24% of global manufacturing.



Paul Souders/Photodisc/Getty Images

With over 18 million people, 5000 skyscrapers, and the world's largest deep sea container port, Shanghai is China's largest city, and the financial heart of the burgeoning economy.



**FIGURE 1.9 Manufacturing Output (in \$US trillions)**

Source: United Nations, "GDP and its breakdown at current prices in US Dollars," National Accounts Aggregates Database, <http://unstats.un.org/unsd/snaama/>, accessed February 10, 2016.

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Low labor costs, economies of scale, and a strong infrastructure have drawn goods production to China. But while China's manufacturing prowess may seem unbeatable, its aging workforce and increased standard of living are causing labor costs to rise and low-cost manufacturing to move to such countries as India, Bangladesh, Indonesia, Vietnam, and Eastern Europe. Because of its proximity to the United States, Mexico and several Central American countries are seeing a resurgence in orders, as well. Quality, reliability, and security problems present additional challenges to managing global operations, as do questions of worker rights and environmental concerns. Physical distance and different mores, laws, and legal systems in other countries can make it harder to maintain control over a global supply chain.

## Productivity and Competitiveness

A global marketplace for products and services means more customers and more intense competition. In the broadest terms, we speak of competitiveness in reference to other *countries* rather than to other companies. That's because how effectively a nation competes in the global marketplace affects the economic success of the nation and the quality of life for its citizens. The OECD (Organisation for Economic Co-operation and Development) defines **competitiveness** as "the degree to which a nation can produce goods and services that meet the test of international markets while simultaneously maintaining or expanding the real incomes of its citizens." The most common measure of competitiveness is productivity. Increases in productivity allow wages to grow without producing inflation, thus raising the standard of living. Productivity growth also represents how quickly an economy can expand its capacity to supply goods and services.

**Competitiveness** The degree to which a nation can produce goods and services that meet the test of international markets.

**Productivity** is calculated by dividing units of output by units of input.

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

**Productivity** The ratio of output to input.

Output can be expressed in units or dollars in a variety of scenarios, such as sales made, products produced, customers served, meals delivered, or calls answered. *Single-factor productivity* compares output to individual inputs, such as labor hours, investment in equipment, material usage, or square footage. *Multifactor productivity* relates output to a combination of inputs, such as (labor + capital) or (labor + capital +

energy + materials). Capital can include the value of equipment, facilities, inventory, and land. *Total factor productivity* compares the total quantity of goods and services produced with all the inputs used to produce them. These productivity formulas are summarized in **Table 1.2**. Note when several factors are included in a formula, they should be expressed in common terms, such as dollars.

**TABLE 1.2 Measures of Productivity**

<i>Single-Factor Productivity</i>		
$\frac{\text{Output}}{\text{Labor}}$	$\frac{\text{Output}}{\text{Materials}}$	$\frac{\text{Output}}{\text{Capital}}$
<i>Multifactor Productivity</i>		
$\frac{\text{Output}}{\text{Labor} + \text{Materials} + \text{Overhead}}$		$\frac{\text{Output}}{\text{Labor} + \text{Energy} + \text{Capital}}$
<i>Total Factor Productivity</i>		
$\frac{\text{Goods and services produced}}{\text{All inputs used to produce them}}$		

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### EXAMPLE 1.1 | Calculating Productivity

Osborne Industries is compiling the monthly productivity report for its board of directors. From the following data, calculate (a) labor productivity, (b) machine productivity, and (c) the multifactor productivity of output per dollars spent on labor, machine, materials, and energy. The average labor rate is \$15 an hour, and the average machine usage rate is \$10 an hour.

