Chapter

11 Industry and Manufacturing

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Where Is Industry Distributed?

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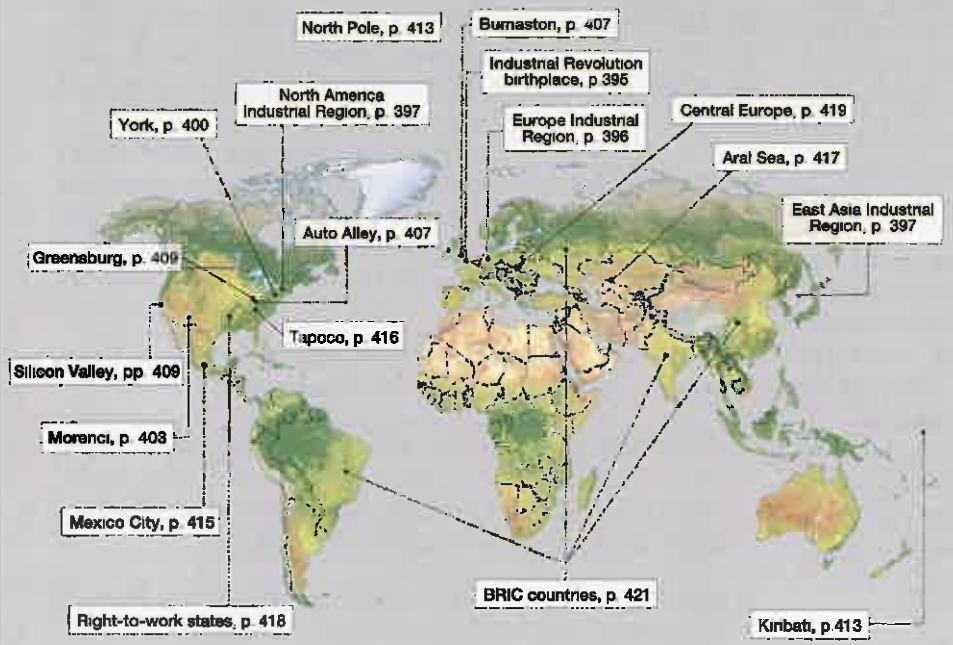
Why Are Situation and Site Factors Important?

Factories Past and Present p. 395

Much of the world's industry is clustered in three regions.

Factors of Production p. 398

Geographers can explain reasons for the location of factories.



▲ Foxconn may not be a familiar brand name, but it is the world's largest manufacturer of electronic components. Owned by Hon Hai Precision Industry Co., Foxconn is the largest exporter of products from China. Its largest main factory in Shenzhen, China, employs several hundred thousand people. Foxconn has become the world's dominant electronics manufacturer because it does the actual manufacturing for several well-known products, including the iPad, iPhone, Kindle, PlayStation 3, and Xbox 360. Geographers study why a company like Apple, which is based in the United States, chooses to have its products made by another company in another country.

KEY ISSUE 3

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Some factories pollute our air, land, and water.

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Manufacturing is expanding into new regions.

Introducing

Industry and Manufacturing

The title of this chapter refers to the manufacturing of goods in a factory. The word *industry* is appropriate because it also means persistence or diligence in creating value. A factory utilizes a large number of people, machinery, and money to turn out valuable products.

In the previous chapter, we looked at agriculture, practiced throughout the inhabited world because the need for food is universal. Industry is much more highly clustered in *space* than is agriculture. In this chapter, we look at the *regions* where factories are located and why. A particular *place* may be well suited or poorly suited for industry, depending on the distinctive characteristics of land, labor, and capital there.

Geographers also recognize that *connections* with the rest of the world are critical in determining whether a particular place is suitable for industry. Two connections are critical in determining the best location for a factory: where the markets for the product are located and where the resources needed to make the product are located.

The invention most important to the development of factories was the steam engine, patented in 1769 by James Watt, a maker of mathematical instruments in Glasgow, Scotland (Figure 11-1). Watt built the first useful steam engine, which could pump water far more efficiently than the watermills then in common use, let alone human or animal power. The large supply of steam power available from James Watt's steam engines induced firms to concentrate all their process steps in one building attached to a single power source. Watt's engine and other inventions enabled the United Kingdom to become the world's dominant industrial power during the nineteenth century.

▲ **FIGURE 11-1 JAMES WATT'S STEAM ENGINE** This Watt steam engine in Wolverhampton, England. Steam injected in a cylinder (inside the brick housing) pushes a piston attached to a crankshaft that drives machinery (right side of engine).

Until the late twentieth century, industry was still highly clustered in a handful of communities within a handful of developed countries, but industry has diffused to many communities in many developing countries. The United States lost one-third of its manufacturing jobs during the first decade of the twenty-first century.

Today, as countries seek to counter the trend toward deindustrialization, government officials everywhere recognize the powerful role of industry in the economic health of a community. Communities around the world view manufacturing jobs as a special asset, and they mourn when factories close and rejoice when they open. To attract and retain factories, government officials offer financial support that, when scrutinized by independent analysts, is considered excessive.

Transnational corporations operate at a global *scale* for the distribution of markets and resources. Raw materials may be collected from many places, sent to factories located in several other places for a succession of specialized manufacturing procedures, and shipped to consumers located in yet other places.

- **KEY ISSUE 1** looks at *where* industry originated and diffused, as well as its current distribution.
- **KEY ISSUE 2** examines factors underlying *why* industry is distributed in a distinctive pattern. Factors relate to a combination of the unique characteristics of a place and the connections between places.
- **KEY ISSUE 3** looks at environmental issues generated by industry, especially of air, water, and land.
- **KEY ISSUE 4** looks at changes in the factors resulting in changes in distribution. Until the late twentieth century, industry was still highly clustered in a handful of communities within a handful of developed countries, but industry has diffused to many communities in many developing countries. With *globalization* of competition to attract new industries—or, in many places, to retain existing ones—each place possesses distinctive location characteristics. Geographers identify the *local diversity* in assets that enables some communities to compete successfully for industries, as well as handicaps communities must overcome to retain older companies.

KEY ISSUE 1

Where Is Industry Distributed?

- The Industrial Revolution
- Industrial Regions

The modern concept of industry—meaning the manufacturing of goods in a factory—originated in northern England and southern Scotland during the second half of the eighteenth century. From there, industry diffused to Europe and to North America in the nineteenth century and to other regions in the twentieth century.

The Industrial Revolution

The **Industrial Revolution** was a series of improvements in industrial technology that transformed the process of manufacturing goods. Prior to the Industrial Revolution, industry was geographically dispersed across the landscape. People made household tools and agricultural equipment in their own homes or obtained them in the local village. Home-based manufacturing was known as the **cottage industry** system.

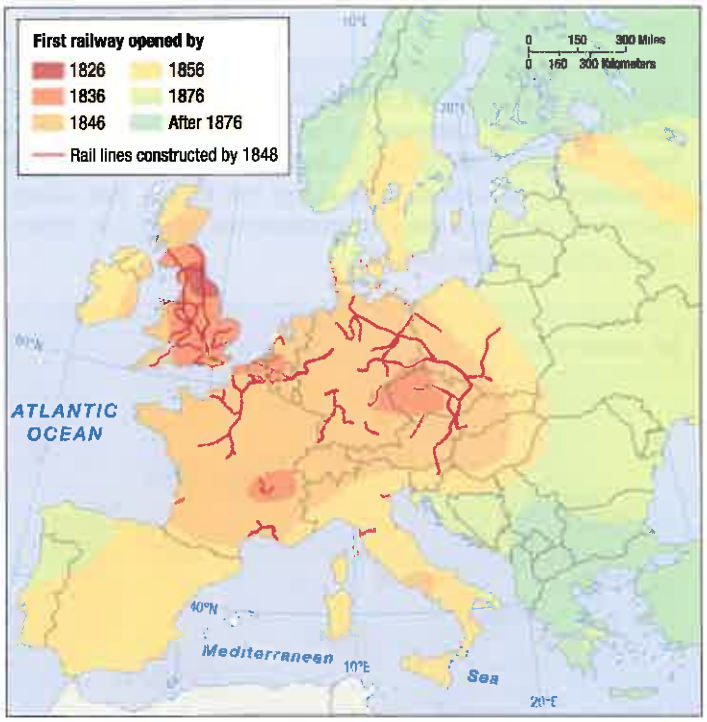
The catalyst of the Industrial Revolution was technology, with several inventions transforming the way in which goods were manufactured, beginning with the steam engine, an example of which is shown in Figure 11-1. The revolution in industrial technology created an unprecedented expansion in productivity, resulting in substantially higher standards of living. In Chapter 2, the Industrial Revolution was cited as a principal cause of population growth in stage 2 of the demographic transition.

The term *Industrial Revolution* is somewhat misleading:

- The transformation was far more than industrial; it resulted in new social, economic, and political inventions, not just industrial ones.
- The changes involved a gradual diffusion of new ideas and techniques over decades rather than an instantaneous revolution.

Nonetheless, the term is commonly used to define the process that began in the United Kingdom in the late 1700s. Among the first industries impacted by the Industrial Revolution were:

- **Iron.** The first industry to benefit from Watt's steam engine was the iron tool industry. The usefulness of iron had been known for centuries, but it was difficult to produce because ovens had to be constantly heated, something the steam engine could do.
- **Coal.** Wood, the main energy source prior to the Industrial Revolution, was becoming scarce in England because it was in heavy demand for construction of ships, buildings, and furniture, as well as for heat. Manufacturers turned to coal, which was then plentiful in England. It became the principal source of energy to operate the ovens and the steam engines.
- **Transportation.** First canals and then railroads enabled factories to attract large numbers of workers, bring in bulky raw materials such as iron ore and coal, and ship finished goods to consumers (Figure 11-2).
- **Textiles.** Textile production was transformed from a dispersed cottage industry to a concentrated factory system during the late eighteenth century. In 1768, Richard Arkwright, a barber and wigmaker in Preston, England, invented machines to untangle cotton prior to spinning. Too large to fit inside a cottage, spinning frames were placed inside factories near sources of rapidly flowing water, which supplied the power.
- **Chemicals.** The chemical industry was created to bleach and dye cloth. In 1746, John Roebuck and Samuel Garbett established a factory to bleach cotton with sulfuric acid obtained from burning coal. When combined with various metals, sulfuric acid produced another acid called vitriol, which was useful for dying clothing.
- **Food processing.** In 1810, French confectioner Nicolas Appert started canning food in glass bottles sterilized in boiling water. Canned food was essential to feed the factory workers who no longer lived on farms.



▲ **FIGURE 11-2 DIFFUSION OF THE INDUSTRIAL REVOLUTION** The construction of railroads in the United Kingdom and on the European continent reflects the diffusion of the Industrial Revolution. Europe's political problems impeded the diffusion of the railroad. Cooperation among small neighboring states was essential to build an efficient rail network and to raise money for constructing and operating the system. Because such cooperation could not be attained, railroads in some parts of Europe were delayed 50 years after their debut in Britain.

Industrial Regions

Learning Outcome 11.1.1
Describe the locations of the principal industrial regions.

Industry is concentrated in three of the nine world regions discussed in Chapter 9 regions of the world: Europe (Figure 11-3), North America (Figure 11-4), and East Asia (Figure 11-5). Each of the three regions accounts for roughly one-fourth of the world's total industrial output. Outside these three regions, the leading industrial producers are Brazil and India.

EUROPE'S INDUSTRIAL AREAS

Major industrial areas in Europe include:

- The **United Kingdom** dominated world production of steel and textiles during the nineteenth century. These industries have declined, but the country has attracted international investment through new high-tech industries that serve the European market.
- The **Rhine-Ruhr Valley** has a concentration of iron and steel manufacturing because of proximity to large coalfields. Rotterdam, the world's largest port, lies at the mouth of several branches of the Rhine River as it flows into the North Sea.
- The **Mid-Rhine** is Europe's most centrally located industrial area. Frankfurt is a financial and commercial center and the hub of Germany's transport network. Stuttgart specializes in high-value goods that require skilled labor. Mannheim, an inland port along the Rhine, has a large chemical industry that manufactures synthetic fibers, dyes, and pharmaceuticals.
- The **Po Basin** has attracted textiles and other industries because of two key assets, compared to Europe's other industrial regions: numerous workers willing to accept lower wages and inexpensive hydroelectricity from the nearby Alps.
- **Northeastern Spain** was Europe's fastest-growing manufacturing area during the late twentieth century. Spain's leading industrial area, Catalonia, centered on the city of Barcelona, is the center of Spain's textile industry and the country's largest motor-vehicle plant.
- **Moscow** is Russia's oldest industrial region, centered around the country's capital and largest city.
- **St. Petersburg**, Russia's second-largest city, specializes in shipbuilding and other industries serving Russia's navy and ports in the Baltic Sea.
- The **Urals**, contain the world's most varied collection of minerals. Proximity to these minerals has attracted iron and steel, chemicals, machinery, and metal fabricating plants.
- **Volga** is the region containing Russia's largest petroleum and natural gas fields. To the northeast, the Ural mountain range contains more than 1,000 types of minerals, the most varied collection found in any mining region in the world.
- **Kuznetsk** is Russia's most important manufacturing district east of the Ural Mountains, with the country's largest reserves of coal and an abundant supply of iron ore.
- **Donetsk**, in Eastern Ukraine, has one of the world's largest coal reserves.
- **Silesia**, Europe's most rapidly growing industrial area, takes advantage of a skilled but low-paid workforce and proximity to wealthy markets in Western Europe.