Units produced	100,000
Labor hours	10,000
Machine hours	5,000
Cost of materials	\$35,000
Cost of energy	\$15,000

### Solution

$$\text{a. Labor productivity} = \frac{\text{Output}}{\text{Labor hours}} = \frac{100,000}{10,000} = 10 \text{ units / hour}$$

$$\text{b. Machine productivity} = \frac{\text{Output}}{\text{Machine hours}} = \frac{100,000}{5,000} = 20 \text{ units / hour}$$

$$\begin{aligned} \text{c. Multifactor productivity} &= \frac{\text{Output}}{(\text{Labor costs} + \text{Machine costs} + \text{Material costs} + \text{Energy costs})} \\ &= \frac{100,000}{(10,000 \times \$15) + (5,000 \times \$10) + \$35,000 + \$15,000} \\ &= \frac{100,000}{\$250,000} = 0.4 \text{ units per dollar spent} \end{aligned}$$

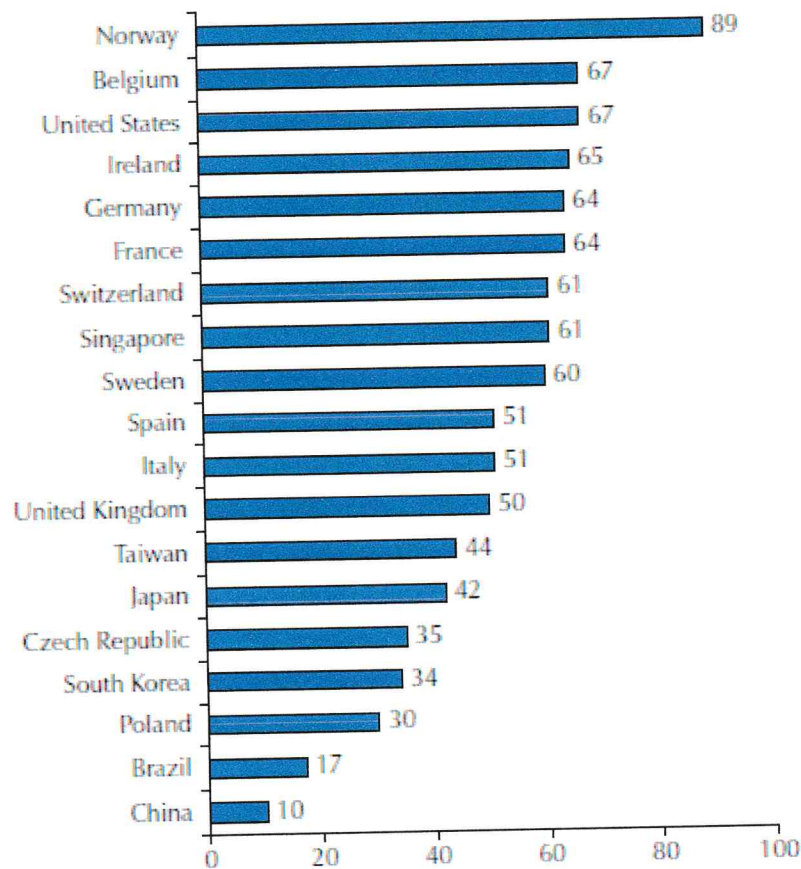
The Excel solution to this problem is shown in [Exhibit 1.1](#).

The most common input in productivity calculations is labor hours. Labor is an easily identified input to virtually every production process. If labor is used as the basis for productivity calculations consistently over time, changes in other factors of production will be reflected in the changes in labor.

There are many ways in which productivity statistics can be misleading. Examining the formula for productivity, *output/input*, it becomes apparent that productivity can

be increased in different ways. For example, a country or firm may increase productivity by decreasing input faster than output. Thus, although a country or firm may be retrenching, its productivity is increasing. Seldom is this avenue for increasing productivity sustainable. Let's look at some recent global productivity statistics.

**Figure 1.10** shows productivity per hour of labor in U.S. dollars for select countries in 2014. Norway is the most productive, with \$89 worth of goods produced with one hour of labor. The United States and Belgium are next, producing \$67 worth of goods for each hour of labor. China is the least productive, using one hour of labor to produce \$10 of output. This makes sense considering that fully developed nations are more invested in automation and thus use fewer labor hours in the production process. Productivity expressed in labor hours (which is the norm) can be misleading since it does not include the cost of the labor.



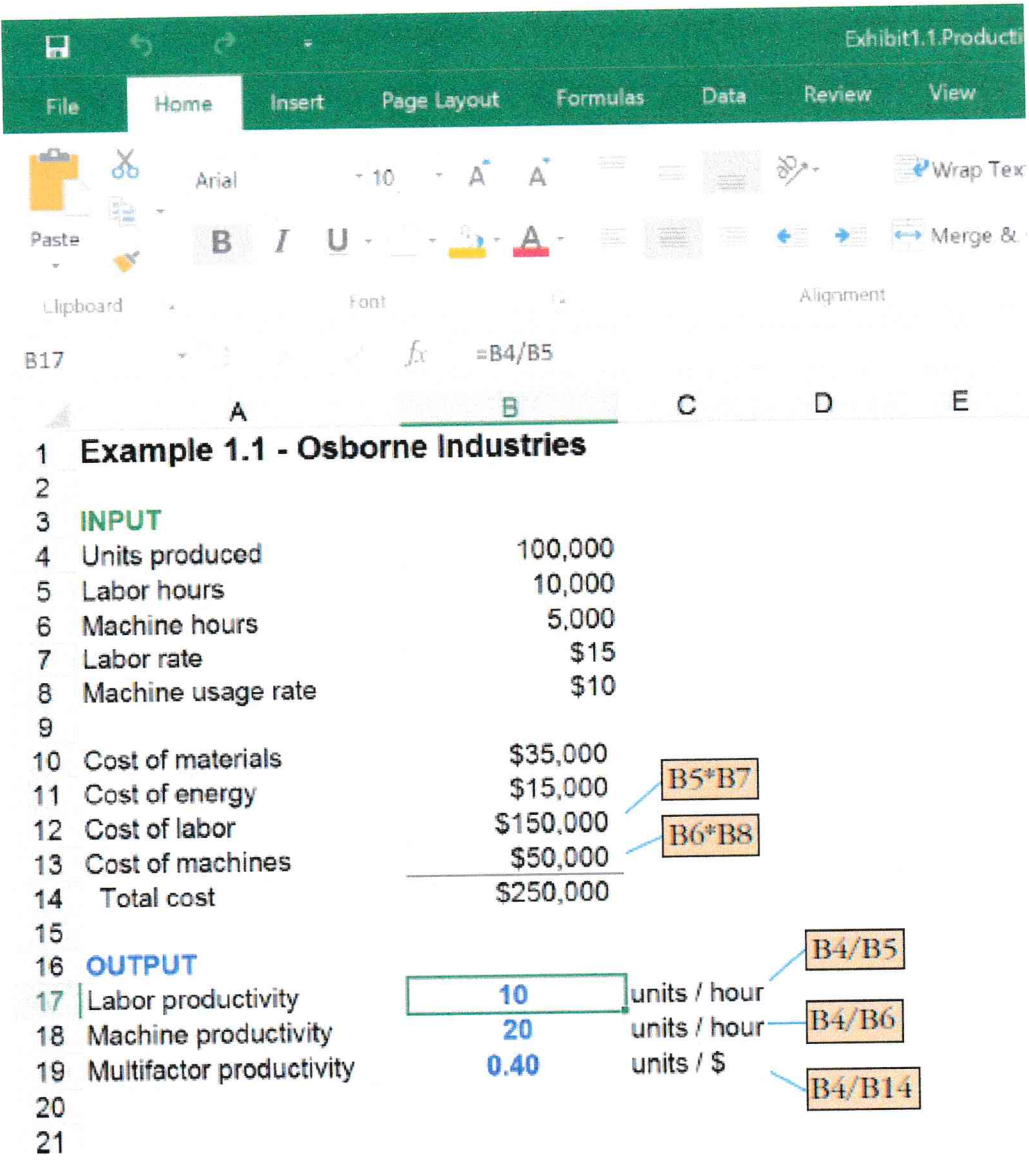
**FIGURE 1.10 Productivity per Hour (\$US)**

Source: *Output, Labor, and Productivity, 1950–2015*, the Conference Board Total Economy Database™, New York, May 2015.