▲ FIGURE 11-3 **EUROPE'S INDUSTRIAL AREAS** Europe was the first region to industrialize during the nineteenth century. Numerous industrial centers emerged in Europe as countries competed with each other for supremacy.

NORTH AMERICA'S INDUSTRIAL AREAS

Major industrial areas in North America include:

- **New England** was a cotton textile center in the early nineteenth century. Cotton was imported from southern states, and finished cotton products were shipped to Europe.
- The **Middle Atlantic** is the largest U.S. market, so the region attracts industries that need proximity to a large number of consumers and depend on foreign trade through one of this region's large ports.
- The **Mohawk Valley**, a linear industrial belt in upper New York State, takes advantage of inexpensive electricity generated at nearby Niagara Falls.
- **Pittsburgh–Lake Erie** was the leading steel-producing area in the nineteenth century because of its proximity to Appalachian coal and iron ore.

◀ **FIGURE 11-4 NORTH AMERICA'S INDUSTRIAL AREAS** Industry arrived a bit later in North America than in Europe, but it grew much faster in the nineteenth century. North America's manufacturing was traditionally highly concentrated in the northeastern United States and southeastern Canada. In recent years, manufacturing has relocated to the South, lured by lower wages and legislation that has made it difficult for unions to organize factory workers.

▲ **FIGURE 11-5 EAST ASIA'S INDUSTRIAL AREAS** East Asia became an important industrial region in the second half of the twentieth century, beginning with Japan. Into the twenty-first century, China has emerged as the world's leading manufacturing country by most measures.

- The **Western Great Lakes**, centered on Chicago, is the hub of the nation's transportation network and is now the center of steel production.
- **Southern California** is now the country's largest area of clothing and textile production, the second-largest furniture producer, and a major food-processing center.
- **Southeastern Ontario**, Canada's most important industrial area, is central to the Canadian and U.S. markets and near the Great Lakes and Niagara Falls.

ASIA'S INDUSTRIAL AREAS

Major industrial areas in Asia include:

- **Japan** became an industrial power in the 1950s and 1960s, initially by producing goods that could be sold in large quantity at cut-rate prices to consumers in other countries. Manufacturing is concentrated in the central region, between Tokyo and Nagasaki.
- **China** has the world's largest supply of low-cost labor and is the world's largest market for many consumer products. Manufacturers cluster in three areas along the east coast: near Guangdong and Hong Kong, in the Yangtze River valley between Shanghai and Wuhan, and along the Gulf of Bo Hai, from Tianjin and Beijing to Shenyang.
- **South Korea** followed Japan's lead in focusing on export-oriented manufacturers. The country is a leading producer of ocean-going ships. Manufacturing is centered along the rim of the country between the capital and largest city Seoul and Busan, the largest port.

CHECK-IN: KEY ISSUE 1

Where Is Industry Distributed?

- ✓ **The Industrial Revolution was a series of improvements that transformed manufacturing. Most of the improvements occurred first in the United Kingdom.**
- ✓ **The world's three principal industrial regions are Europe, North America, and East Asia.**

KEY ISSUE 2

Why Are Situation and Site Factors Important?

- Situation Factors: Proximity to Inputs
- Situation Factors: Proximity to Markets
- Changing Situation Factors in Key Industries
- Site Factors

Learning Outcome 11.2.1

Identify the two types of situation factors and explain why some industries locate near inputs.

Having looked at the "where" question for industrial location, we can next consider the "why" question: Why are industries located where they are? Geographers try to explain why one location may prove more profitable for a factory than others. A company ordinarily faces two geographic costs—situation and site:

- **Situation factors** involve transporting materials to and from a factory. A firm seeks a location that minimizes the cost of transporting inputs to the factory and finished goods to consumers.
- **Site factors** result from the unique characteristics of a location.

Situation Factors: Proximity to Inputs

Manufacturers buy from companies and individuals who supply inputs, such as minerals, materials, energy, machinery, and supporting services. They sell to companies and individuals who purchase the product. The farther something is transported, the higher the cost, so a manufacturer tries to locate its factory as close as possible to its inputs and markets:

- **Proximity to inputs.** The optimal plant location is as close as possible to inputs if the cost of transporting raw materials to the factory is *greater than* the cost of transporting the product to consumers.
- **Proximity to markets.** The optimal plant location is as close as possible to the customer if the cost of transporting raw materials to the factory is *less than* the cost of transporting the product to consumers.

Every industry uses some inputs. The inputs may be resources from the physical environment, such as minerals, or they may be parts or materials made by other companies. An industry in which the inputs weigh more than the final products is a **bulk-reducing industry**. To minimize transport costs, a bulk-reducing industry locates near its sources of inputs.

Minerals are especially important inputs for many industries. Earth has 92 natural elements, but about 99 percent of the crust is composed of 8 of them (Figure 11-6). The eight most common elements combine with thousands of rare ones to form approximately 3,000 different minerals, all with their own properties of hardness, color, and density, as well as spatial distribution. Many of these minerals have important industrial uses.

Like energy, mineral resources are not distributed uniformly across Earth. Countries with important mineral resources are shown in orange in Figure 11-7. Few important minerals are found in Europe, Central Asia, and Southwest Asia & North Africa.

NONMETALLIC MINERALS

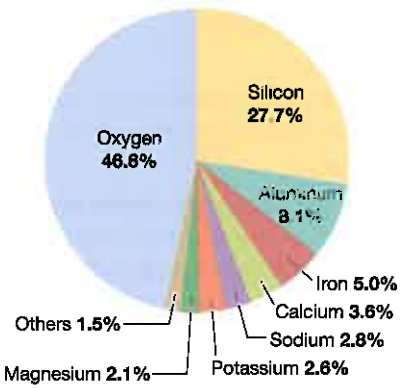
Minerals are either nonmetallic or metallic. In weight, more than 90 percent of the minerals that humans use are nonmetallic. Important nonmetallic minerals include building stones, gemstones such as diamonds, and minerals used in the manufacture of fertilizers such as nitrogen, phosphorus, potassium, calcium, and sulfur.

METALLIC MINERALS

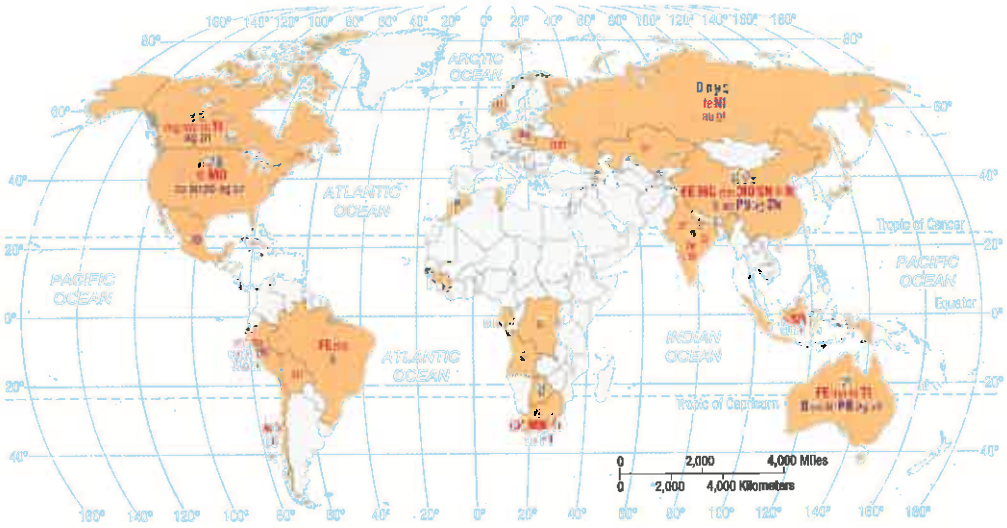
Metallic minerals have properties that are especially valuable for fashioning machinery, vehicles, and other essential elements of contemporary society. They are to varying degrees malleable (able to be hammered into thin plates) and ductile (able to be drawn into fine wire) and are good conductors of heat and electricity. Each metal possesses these qualities in different combinations and degrees and therefore has a distinctive set of uses.

Many metals are capable of combining with other metals to form alloys with distinctive properties important for industry. Alloys are known as ferrous or nonferrous.

FERROUS ALLOYS. A **ferrous** alloy contains iron, and a **nonferrous** one does not. The word *ferrous* comes from the



◀ **FIGURE 11-6 ELEMENTS IN EARTH'S CRUST** Oxygen, silicon, and aluminum are the most common elements in Earth's crust.



Nonmetallic minerals

D	d	Diamonds	P	p	Phosphorus
N	n	Nitrogen	S	s	Sulfur

Ferrous metals

FE	fe	Iron ore	NI	ni	Nickel
CR	cr	Chromium	SN	sn	Tin
MG	mg	Magnesium	TI	ti	Titanium
MN	mn	Manganese	W	w	Tungsten
MO	mo	Molybdenum			

Nonferrous metals

B	b	Bauxite	PT	pt	Platinum
CU	cu	Copper	AG	ag	Silver
AU	au	Gold	ZN	zn	Zinc
PB	pb	Lead			

XX represents 15% and above of world production

xx represents 5–15% of world production

▲ **FIGURE 11-7 DISTRIBUTION OF MINERALS**
Australia and China are especially well endowed with minerals that are important for industry.

Latin for "iron." Iron is extracted from iron ore, by far the world's most widely used ore. Humans began fashioning tools and weapons from iron 4,000 years ago. Important metals used to make ferrous alloys include:

- **Chromium** is a principal component of stainless steel, extracted from chromite ore, one-half of which is mined in South Africa.
- **Manganese** imparts toughness and carries off undesirable sulfur and oxygen during the smelting process. Brazil, Gabon, and South Africa are the leading producers.
- **Molybdenum** imparts toughness and resilience to steel. The United States is the leading producer.
- **Nickel** is used primarily for stainless steel and high-temperature and electrical alloys. Russia, Australia, and Canada are the leading producers.
- **Tin** is valued for its corrosion-resistant properties and is used for plating iron and steel. China is the leading producer.
- **Titanium** is used as white pigment in paint. It is extracted primarily from the mineral ilmenite, and Australia is the leading producer.
- **Tungsten** is used to manufacture tungsten carbide for cutting tools. China is responsible for 90 percent of world production.

NONFERROUS METALS. Important metals utilized to manufacture products that don't contain iron and steel include:

- **Aluminum** is the most abundant nonferrous metal. Lighter, stronger, and more resistant to corrosion than iron and steel, aluminum is obtained primarily through extraction from bauxite ore. Australia is the leading producer.
- **Copper** is valued for its high ductility, malleability, thermal and electrical conductivity, and resistance to corrosion. It is used primarily in electronics and constructing buildings. Chile is the leading producer.
- **Lead** is has been used for thousands of years, first in building materials and pipes; then in ammunition, brass, glass, and crystal; and now primarily in motor-vehicle batteries. Australia and China are the leading producers.
- **Lithium** is used in batteries for a wide variety of devices such as cell phones, laptop computers, and hybrid and electric-powered vehicles. Chile and Australia each produce about one-third of global output.
- **Magnesium** is relatively light yet strong, so it is used to produce lightweight, corrosion-resistant alloys, especially with aluminum to make beverage cans. China supplies three-fourths of the world's magnesium.
- **Zinc** is primarily used as a coating to protect iron and steel from corrosion, and it is also used as an alloy to make bronze and brass. China is the leading producer.
- **Precious metals** include silver, gold, and the platinum group. Silver and gold have been prized since ancient times for their beauty and durability. Platinum is used in motor vehicles for catalytic converters and fuel cells.
- **Rare earth metals** comprise 17 elements, 15 of which are lanthanides, such as cerium. They are called "rare" because only a few deposits in the world are economically profitable to mine, nearly all of them in China. Rare earth metals are used in electronics and motors.

Pause and Reflect 11.2.1
North America is a leading source of which minerals?

Situation Factors: Proximity to Markets

Learning Outcome 11.2.2
Explain why some industries locate near markets.

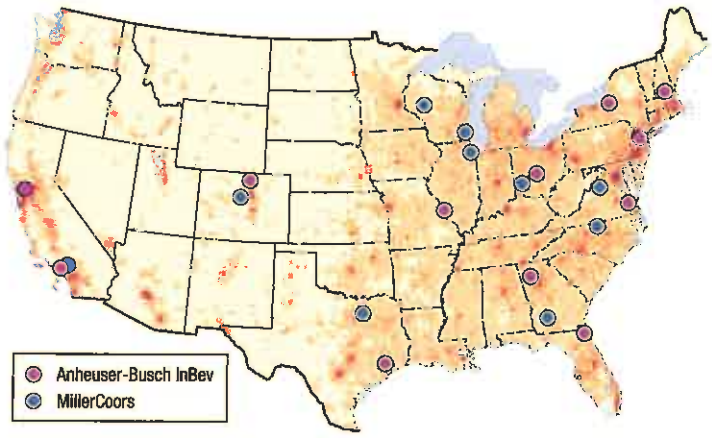
For many firms, the optimal location is close to customers. Proximity to markets is a critical locational factor for three types of industries: bulk-gaining industries, single-market manufacturers, and perishable products companies.

BULK-GAINING INDUSTRIES

A **bulk-gaining industry** makes something that gains volume or weight during production. To minimize transport costs, a bulk-gaining industry needs to locate near where the product is sold.

FABRICATED METALS. A prominent example of a bulk-gaining industry is the fabrication of parts and machinery from steel and other metals (Figure 11-8). A fabricated-metal factory brings together metals such as steel and previously manufactured parts as the main inputs and transforms them into a more complex product. Fabricators shape individual pieces of metal using such processes as bending, forging (hammering or rolling metal between two dies), stamping (pressing metal between two dies), and forming (pressing metal against one die). Separate parts are joined together through welding, bonding, and fastening with bolts and rivets.