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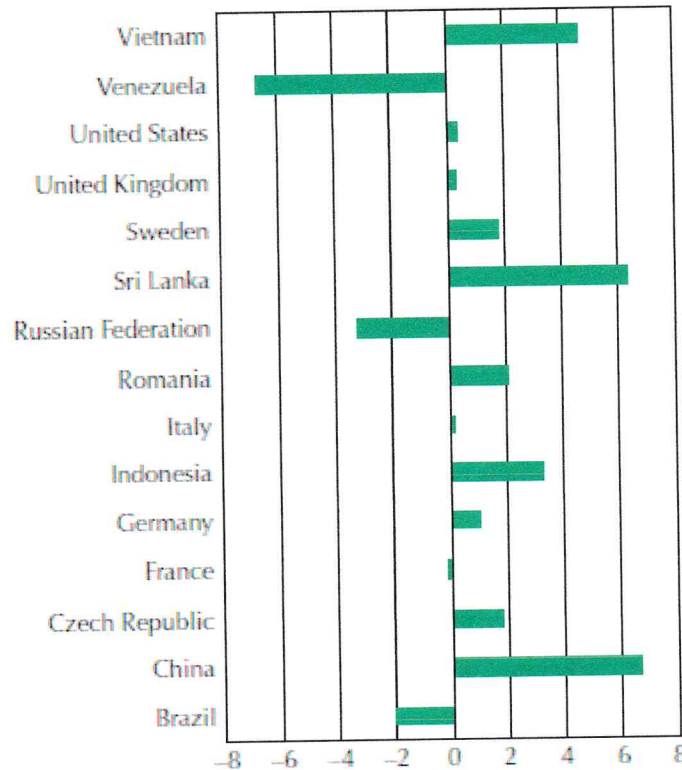
EXHIBIT 1.1 | Osborne Industries



Productivity statistics also assume that if more input were available, output would increase at the same rate. This may not necessarily be true, as there are limits to output in addition to those on which the productivity calculations are based. Furthermore, productivity emphasizes *output produced*, not *output sold*. If products produced are not sold, inventories pile up and increases in output can actually accelerate a company's decline.

Finally, productivity is a relative measure, which is why statistics provided in government reports typically measure percent *changes* in productivity from month to month, quarter to quarter, year to year, or over a number of years. Thus, **Figure 1.11**, showing percent changes in productivity from 2014 to 2015, paints quite a different picture than **Figure 1.10**. Here the 6.7%, 6.3%, and 4.7% increases in productivity by

China, Sri Lanka, and Vietnam are excellent; while the 6.7%, 3.2% and 2% decreases in productivity in Venezuela, the Russian Federation, and Brazil are discouraging. The United States shows a very small increase in productivity at 0.4%.



**FIGURE 1.11 Percent Changes in Productivity in Select Countries, 2014–2015**

Source: “Labor productivity per hour worked in US\$,” The Conference Board Total Economy Database™, New York, May 2015.

As the business world becomes more competitive, firms must find their own path to sustainable competitive advantage. Effectively managed operations are important to a firm’s competitiveness. How a firm chooses to compete in the marketplace is the subject of the next section: *Strategy and Operations*.

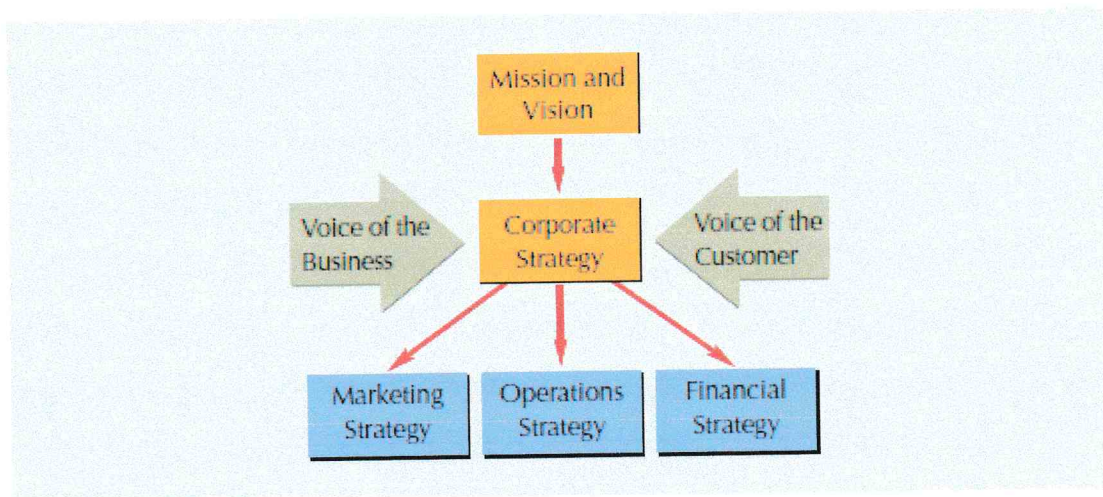
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# Strategy and Operations

**Strategy** is how the mission of a company is accomplished. It unites an organization, provides consistency in decisions, and keeps the organization moving in the right direction. Operations and supply chain management play an important role in corporate strategy.