▼ **FIGURE 11-8 BULK-GAINING: FABRICATED METAL PRODUCTION** Motorcycle wheels are fabricated at the Harley-Davidson factory in York, Pennsylvania.



▲ **FIGURE 11-9 BULK-GAINING: BEVERAGE PRODUCTION** Beer is a bulk-gaining industry. The cans or bottles are filled mostly with water. Most beer is bottled near major metropolitan areas, where most of the consumers are clustered add to caption: The areas in color on the map have relatively high population density.

Because fabricated and machined products typically occupy a larger volume than the sum of their individual parts and metals, the cost of shipping the final product to consumers is usually the most critical factor. Whereas steelmakers have traditionally located near raw materials, steel fabricators have traditionally located near markets. Machinery is fabricated for use in farms, factories, offices, and homes. Common fabricated goods include microwave ovens, televisions, refrigerators, and air conditioners. Machine shops also transform metal into useful products such as structural metal for buildings and bridges.

BEVERAGE PRODUCTION. Beverage bottling is another good example of an industry that adds bulk (Figure 11-9). Empty cans or bottles are brought to the bottler, filled with the soft drink or beer, and shipped to consumers. The principal input placed in a beverage container is water, which is relatively bulky, heavy, and expensive to transport. Major soft-drink companies add syrups, and beer companies add barley, hops, and yeast, according to proprietary recipes. These added ingredients are much less bulky than the water and much easier to transport.

If water were only available in a few locations around the country, then bottlers might cluster near the source of such a scarce, bulky input. But because water is available where people live, bottlers can minimize costs by producing beverages near their consumers instead of shipping water (their heaviest and bulkiest input) long distances. A filled container has the same volume as an empty one, but it is much heavier. Therefore, shipping filled containers is more expensive than shipping empty ones, and bottlers locate near their customers rather than the manufacturers of the containers.

▲ FIGURE 11-10 **SINGLE-MARKET MANUFACTURER** YKK, the world's largest manufacturer of zippers, has factories in 68 countries, in order to serve its single market: clothing manufacturers.

Pause and Reflect 11.2.2

Why isn't wine bottled near the market, like beer and soft drinks?

SINGLE-MARKET MANUFACTURERS

Single-market manufacturers are specialized manufacturers with only one or two customers. The optimal location for these factories is often in close proximity to the customers.

An example of a single-market manufacturer is a producer of buttons, zippers, clips, pins, or other specialized components attached to clothing (Figure 11-10). The clothing manufacturer may need additional supplies of these pieces on very short notice. The world's largest manufacturer of zippers, YKK, for example, has factories in 68 countries, in order to be near its customers, the manufacturers of clothing.

The makers of parts for motor vehicles are another example of specialized manufacturers with only one or two customers—the major motor vehicle producers, such as GM and Toyota. In the past, most motor vehicle parts were made in Michigan and shipped to nearby warehouses and distribution centers maintained in that state by the major producers. From the warehouses, the producers sent the parts to plants around the country where the vehicles were assembled. Parts makers now ship most of their products directly to assembly plants.

Proximity to the assembly plant is increasingly important for parts producers because of the diffusion of "just-in-time" delivery (see Key Issue 4). Under just-in-time, parts are delivered to the assembly plant just in time to be used, often within minutes, rather than weeks or months in advance. For some parts makers, just-in-time delivery dictates that they build their factories as close as possible to their customers, the final assembly plants. Most engines, transmissions, seats, and metal body parts are produced at locations only a couple of hours away from an assembly plant.

PERISHABLE PRODUCTS

To deliver their products to consumers as rapidly as possible, perishable-product industries must be located near their markets. Because few people want stale bread or sour milk, food producers such as bakers and milk bottlers must locate near their customers to assure rapid delivery (Figure 11-11). Processors of fresh food into frozen, canned, and preserved products can, however, locate far from their customers. Cheese and butter, for example, are manufactured in Wisconsin because rapid delivery to the urban markets is not critical for products with a long shelf life, and the area is well suited agriculturally for raising dairy cows.

The daily newspaper is an example of a product other than food that is highly perishable because it contains dated information. People demand their newspaper as soon after its printing as possible. Therefore, newspaper publishers must locate near markets to minimize transportation cost. Difficulty with timely delivery is one of the main factors in the decline of printed and home-delivered daily newspapers. Electronic devices—computers and handheld devices—can deliver news more quickly than a printed newspaper. Little wonder that during the first decade of the twenty-first century, print publishing jobs declined from 1 million to 800,000 in the United States, whereas Internet publishing jobs increased from 70,000 to 80,000.

▲ FIGURE 11-11 **PERISHABLE PRODUCTS**
Potato chips are best consumed when fresh, and they are much bulkier after they have been sliced, fried until they curl, and placed in large air-filled bags. As a result, most are produced relatively close to the market.

SHIP, RAIL, TRUCK, OR AIR?

Learning Outcome 11.2.3

Explain why industries use different types of transportation.

Inputs and products are transported in one of four ways: via ship, rail, truck, or air. Firms seek the lowest-cost mode of transport, but which of the four alternatives is cheapest changes with the distance that goods are being sent.

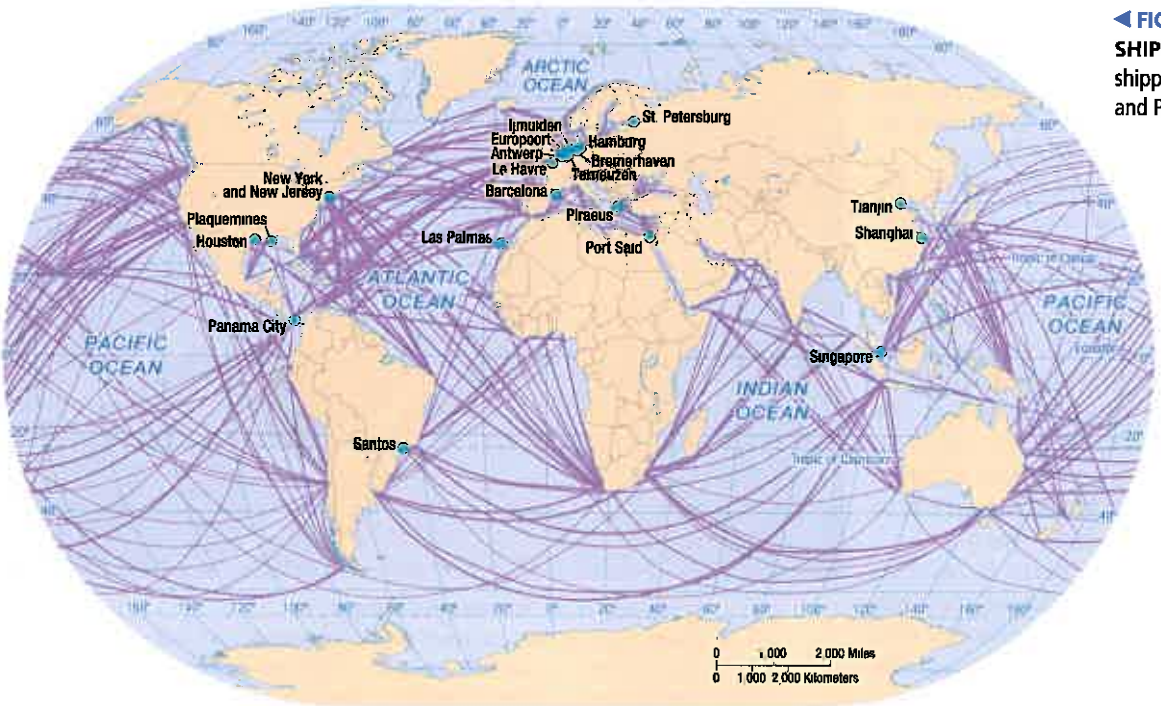
The farther something is transported, the lower is the cost per kilometer (or mile). Longer-distance transportation is cheaper per kilometer in part because firms must pay workers to load goods on and off vehicles, whether the material travels 10 kilometers or 10,000. The cost per kilometer decreases at different rates for each of the four modes because the loading and unloading expenses differ for each mode:

- **Trucks** are most often used for short-distance delivery, because they can be loaded and unloaded quickly and cheaply. Truck delivery is especially advantageous if the driver can reach the destination within one day, before having to stop for an extended rest.
- **Trains** are often used to ship to destinations that take longer than one day to reach, such as between the East and West coasts of the United States. Trains take longer than trucks to load, but once under way, they aren't required to make daily rest stops like trucks.
- **Ships** are attractive for transport over very long distances because the cost per kilometer is very low. Ships are slower than land-based transportation, but unlike trains or trucks, they can cross oceans, such as to North America from Europe or Asia (Figure 11-12).
- **Air** is most expensive for all distances so is usually reserved for speedy delivery of small-bulk, high-value packages.

Modes of delivery are often mixed. For example, air-freight companies pick up packages in the afternoon and transport them by truck to the nearest airport. Late at night, planes filled with packages are flown to a central hub airport in the interior of the country, such as Memphis, Tennessee, or Louisville, Kentucky. The packages are transferred to other planes, flown to airports nearest their destination, transferred to trucks, and delivered the next morning.

Containerization has facilitated transfer of packages between modes. Containers may be packed into a rail car, transferred quickly to a container ship to cross the ocean, and unloaded onto trucks at the other end. Large ships have been specially built to accommodate large numbers of rectangular box-like containers.

Regardless of transportation mode, cost rises each time inputs or products are transferred from one mode to another. For example, workers must unload goods from a truck and then reload them onto a plane. The company may need to build or rent a warehouse to store goods temporarily after unloading from one mode and before loading to another mode. Some companies may calculate that the cost of one mode is lower for some inputs and products, whereas another mode may be cheaper for other goods. Many companies that use multiple transport modes locate at a **break-of-bulk point**, which is a location where transfer among transportation modes is possible. Important break-of-bulk points include seaports and airports. For example, a steel mill near the port of Baltimore receives iron ore by ship from South America and coal by train from Appalachia.



◀ FIGURE 11-12 WORLD SHIPPING ROUTES The heaviest shipping traffic is across the Atlantic and Pacific oceans to North America.

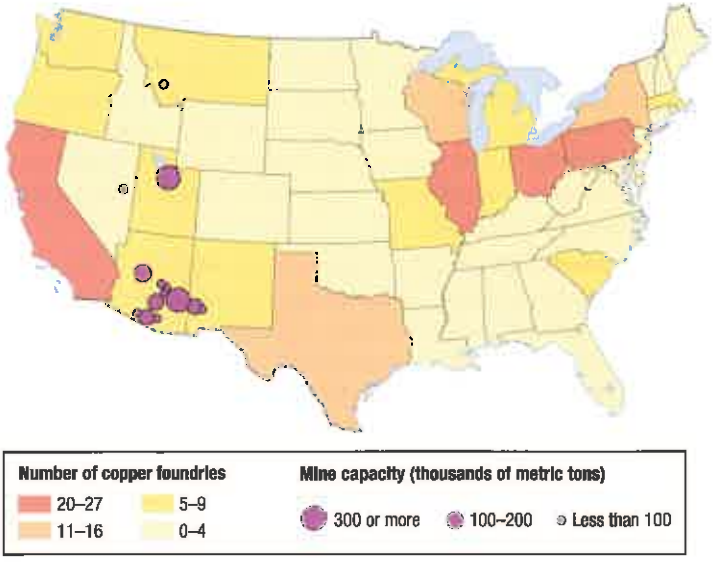
Changing Situation Factors in Key Industries

Each step in the production process can result in a different combination of situation factors. As a result, the optimal locations for the different steps can vary. In other cases, the relative importance of various situation factors can change over time, or their costs can change. If the mix of situation factors changes, the optimal location for an individual factory, or for an entire industry, can change.

COPPER: PROXIMITY TO INPUTS OR MARKETS?

Copper production involves several steps. The first three steps are good examples of bulk-reducing activities that need to be located near their sources of inputs (Figure 11-13). The fourth step is not bulk reducing, so does not need to be near inputs:

1. **Mining.** The first step in copper production is mining the copper ore. Mining in general is bulk reducing because the heavy, bulky ore extracted from mines is mostly waste, known as *gangue*. Copper ore mined in North America is especially low grade, less than 0.7 percent copper.
2. **Concentration.** Concentration mills crush and grind the ore into fine particles, mix them with water and chemicals, and filter and dry them. Copper concentrate is about 25 percent copper. Concentration mills are always near the mines because concentration transforms the heavy, bulky copper ore into a product of much higher value per weight (Figure 11-14).
3. **Smelting.** The concentrated copper becomes the input for smelters, which remove more impurities. Smelters produce copper matte (about 60 percent copper), blister copper (about 97 percent copper), and anode copper (about 99 percent copper). As another bulk-reducing industry, smelters are built near their main inputs—the concentration mills—again to minimize transportation cost.
4. **Refining.** The purified copper produced by smelters is treated at refineries to produce copper cathodes, about 99.99 percent pure copper. Most refineries are located near smelters.



▲ **FIGURE 11-13 U.S. COPPER INDUSTRY** Copper mining, concentrating, and smelting are examples of bulk-reducing industries. In the United States, most plants that concentrate, smelt, and refine copper are in or near Arizona, where most copper mines are located. In contrast, most foundries, where copper products are manufactured, are located near markets in the East and West coasts.

▲ **FIGURE 11-14 COPPER MINING AND CONCENTRATION** Morenci Mine, Arizona, is the largest copper mine in the United States. Nearby are other bulk-reducing facilities, including the concentrator shown here.

Another important locational consideration is the source of energy to power these energy-demanding operations. In general, metal processors such as the copper industry try to locate near economical electrical sources and to negotiate favorable rates from power companies.

Figure 11-13 shows the distribution of the U.S. copper industry. Two-thirds of U.S. copper is mined in Arizona, so the state also has most of the concentration mills and smelters. Most foundries, where copper is manufactured, are located near markets on the East and West coasts.

Pause and Reflect 11.2.3

What is an example of a product purchased by consumers that is made of copper?

STEEL: CHANGING INPUTS

Learning Outcome 11.2.4
Describe how the optimal location for steel production has changed.

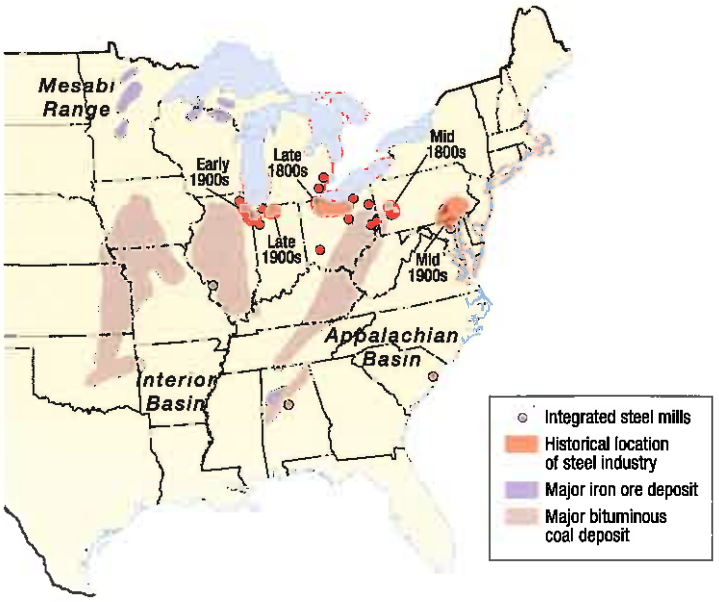
Steel is an alloy of iron that is manufactured by removing impurities in iron, such as silicon, phosphorus, sulfur, and oxygen, and adding desirable elements, such as manganese and chromium. Steel was a luxury item until Henry Bessemer (1813–1898) patented an efficient process for casting steel in 1855. The Bessemer process remained the most common method of manufacturing steel until the mid-twentieth century.

Steelmaking is an example of a bulk-reducing industry that traditionally located its facilities because of situation factors. Two changes in situation factors have influenced changes in the distribution of steel mills within the United States and worldwide:

- Changes in the relative importance of the main inputs.
- Increasing importance of proximity to markets rather than proximity to inputs.

CHANGING DISTRIBUTION OF THE U.S. STEEL INDUSTRY. The two principal inputs in steel production are iron ore and coal. Because of the need for large quantities of bulky, heavy iron ore and coal, steelmaking traditionally clustered near sources of the two key raw materials. Within the United States, the distribution of steel production changed several times because of changing inputs (Figure 11-15):

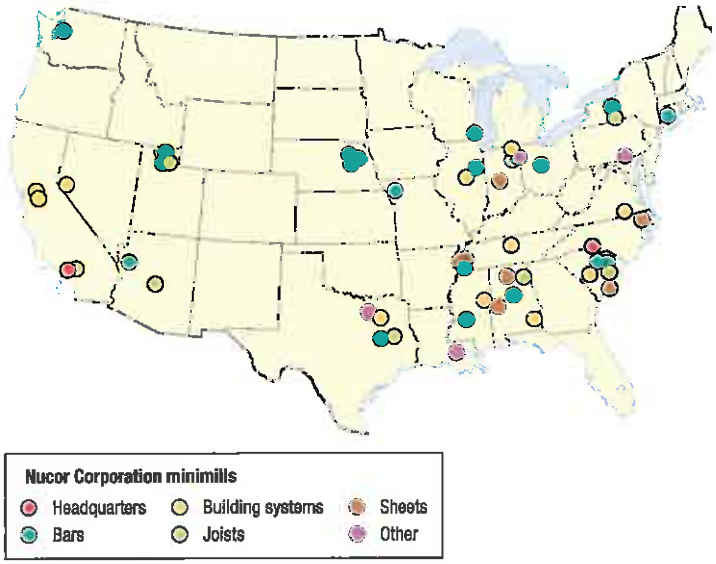
- **Mid-nineteenth century: Southwestern Pennsylvania.** The U.S. steel industry concentrated around Pittsburgh in southwestern Pennsylvania because iron ore and coal were both mined there. The area no longer has steel mills, but it remains the center for research and administration.
- **Late nineteenth century: Lake Erie.** Steel mills were built around Lake Erie, in the Ohio cities of Cleveland, Youngstown, and Toledo, and near Detroit. The locational shift was largely influenced by the discovery of rich iron ore in the Mesabi Range, a series of low mountains in northern Minnesota. This area soon became the source for virtually all iron ore used in the U.S. steel industry. The ore was transported by way of Lake Superior, Lake Huron, and Lake Erie. Coal was shipped from Appalachia by train.
- **Early twentieth century: Southern Lake Michigan.** Most new steel mills were located near the southern end of Lake Michigan—in Gary, Indiana, Chicago, and other communities. The main raw materials continued to be iron ore and coal, but changes in steelmaking required more iron ore in proportion to coal. Thus, new steel mills were built closer to the Mesabi Range to minimize transportation cost. Coal was available from nearby southern Illinois, as well as from Appalachia.



▲ **FIGURE 11-15 INTEGRATED STEEL MILLS IN THE UNITED STATES** Integrated steel mills are highly clustered near the southern Great Lakes, especially Lake Erie and Lake Michigan. Historically, the most critical factor in situating a steel mill was to minimize transportation cost for raw materials, especially heavy, bulky iron ore and coal. In recent years, many integrated steel mills have closed. Most surviving mills are in the Midwest to maximize access to consumers.

- **Mid-twentieth century: East and West coasts.** Most new U.S. steel mills were located in communities near the East and West coasts, including Baltimore, Los Angeles, and Trenton, New Jersey. These coastal locations partly reflected further changes in transportation cost. Iron ore increasingly came from other countries, especially Canada and Venezuela, and locations near the Atlantic and Pacific oceans were more accessible to those foreign sources. Further, scrap iron and steel—widely available in the large metropolitan areas of the East and West coasts—became an important input in the steel-production process.
- **Late twentieth century: Proximity to markets.** Most steel mills in the United States closed. Most of the survivors were around southern Lake Michigan and along the East Coast. Proximity to markets has become more important than the traditional situation factor of proximity to inputs. Coastal plants provide steel to large East Coast population centers, and southern Lake Michigan plants are centrally located to distribute their products countrywide.

The increasing importance of proximity to markets is also demonstrated by the recent growth of steel minimills, which have captured one-fourth of the U.S. steel market (Figure 11-16). Rather than iron ore and coal, the main input into minimill production is scrap metal. In the past, most steel was produced at large integrated mill complexes. They processed iron ore, converted coal into coke, converted the iron into steel, and formed the steel into sheets, beams, rods, or other shapes. Minimills, generally limited to one step in the process—steel production—are



▲ **FIGURE 11-16 MINIMILLS** Minimills, which produce steel from scrap metal, are more numerous than integrated steel mills, and they are distributed around the country near local markets. Shown are the plants of Nucor, the largest minimill operator in the United States.

less expensive than integrated mills to build and operate, and they can locate near their markets because their main input—scrap metal—is widely available.

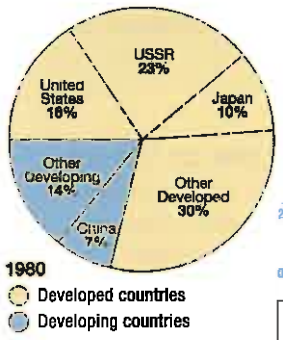
CHANGING DISTRIBUTION OF THE WORLD STEEL INDUSTRY. The shift of world manufacturing to new industrial regions can be seen clearly in steel production. In 1980, 80 percent of world steel was produced in developed countries and 20 percent in developing countries (Figure 11-17, top). Between 1980 and 2010, the share of world steel production declined to 37 percent in developed countries and increased to 68 percent in developing countries (Figure 11-17, bottom).

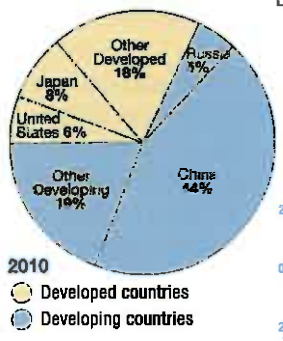
World steel production doubled between 1980 and 2010, from around 700 million to around 1,400 million metric tons. China was responsible for 600 million of the 700 million metric ton increase, and other developing countries (primarily India and South Korea) for the other 100 million (Figure 11-18). Production in developed countries remained unchanged, at approximately 100 million metric tons.

China's steel industry has grown in part because of access to the primary inputs iron ore and coal. However, the principal factor in recent years has been increased demand by growing industries in China that use a lot of steel, such as motor vehicles.

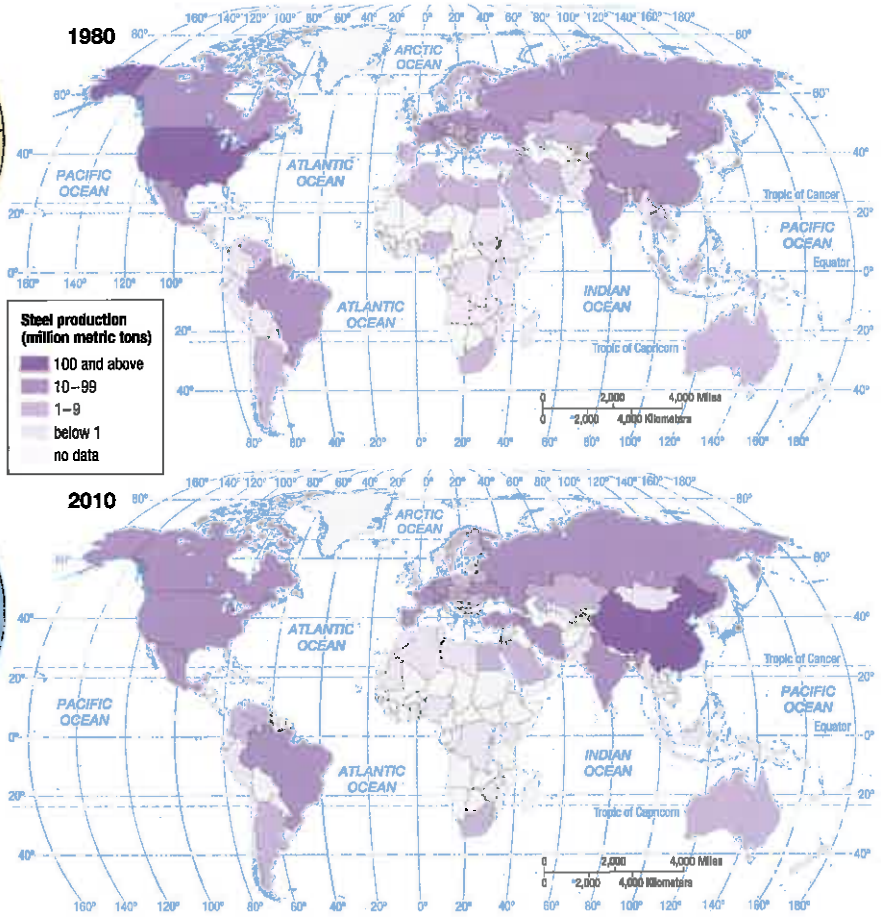
Pause and Reflect 11.2.4

Although Pittsburgh's football team is named "Steelers," based on Figure 11-15, what city's team might be more appropriately given this nickname?





▲ **FIGURE 11-17 SHARE OF GLOBAL STEEL PRODUCTION, 1980 AND 2010** The share of world steel produced in developing countries increased from 21 percent in 1980 to 68 percent in 2010.



▲ **FIGURE 11-18 WORLD STEEL PRODUCTION, 1980 AND 2010** The leading steel producer in 1980 was the United States, and in 2010 it was China.

MOTOR VEHICLES: CHANGING MARKETS

Learning Outcome 11.2.5
Explain the distribution of motor vehicle production.

The motor vehicle is a prominent example of a fabricated metal product, described earlier as one of the main types of bulk-gaining industries. Motor vehicles are therefore built near their markets. As the markets for new cars change, the distribution of factories changes.

GLOBAL DISTRIBUTION OF VEHICLE PRODUCTION. Carmakers manufacture vehicles at final assembly plants, using thousands of parts supplied by independent companies. The world's three major industrial regions house 80 percent of the world's final assembly production, including 40 percent in East Asia, 25 percent in Europe, and 15 percent in North America (Figure 11-19). Most assembly plants are clustered in these three regions because most of the world's car buyers are there.

Ten carmakers control 85 percent of the world's sales:

- Two based in North America: Ford and GM.
- Four based in Europe: Germany's Volkswagen, Italy's Fiat (which controls Chrysler), France's Renault (which controls Nissan) and Peugeot.
- Four based in East Asia: Japan's Toyota, Honda, and Suzuki and South Korea's Hyundai.

These carmakers operate assembly plants in at least two of the three major industrial regions (Figure 11-20). Three-fourths of vehicles sold in North America are assembled in North America. Similarly, most vehicles sold in Europe are assembled in Europe, most vehicles sold in Japan are assembled in Japan, and most vehicles sold in China are assembled in China.