**Strategy** A common vision that unites an organization, provides consistency in decisions, and keeps the organization moving in the right direction.

As shown in **Figure 1.12**, the strategic planning process involves a hierarchy of decisions. Senior management, with input and participation from different levels of the organization, develops a corporate strategic plan in concurrence with the firm's mission and vision, customer requirements (voice of the customer), and business conditions (voice of the business). The strategic plan focuses on the gap between the firm's vision and its current position. It identifies and prioritizes what needs to be done to close the gap, and it provides direction for formulating strategies in the functional areas of the firm, such as marketing, operations, and finance. It is important that strategy in each of the functional areas be internally consistent as well as consistent with the firm's overall strategy.



**FIGURE 1.12 Strategic Planning**

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Strategy formulation consists of five basic steps:

1. Defining a primary task.
2. Assessing core competencies.
3. Determining order winners and order qualifiers.
4. Positioning the firm.
5. Deploying the strategy.

## Primary Task

The **primary task** represents the purpose of a firm—what the firm is in the business of doing. It also determines the competitive arena. As such, the primary task should not be defined too narrowly. For example, Norfolk Southern Railway is in the business of transportation, not railroads. Paramount is in the business of communication, not making movies. Amazon's business is providing the fastest, easiest, and most enjoyable shopping experience, while Disney's is making people happy! The primary task is usually expressed in a firm's *mission* statement.

**Primary Task** The task that is most central to the operation of a firm; it defines the business that a firm is in and is often expressed in a mission statement.

Mission statements clarify what business a company is in—for Google, it's "organizing the world's information"; for Hallmark, it's creating a "more emotionally connected world"; for Twitter, it's giving "everyone the power to create and share ideas and information instantly, without barriers"; and for Merck it's "saving and improving human life." Mission statements are the "constitution" for an organization, the corporate directive, but they are no good unless they are supported by strategy and converted into action. Thus, the next step in strategy formulation is assessing the core competencies of a firm.



## Core Competencies

**Core competency** is what a firm does better than anyone else, its *distinctive competence*. A firm's core competence can be exceptional service, higher quality, faster delivery, or lower cost. One company may strive to be first to the market with innovative designs, whereas another may look for success arriving later but with better quality.

**Core competency** The essential capabilities that create a firm's sustainable competitive advantage.

Based on experience, knowledge, and know-how, core competencies represent *sustainable competitive advantages*. For this reason, products and technologies are seldom core competencies. The advantage they provide is short-lived, and other companies can readily purchase, emulate, or improve on them. Core competencies are more likely to be *processes*, a company's ability to *do* certain things better than a competitor. Thus, while a particular product is not a core competence, the process of developing new products is. For example, while the iPod was a breakthrough product, it is Apple's ability to turn out hit product after hit product (e.g., iPhone, iPad, MacBook, iWatch, etc.) that gives it that competitive advantage.

Core competencies are not static. They should be nurtured, enhanced, and developed over time. Close contact with the customer is essential to ensuring that a competence does not become obsolete. Core competencies that do not evolve and are not aligned with customer needs can become *core rigidities* for a firm. Walmart and Dell, seemingly unstoppable companies in their field, went astray when they failed to update their competencies to match changes in customer desires. For Dell, the low cost and mail-order delivery of computers did not match the customer's desire to see and test computers before purchase, or to receive personalized after-purchase customer service. For Walmart, their big-box retail model is being challenged by Amazon's online shopping model. Walmart tried smaller stores with little success, and may now convert some of their larger stores into warehouses for shipping out customer orders. To avoid these problems, companies need to continually evaluate the characteristics of their products or services that prompt customer purchase; that is, the order qualifiers and order winners.

## Order Winners and Order Qualifiers

A firm is in trouble if the things it does best are not important to the customer. That's why it's essential to look toward customers to determine what influences their purchase decision.