Carmakers' assembly plants account for only around 30 percent of the value of the vehicles that bear their names. Independent parts makers supply the other 70 percent of the value. The typical passenger car weighs about 1,600 kilograms (3,500 pounds) and contains about 45 percent steel, 13 percent iron, 11 percent each aluminum and plastic, 7 percent fluids and lubricants, 4 percent rubber, 2 percent glass, and 7 percent other materials.

Many parts makers are examples of single-market manufacturers because they ship most of their products to one or perhaps a handful of final assembly plants. As single-market manufacturers, parts makers cluster near the final assembly plants. Motor vehicle seats, for example, are invariably manufactured within an hour of the final assembly plant. A seat is an especially large and bulky object, and carmakers do not want to waste valuable space in their assembly plants by piling up an inventory of them.

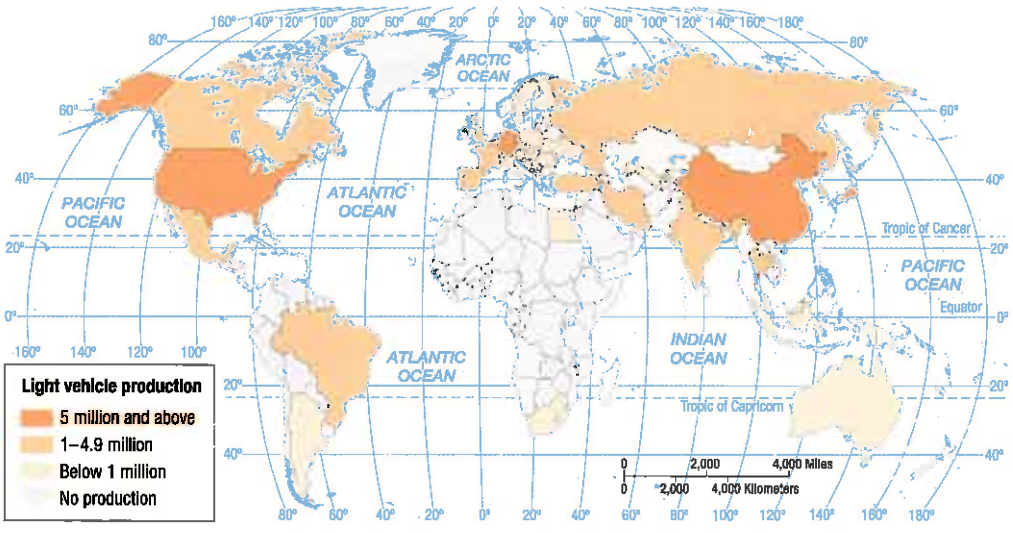
On the other hand, some parts do not need to be manufactured close to the customer. For them, changing site factors are more important, discussed beginning on the next page. Some locate in countries that have relatively low labor costs, such as Mexico, China, and Czech Republic.

Pause and Reflect 11.2.5
Why is the percentage of steel in vehicles declining, while the percentage of aluminum and plastic is increasing?

REGIONAL DISTRIBUTION OF VEHICLE PRODUCTION. Within each of the three major industrial regions, motor vehicle production is highly clustered. Because a final assembly plant is a bulk-gaining operation, its critical location factor is minimizing transportation to the market:

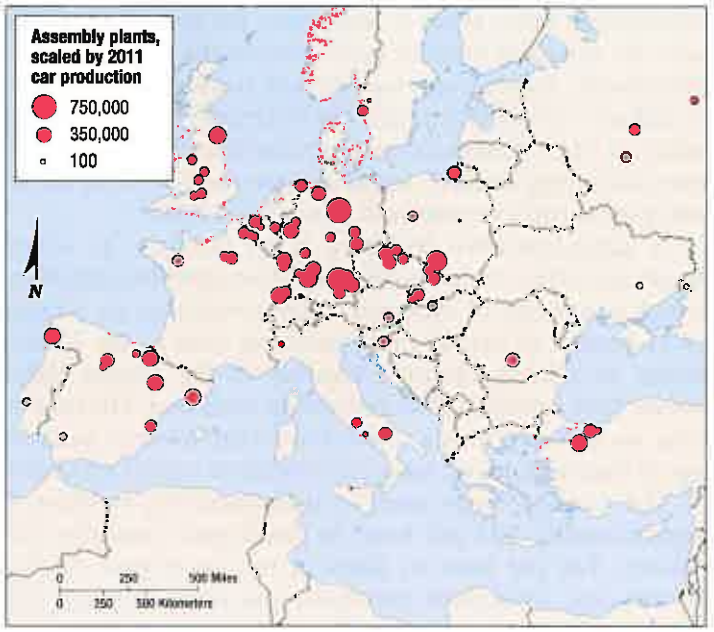
- **North America.** Most of the assembly and parts plants are located in the interior of the United States, between Michigan and Alabama, centered in a corridor known as "auto alley," formed by north–south interstate highways 65 and 75, with an extension into southwestern Ontario (Figure 11-21). The principal cluster of assembly plants outside auto alley is in central Mexico. Within auto alley, U.S.-owned carmakers and suppliers have clustered in Michigan and nearby northern states, whereas foreign-owned carmakers and parts suppliers have clustered in the southern portion of auto alley.

▼ **FIGURE 11-19 MOTOR VEHICLE PRODUCTION**
China is the world's leading producer of cars, followed by the United States, Japan, and Germany.

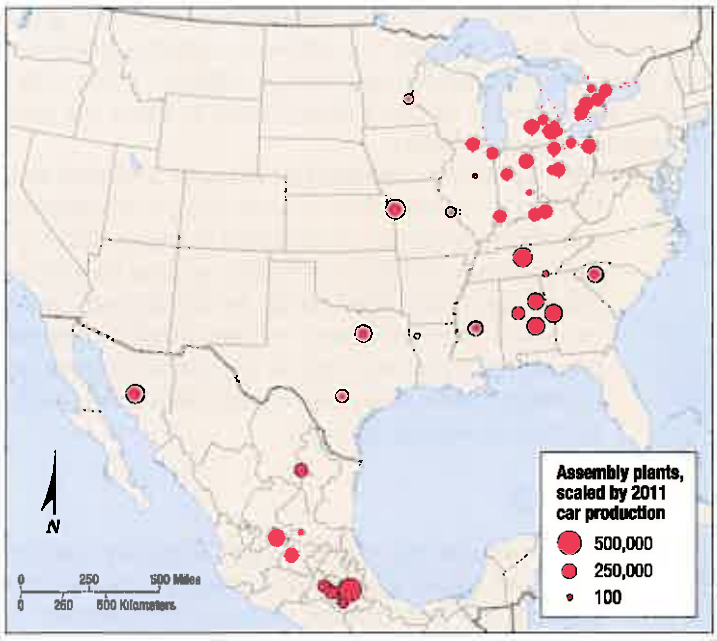


◀ FIGURE 11-20 ASSEMBLY PLANT IN EUROPE Toyota's factory near Burnaston, in the United Kingdom, is surrounded by farmland.

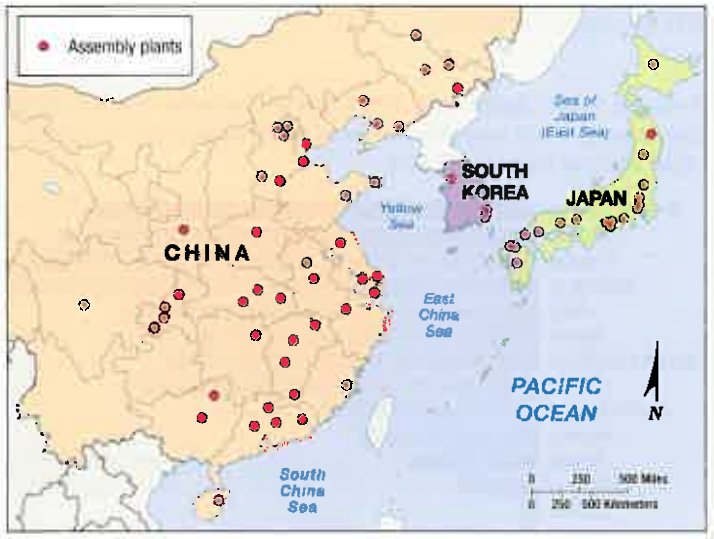
- **Europe.** Most plants are clustered in an east–west corridor between the United Kingdom and Russia (Figure 11-22). Germany is the leading producer of vehicles in Europe. Since the end of communism in Eastern Europe in the early 1990s, that region has had most of the growth in vehicle production. The large carmakers have modernized inefficient Communist-era factories or built entirely new ones in Eastern Europe. Labor costs are lower there than in Western Europe, and demand for vehicles has increased with the end of Communist restrictions on the ability of private individuals to buy consumer goods such as cars.
- **East Asia.** China's assembly plants are clustered in the east in order to be near the major population centers (Figure 11-23). Most car buyers in China are located in the large cities, such as Shanghai and Beijing.



▲ FIGURE 11-22 MOTOR VEHICLE PRODUCTION IN EUROPE Within Europe, most vehicles are produced in an east–west corridor centered on Germany.



▲ FIGURE 11-21 MOTOR VEHICLE PRODUCTION IN NORTH AMERICA Most vehicles are produced in auto alley. Most U.S.-owned companies are clustered in the north, and most foreign-owned ones in the south.



▲ FIGURE 11-23 MOTOR VEHICLE PRODUCTION IN EAST ASIA Most vehicles are produced near major metropolitan areas, especially in western China.

Site Factors

Learning Outcome 11.2.6
List the three types of site factors.

Firms take into consideration site factors as well as situation factors (see the Contemporary Geography Tools feature). Labor, capital, and land are the three traditional production factors that may vary among locations.

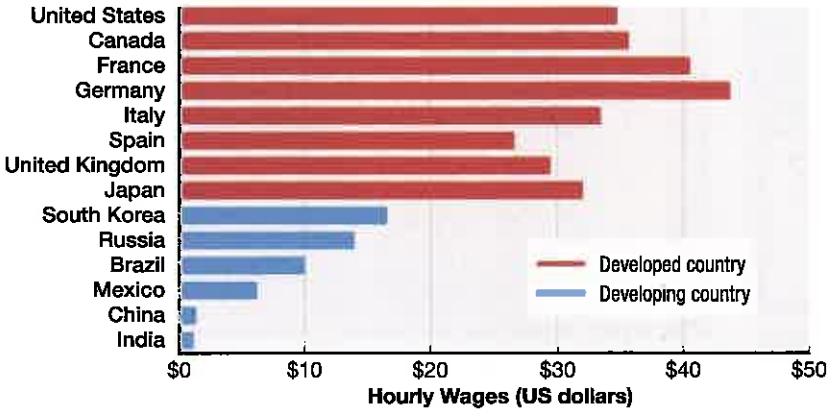
LABOR

The most important site factor on a global scale is labor. Minimizing labor costs is important for some industries, and the variation of labor costs around the world is large. Worldwide, around one-half billion workers are engaged in industry, according to the UN International Labor Organization (ILO). China has around one-fourth of the world's manufacturing workers, India around one-fifth, and all developed countries combined around one-fifth.

A **labor-intensive industry** is an industry in which wages and other compensation paid to employees constitute a high percentage of expenses. Labor constitutes an average of 11 percent of overall manufacturing costs in the United States, so a labor-intensive industry in the United States would have a much higher percentage than that. The reverse case, an industry with a much lower-than-average percentage of expenditures on labor, is considered capital intensive.

The average wage paid to manufacturing workers is approximately $35 per hour in developed countries and exceeds $40 per hour in parts of Europe (Figure 11-24). Health-care, retirement pensions, and other benefits add substantially to the compensation. In China and India, average wages are approximately $1 per hour and include limited additional benefits. For some manufacturers—but not all—the difference between paying workers $1 and $35 per hour is critical.

▼ **FIGURE 11-24 LABOR AS A SITE FACTOR: MANUFACTURING WAGES** The chart shows average hourly wages for workers in manufacturing in the 14 countries with the largest industrial production in 2010.



A labor-intensive industry is not the same as a high-wage industry. "Labor-intensive" is measured as a percentage, whereas "high-wage" is measured in dollars or other currencies. For example, motor-vehicle workers are paid much higher hourly wages than textile workers, yet the textile industry is labor intensive, and the auto industry is not. Although auto workers earn relatively high wages, most of the value of a car is accounted for by the parts and the machinery needed to put together the parts. On the other hand, labor accounts for a large percentage of the cost of producing a towel or shirt compared with materials and machinery.

Pause and Reflect 11.2.6
Labor accounts for around 5 percent of the cost of manufacturing a car. Does this mean that motor vehicle manufacturing is a labor-intensive industry? Explain.

CAPITAL

Manufacturers typically borrow capital—the funds to establish new factories or expand existing ones. The U.S. motor-vehicle industry concentrated in Michigan early in the twentieth century largely because that region's financial institutions were more willing than eastern banks to lend money to the industry's pioneers. The most important factor in the clustering of high-tech industries in California's Silicon Valley—even more important than proximity to skilled labor—was the availability of capital. Banks in Silicon Valley have long been willing to provide money for new software and communications firms, even though lenders elsewhere have hesitated. High-tech industries have been risky propositions—roughly two-thirds of them fail—but Silicon Valley financial institutions have continued to lend money to engineers who have good ideas so that they can buy the software, communications, and networks they need to get started (Figure 11-25). One-fourth of all capital in the United States is spent on new industries in Silicon Valley.

The ability to borrow money has become a critical factor in the distribution of industry in developing countries. Financial institutions in many developing countries are short of funds, so new industries must seek loans from banks in developed countries. But enterprises may not get loans if they are located in a country that is perceived to have an unstable political system, a high debt level, or ill-advised economic policies.

LAND

Land suitable for constructing a factory can be found in many places. If considered to encompass natural and human resources in addition to terra firma, "land" is a critical site factor.

Early factories located inside cities due to a combination of situation and site factors. A city

▲ FIGURE 11-25 **CAPITAL AS A SITE FACTOR: SILICON VALLEY**
A Google employee bicycles to work past the Green Android statue at Googleplex, Google's world headquarters in Mountain View, California, in the heart of Silicon Valley.

offered an attractive situation—proximity to a large local market and convenience in shipping to a national market by rail. A city also offered an attractive site—proximity to a large supply of labor as well as to sources of capital. The site factor that cities have always lacked is abundant land. To get the necessary space in cities, early factories were typically multistory buildings. Raw materials were hoisted to the upper floors to make smaller parts, which were then sent downstairs on chutes and pulleys for final assembly and shipment. Water was stored in tanks on the roof.

Contemporary factories operate most efficiently when laid out in one-story buildings (see for example, Figure 11-20). Raw materials are typically delivered at one end and moved through the factory on conveyors or forklift trucks. Products are assembled in logical order and shipped out at the other end. The land needed to build one-story factories is now more likely to be available in suburban and rural locations. Also, land is much cheaper in suburban and rural locations than near the center of a city.

In addition to providing enough space for one-story buildings, locations outside cities are also attractive because they facilitate delivery of inputs and shipment of products. In the past, when most material moved in and out of a factory by rail, a central location was attractive because rail lines converged there. With trucks now responsible for transporting most inputs and products, proximity to major highways is more important for a factory. Especially attractive is the proximity to the junction of a long-distance route and the beltway, or ring road, that encircles most cities. Thus, factories cluster in industrial parks located near suburban highway junctions.

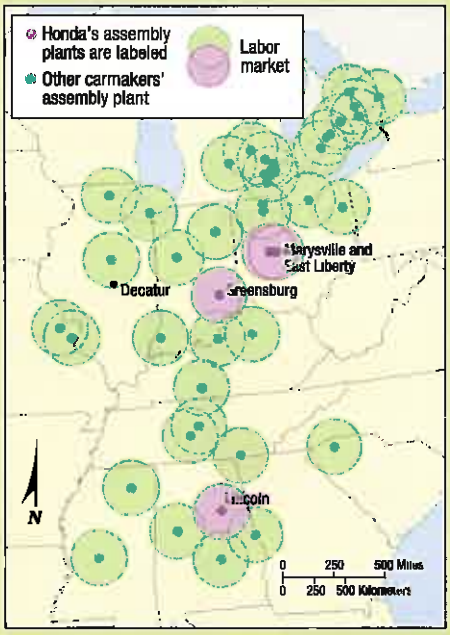
CONTEMPORARY GEOGRAPHIC TOOLS

Honda Selects a Factory Location

When Honda decided that it needed another assembly plant in the United States, it applied situation and site factors to select a location for the factory:

- Situation factors were considered first:
  - Proximity to markets. To minimize the cost of shipping vehicles, Honda looked for locations within auto alley (Figure 11-26).
  - Proximity to inputs. Honda's most important inputs, the engine and transmission, were to come from existing factories in western Ohio. That guided Honda to the portion of auto alley encompassing Illinois, Indiana, and Ohio.
- Site factors helped Honda find specific locations within auto alley:
  - Land. Honda wanted a large tract of land near at least one interstate highway and a rail line.
  - Labor. Honda needed a large labor supply within a one-hour commuting range, but it didn't want to compete for workers with existing assembly plants. That could lead to a shortage of skilled workers and push up wages. So Honda looked for areas outside the one-hour commuting range around existing assembly plants.

Honda's short list of locations included Decatur in eastern Illinois, Greensburg in southwestern Indiana, and unnamed communities in west-central Ohio. Honda considered Indiana the safest choice, because the governors of the other two states at the time were involved in financial scandals.



▲ FIGURE 11-26 **HONDA PICKS AN ASSEMBLY PLANT SITE** An assembly plant draws its workforce from within a radius of roughly one hour. New plants have been located outside the labor market areas of existing plants to minimize competition for workers

TEXTILES AND APPAREL: CHANGING INPUTS

Learning Outcome 11.2.7

Explain the distribution of textile and apparel production.

Production of **textiles** (woven fabrics) and **apparel** (clothing) is a prominent example of an industry that generally requires less-skilled, low-cost workers. The textile and apparel industry accounts for 6 percent of the dollar value of world manufacturing but a much higher 14 percent of world manufacturing employment, an indicator that it is a labor-intensive industry. The percentage of the world's women employed in this type of manufacturing is even higher.

Textile and apparel production involves three principal steps:

- Spinning of fibers and other preparatory work to make yarn from natural or human-made materials
- Weaving or knitting of yarn into fabric (as well as finishing of fabric by bleaching or dyeing)
- Cutting and sewing of fabric for assembling into clothing and other products

Spinning, weaving, and sewing are all labor intensive compared to other industries, but the importance of labor varies somewhat among them. As a result, their global distributions are not identical because the three steps are not equally labor intensive.

SPINNING. Fibers can be spun from natural or synthetic elements. The principal natural fiber is cotton. Synthetics now account for three-fourths and natural fibers only one-fourth of world thread production. Because it is a labor-intensive industry, spinning is done primarily in low-wage countries (Figure 11-27). China produces two-thirds of the world's cotton thread.

TEXTILE AND APPAREL WEAVING. For thousands of years, fabric has been woven or laced together by hand on a loom, which is a frame on which two sets of threads are placed at right angles to each other. One set of threads, called the warp, is strung lengthwise. A second set of threads, called the weft, is carried in a shuttle that is inserted over and under the warp. Because the process of weaving by hand is physically hard work, weavers were traditionally men.

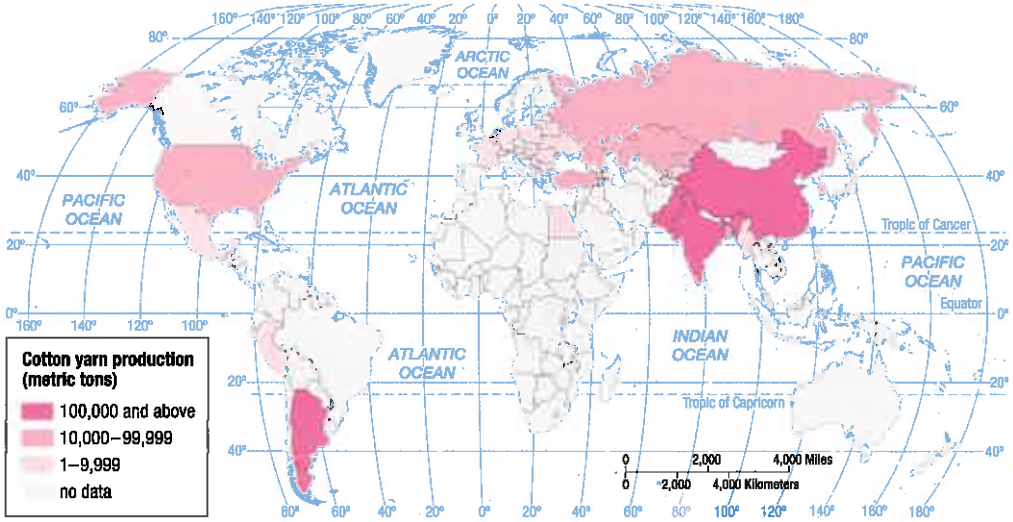
For mechanized weaving, labor constitutes a high percentage of the total production cost. Consequently, weaving is highly clustered in low-wage countries (Figure 11-28). Despite their remoteness from European and North American markets, China and India have become the dominant fabric producers because their lower labor costs offset the expense of shipping inputs and products long distances. China accounts for nearly 60 percent of the world's woven cotton fabric production and India another 30 percent.

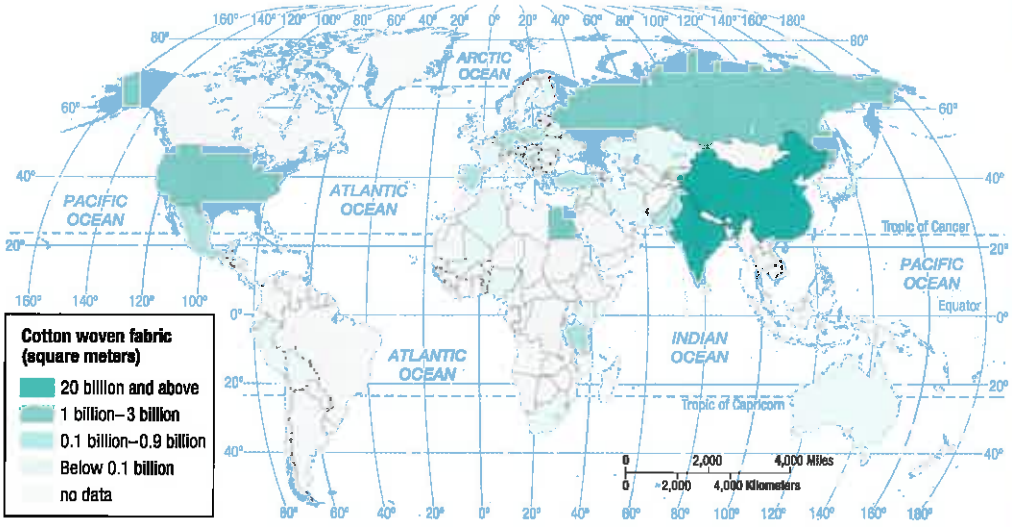
TEXTILE AND APPAREL ASSEMBLY. Sewing is probably an even older human activity than spinning and weaving. Needles made from animal horns or bones date back tens of thousands of years, and iron needles date from the fourteenth century.

The first functional sewing machine was invented by French tailor Barthelemy Thimonnier in 1830. In 1841, Thimonnier installed 80 sewing machines in a factory in St.-Etienne, France, to sew uniforms for the French army. However, Parisian tailors, fearing that the machines would put them out of work, stormed the factory and destroyed the machines. Isaac Singer manufactured the first commercially successful sewing machine in the United States during the 1850s, but he was convicted of infringing a patent filed by Elias Howe in 1846.

Textiles are assembled into four main types of products: garments, carpets, home products such as bed linens and curtains, and industrial items such as headliners for inside motor vehicles. Developed countries play a larger role in

▼ **FIGURE 11-27 COTTON SPINNING** Two-thirds of world cotton yarn is produced in China, including by this woman.





▲ **FIGURE 11-28 COTTON WEAVING** China and India together account for nearly 90 percent of the world's woven cotton production. In the image, cotton is being woven in China.

assembly than in spinning and weaving because most of the consumers of assembled products are located in developed countries (Figure 11-29). For example, two-thirds of the women's blouses sold worldwide in a year are sewn in developed countries.

Pause and Reflect 11.2.7

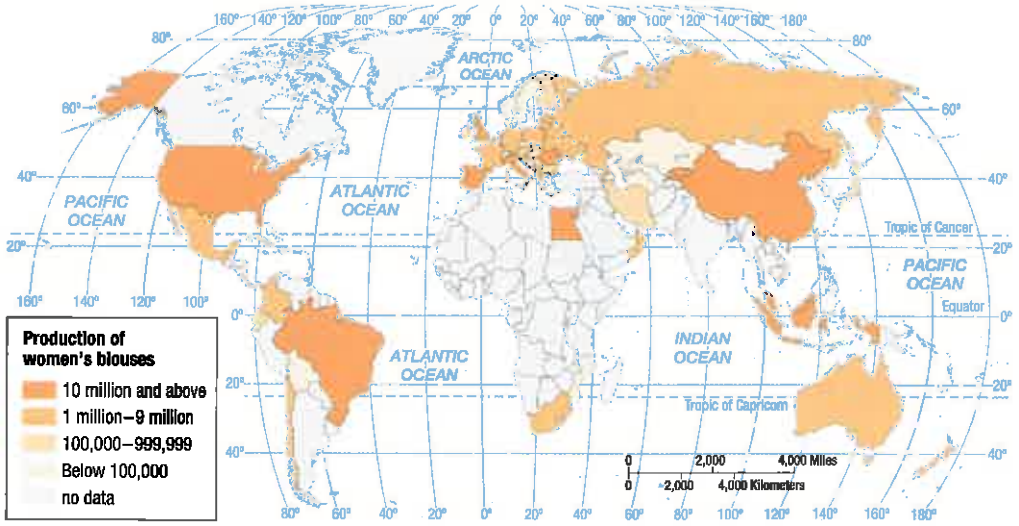
Check the labels on the clothes you are wearing. Where were they made?

CHECK-IN: KEY ISSUE 2

Why Are Situation and Site Factors Important?

- ✓ **Situation factors involve transporting materials to and from a factory.**
- ✓ **Bulk-reducing industries are located near their sources of inputs.**
- ✓ **Bulk-gaining, single-market, and perishable industries locate near their markets.**
- ✓ **Site factors derive from distinctive features of a particular place, including labor, capital, and land.**

▼ **FIGURE 11-29 DISTRIBUTION OF WOMEN'S BLOUSE PRODUCTION** The United States is the leading producer of women's blouses. These women are sewing blouses in China, which is the leading producer among developing countries.



KEY ISSUE 3

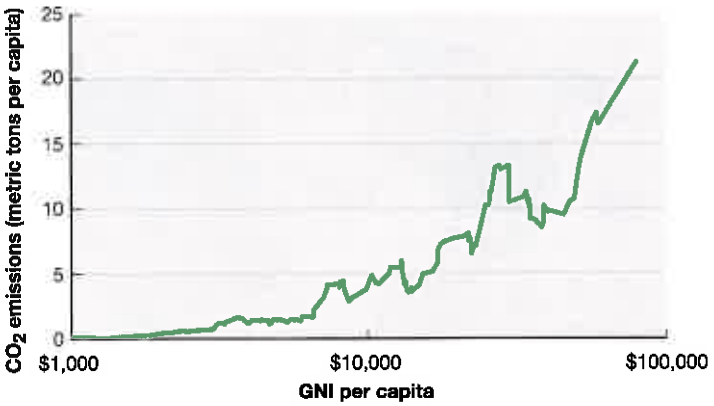
Where Does Industry Cause Pollution?

- Air Pollution
- Solid Waste Pollution
- Water Pollution

Learning Outcome 11.3.1
Describe causes and effects of global warming and damage to the ozone layer.

Industry is a major polluter of air, water, and land. People rely on air, water, and land to remove and disperse waste from factories as well as from other human activities. Pollution occurs when more waste is added than air, water, and land resources can handle.

As a country's per capita income increases, its per capita carbon dioxide emissions also increase. Some of the wealthiest countries, located primarily in Europe, with gross national income (GNI) per capita between $30,000 and $50,000, show declines in pollution. However, the world's richest countries, including the United States and several countries in Southwest Asia, display the highest pollution levels (Figure 11-30).



▲ **FIGURE 11-30 GNI AND POLLUTION** Carbon dioxide emissions generally increase with rising income. The principal exception is in Europe, where some relatively wealthy countries have curbed emissions.

Air Pollution

At ground level, Earth's average atmosphere is made up of about 78 percent nitrogen, 21 percent oxygen, and less than 1 percent argon. The remaining 0.04 percent includes several trace gases, some of which are critical. **Air pollution** is concentration of trace substances at a greater level than occurs in average air. Concentrations of these trace gases in the air can damage property and adversely affect the health of people, other animals, and plants.

Most air pollution is generated from factories and power plants, as well as from motor vehicles. Factories and power plants produce sulfur dioxides and solid particulates, primarily from burning coal. Burning petroleum in motor vehicles produces carbon monoxide, hydrocarbons, and nitrogen oxides.

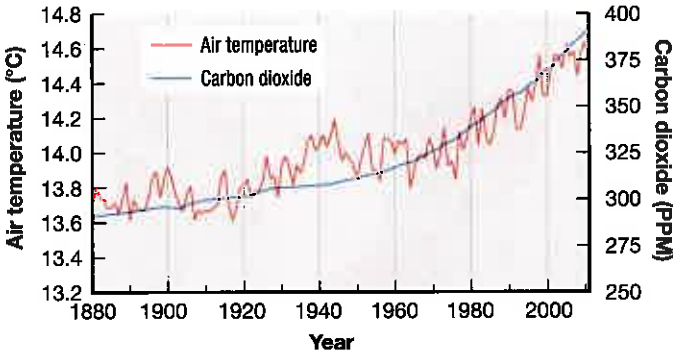
GLOBAL-SCALE AIR POLLUTION

Air pollution concerns geographers at three scales—global, regional, and local. At the global scale, air pollution may contribute to global warming. It may also damage the atmosphere's ozone layer.

GLOBAL WARMING. The average temperature of Earth's surface has increased by 1°C (2°F) since 1880 (Figure 11-31). Human actions, especially the burning of fossil fuels in factories and vehicles, may have caused this.

Earth is warmed by sunlight that passes through the atmosphere, strikes the surface, and is converted to heat. When the heat tries to pass back through the atmosphere to space, some gets through and some is trapped. This process keeps Earth's temperatures moderate and allows life to flourish on the planet. A concentration of trace gases in the atmosphere can block or delay the return of some of the heat leaving the surface heading for space, thereby raising Earth's temperatures. When fossil fuels are burned, one of the trace gases, carbon dioxide, is discharged into the atmosphere. Plants and oceans absorb much of the discharges, but increased fossil fuel burning during the past 200 years, as shown in Figure 11-30, has caused the level of carbon dioxide in the atmosphere to rise by more than one-fourth, according to the UN Intergovernmental Panel on Climate Change.

The anticipated increase in Earth's temperature, caused by carbon dioxide and other greenhouse gases trapping some of the radiation emitted by the surface, is called the **greenhouse effect**. The term is somewhat misleading because a greenhouse does not work in the same way as do trace gases in the atmosphere. In a real greenhouse, the interior gets very warm when the windows remain closed on a sunny day. The Sun's light energy passes through the glass

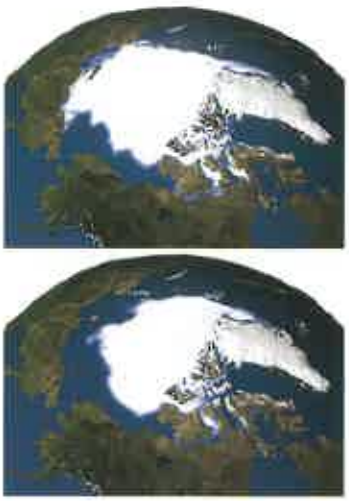


▲ **FIGURE 11-31 GLOBAL-SCALE AIR POLLUTION: GLOBAL WARMING AND CARBON DIOXIDE CONCENTRATIONS, 1880–2010** Since 1880, carbon dioxide concentration has increased by more than one-third, and Earth has warmed by about 1°C (2°F).

into the greenhouse and is converted to heat, and the heat trapped inside the building is unable to escape out through the glass. Although this is an imprecise analogy, "greenhouse effect" is a term that has been widely adopted to describe the anticipated warming of Earth's surface when trace gases block some of the heat trying to escape into space.

Regardless of what it is called, global warming of only a few degrees could melt the polar ice sheets and raise the level of the oceans many meters (Figure 11-32). Coastal cities such as New York, Los Angeles, Rio de Janeiro, and Hong Kong would flood (see the Sustainability and Inequality in Our Global Village feature). Global patterns of precipitation could shift: Some deserts could receive more rainfall, and currently productive agricultural regions, such as the U.S. Midwest, could become too dry for farming. Humans can adapt to a warmer planet, but the shifts in coastlines and precipitation patterns could require massive migration and could be accompanied by political disputes.

GLOBAL-SCALE OZONE DAMAGE. Earth's atmosphere has zones with distinct characteristics. The stratosphere—the zone 15 to 50 kilometers (9 to 30 miles) above Earth's surface—contains a concentration of **ozone** gas. The ozone layer absorbs dangerous ultraviolet (UV) rays from the Sun. Were it not for the ozone in the stratosphere, UV rays would damage plants, cause skin cancer, and disrupt food chains.



◀ **FIGURE 11-32 RECEDING NORTH POLAR ICE SHEET** These images taken by NASA show that between 1979 (top) and 2005 (bottom), the north polar ice sheet melted visibly.

Earth's protective ozone layer is threatened by pollutants called **chlorofluorocarbons** (CFCs). CFCs such as Freon were once widely used as coolants in refrigerators and air conditioners. When they leak from these appliances, the CFCs are carried into the stratosphere, where they break down Earth's protective layer of ozone gas. In 2007, virtually all countries of the world agreed to cease using CFCs, by 2020 in developed countries and by 2030 in developing countries.

Pause and Reflect 11.3.1

What gas is now most commonly used as a coolant instead of CFC? Google "what replaced CFCs?"

SUSTAINABILITY AND INEQUALITY IN OUR GLOBAL VILLAGE

Climate Change in the South Pacific

One consequence of global warming is a rise in the level of the oceans. The large percentage of the world's population—including one-half of Americans—who live near the sea face increased threat of flooding. The threat is especially severe for island countries in the Pacific Ocean; they could be wiped off the map entirely.

Kiribati is a collection of approximately 32 small islands, one of the world's most isolated countries (Figure 11-33). Despite its extreme isolation, global forces threaten Kiribati's existence. Rising sea levels due to global warming threaten Kiribati because the entire country is within a few meters of sea level. Two of Kiribati's islands—Tebua Tarawa and Abanuea—have already disappeared.

Kiribati and other Pacific island microstates are atolls—that is, islands made of coral reefs. A coral is a small sedentary marine animal that has a horny or calcareous skeleton. Corals form colonies, and the skeletons build up to form coral reefs. Coral is very fragile. Humans are attracted to coral for its beauty and the diversity of species it supports, but handling coral can kill it. The threat of global warming to coral is especially severe: Coral stays alive in only a narrow range of ocean temperatures, between 23°C and 25°C (between 73°F and 77°F), so global warming threatens the ecology of Kiribati, even if it remains above sea level.

Kiribati has an emergency response to rising sea levels. The government has negotiated with Fiji to purchase 2,000 hectares (5,000 acres) of land on the island of Vanua Levu to relocate people from Kiribati someday.

◀ **FIGURE 11-33 KIRIBATI** Global warming may cause the oceans to rise, submerging small island countries such as Kiribati.

REGIONAL-SCALE AIR POLLUTION

Learning Outcome 11.3.2

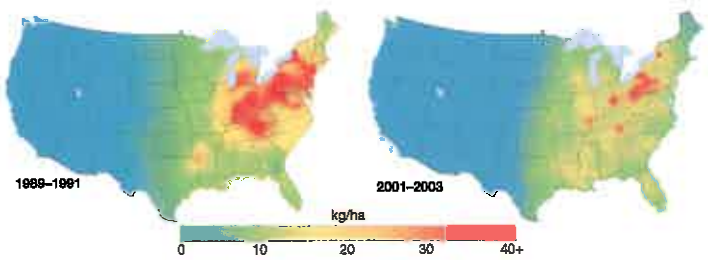
Describe causes and effects of regional and local-scale air pollution and solid waste pollution.

At the regional scale, air pollution may damage a region's vegetation and water supply through acid deposition. The world's three principal industrial regions are especially affected by acid deposition.

Sulfur oxides and nitrogen oxides, emitted by burning fossil fuels, enter the atmosphere, where they combine with oxygen and water. Tiny droplets of sulfuric acid and nitric acid form and return to Earth's surface as **acid deposition**. When dissolved in water, the acids may fall as **acid precipitation**—rain, snow, or fog. The acids can also be deposited in dust. Before they reach the surface, these acidic droplets might be carried hundreds of kilometers.

Acid precipitation damages lakes, killing fish and plants. On land, concentrations of acid in the soil can injure plants by depriving them of nutrients and can harm worms and insects. Buildings and monuments made of marble and limestone have suffered corrosion from acid rain.

Geographers are particularly interested in the effects of acid precipitation because the worst damage is not experienced at the same location as the emission of the pollutants. Within the United States the major generators of acid deposition are in Ohio and other industrial states along the southern Great Lakes. However, the severest effects of acid rain are felt in several areas farther east. The United States reduced sulfur dioxide emissions significantly during the late twentieth century (Figure 11-34).



▲ **FIGURE 11-34 REGIONAL-SCALE AIR POLLUTION: ACID DEPOSITION IN THE UNITED STATES** As a result of emissions controls, the rate of acid deposition has declined.

LOCAL-SCALE AIR POLLUTION

At the local scale, air pollution is especially severe in places where emission sources are concentrated, such as in urban areas. The air above urban areas may be polluted because a large number of factories, motor vehicles, and other polluters emit residuals in a concentrated area. Urban air pollution has three basic components:

- **Carbon monoxide.** Breathing carbon monoxide reduces the oxygen level in blood, impairs vision and alertness, and threatens those with breathing problems.
- **Hydrocarbons.** In the presence of sunlight, hydrocarbons, as well as nitrogen oxides, form **photochemical smog**, which causes respiratory problems, stinging in the eyes, and an ugly haze over cities.
- **Particulates.** They include dust and smoke particles. The dark plume of smoke from a factory stack and the exhaust of a diesel truck are examples of particulate emission.

The worst urban air pollution occurs when winds are slight, skies are clear, and a temperature inversion exists. When the wind blows, it disperses pollutants; when it is calm, pollutants build. Sunlight provides the energy for the formation of smog. Air is normally cooler at higher elevations, but during temperature inversions—in which air is warmer at higher elevations—pollutants are trapped near the ground.

According to the American Lung Association, the worst area in the United States for concentrations of particulates is in southern California, including Los Angeles and nearby communities. Worldwide, according to the World Health Organization, the 10 most polluted cities are all in developing regions, including 4 each in Iran and South Asia. Mexico City is an example of a city in a developing country that has improved its air quality since the 1990s (Figure 11-35).

Pause and Reflect 11.3.2

What environmental features can be seen in Mexico City on a clear day but not during smog periods? What is their role in the city's air pollution problem?

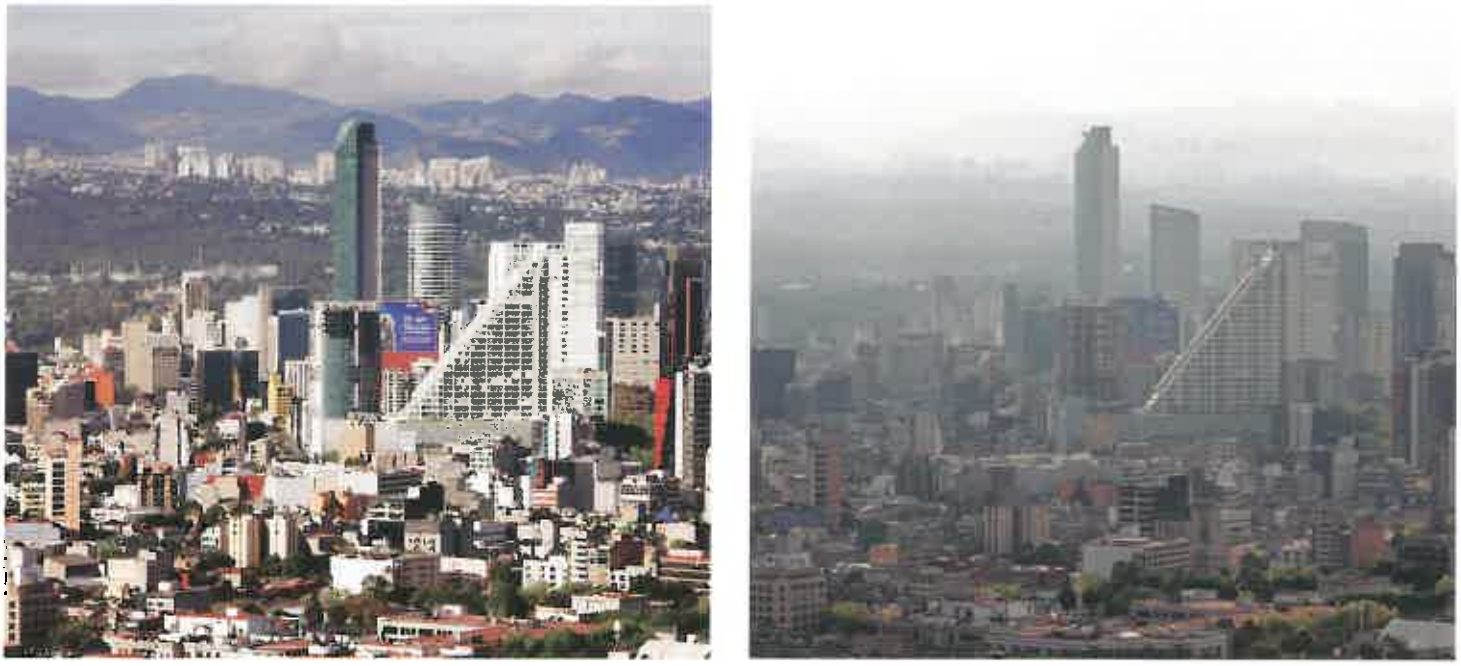
Progress in controlling urban air pollution is mixed. In developed countries, air has improved where strict clean-air regulations are enforced. Limited emission controls in developing countries are contributing to severe urban air pollution. Changes in manufacturing processes, motor vehicle engines, and electric generation have all helped. For example, since the 1970s, when the U.S. government began to require catalytic converters on motor vehicles, carbon monoxide emissions have been reduced by more than three-fourths, and nitrogen oxide and hydrocarbon emissions have been reduced by more than 95 percent. But more people are driving, offsetting gains made by emission controls.

Solid Waste Pollution

About 2 kilograms (4 pounds) of solid waste per person is generated daily in the United States, about 60 percent from residences and 40 percent from businesses. Paper products, such as corrugated cardboard and newspapers, account for the largest percentage of solid waste in the United States, especially among residences and retailers. Manufacturers discard large quantities of metals as well as paper.

SANITARY LANDFILL

Using a **sanitary landfill** is by far the most common strategy for disposal of solid waste in the United States: More than one-half of the country's waste is trucked to landfills



▲ **FIGURE 11-35 LOCAL-SCALE AIR POLLUTION: MEXICO CITY SMOG** Downtown Mexico City without smog (left) and with smog (right).

and buried under soil. But the number of landfills in the United States has declined by three-fourths since 1990.

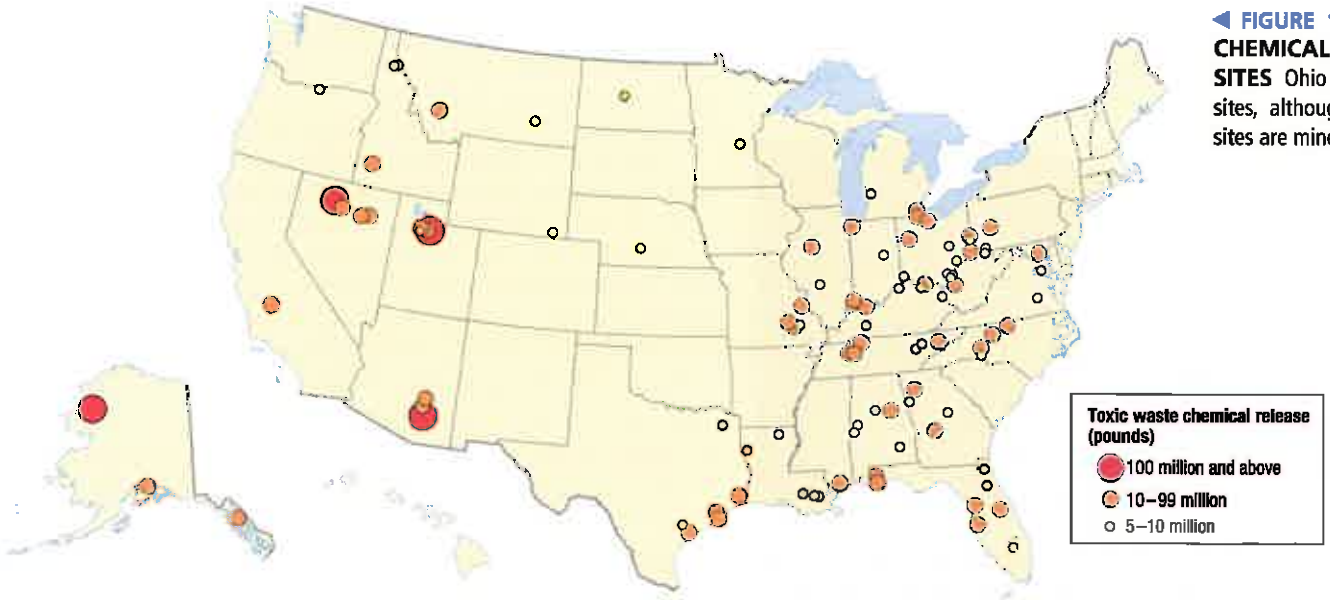
Given the shortage of space in landfills, alternatives have been sought to disposal of solid waste. A rapidly growing alternative is incineration. Burning trash reduces its bulk by about three-fourths, and the remaining ash demands less landfill space. Incineration also provides energy: The incinerator's heat can boil water to produce steam heat or operate a turbine that generates electricity.

HAZARDOUS WASTE

Disposing of hazardous waste is especially difficult. Hazardous wastes include heavy metals (including mercury, cadmium, and zinc), PCB oils from electrical equipment, cyanides, strong solvents, acids, and caustics. These may be unwanted by-products generated in manufacturing or waste to be discarded after usage.

According to the toxic waste inventory published by the U.S. Environmental Protection Agency (EPA), 1.78 billion kilograms (3.93 billion pounds) of toxic chemicals were released into the environment in 2010. Mining operations were the largest polluters. Ohio had 10 of the 100 largest polluting firms (Figure 11-36).

If poisonous industrial residuals are not carefully placed in protective containers, the chemicals may leach into the soil and contaminate groundwater or escape into the atmosphere. Breathing air or consuming water contaminated with toxic wastes can cause cancer, mutations, chronic ailments, and even immediate death.



◀ **FIGURE 11-36 TOXIC CHEMICAL RELEASE SITES** Ohio has the most sites, although the largest sites are mines in the West.

Water Pollution

Learning Outcome 11.3.3

Compare and contrast point and nonpoint sources of water pollution.

Some manufacturers are heavy users of water. One example is the aluminum industry. Aluminum producers locate near dams to take advantage of cheap hydroelectric power. A large amount of electricity is needed to separate pure aluminum from bauxite ore (Figure 11-37). Alcoa, the world's largest aluminum producer, even owns dams in North Carolina and Tennessee.

Water also serves many human purposes:

- It must be drunk to survive.
- It is used for cooking.
- It is used for bathing.
- It provides a location for boating, swimming, fishing, and other recreation activities.
- It is home to fish and other edible aquatic life.

When all these uses are totaled, the average American consumes 5,300 liters (1,400 gallons) of water per day, including 680 liters (180 gallons) for drinking, cooking, and bathing. These uses require fresh, clean, unpolluted water.

But clean water is not always available because people and industries also use water for purposes that pollute it. Pollution is widespread because it is easy to dump waste into a river and let the water carry it downstream, where it becomes someone else's problem. By polluting water, humans harm the health of aquatic life and the health of land-based life (including humans themselves).

WATER POLLUTION SOURCES

The sources of pollution can be divided into point sources and nonpoint sources. **Point-source pollution** enters a body of water at a specific location, whereas **nonpoint-source pollution** comes from a large, diffuse area.

▼ **FIGURE 11-37 HYDROELECTRIC POWER** The Cheoah Dam in Tapoco, Tennessee, provides electricity for Alcoa's nearby aluminum factory.

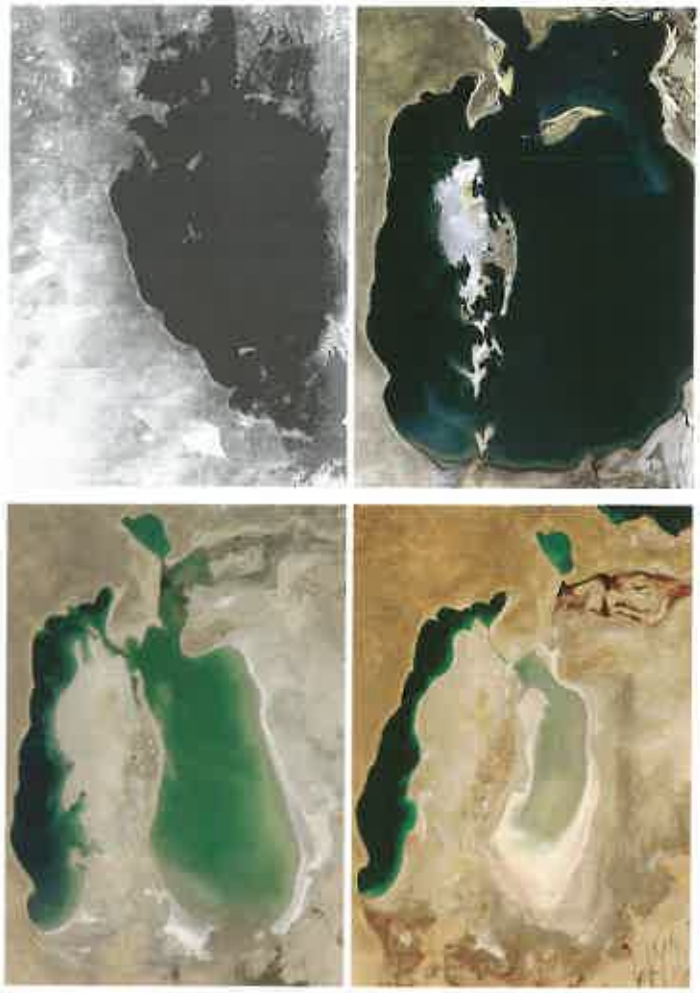
POINT SOURCES. Point-source pollutants are usually smaller in quantity and much easier to control than nonpoint-source pollutants. Point-source water pollution originates from a specific point, such as a pipe from a wastewater treatment plant. The two main point sources of pollution are manufacturers and municipal sewage systems:

- **Water-using manufacturers.** Steel, chemicals, paper products, and food processing are major industrial polluters of water. Each requires a large amount of water in the manufacturing process and generates a lot of wastewater. Food processors, for example, wash pesticides and chemicals from fruit and vegetables. They also use water to remove skins, stems, and other parts. Water can also be polluted by industrial accidents, such as petroleum spills from ocean tankers and leaks from underground tanks at gasoline stations.
- **Municipal sewage.** In developed countries, sewers carry wastewater from sinks, bathtubs, and toilets to a municipal treatment plant, where most—but not all—of the pollutants are removed. The treated wastewater is then typically dumped back into a river or lake. Since passage of the U.S. Clean Water Act and equivalent laws in other developed countries, most treatment plants meet high water-quality standards. In developing countries, sewer systems are rare, and wastewater usually drains, untreated, into rivers and lakes. The drinking water, usually removed from the same rivers, may be inadequately treated as well. The combination of untreated water and poor sanitation makes drinking water deadly in developing countries. Waterborne diseases such as cholera, typhoid, and dysentery are major causes of death.

NONPOINT SOURCES. Nonpoint sources usually pollute in greater quantities and are much harder to control than point sources of pollution. The principal nonpoint source is agriculture. Fertilizers and pesticides spread on fields to increase agricultural productivity are carried into rivers and lakes by irrigation systems or natural runoff. Expanded use of these products may help to avoid a global food crisis, but they destroy aquatic life by polluting rivers and lakes.

One of the world's most extreme instances of nonpoint water pollution is the Aral Sea in the former Soviet Union, now divided between the countries of Kazakhstan and Uzbekistan. The Aral Sea was the world's fourth-largest lake in 1960, at 68,000 square kilometers (26,000 square miles). It had shrunk to approximately 5,000 square kilometers (2,000 square miles) in 2010, and it could disappear altogether by 2020 (Figure 11-38). The shrinking has been captured in air photos and satellite imagery:

- **1975.** In 1975, the Aral Sea was in the early stages of destruction. Small islands are barely visible in the center of the sea (Figure 11-38, upper left).
- **1989.** A large island had formed in the middle of the sea by 1989 (Figure 11-38, upper right).



▲ FIGURE 11-38 **THE DISAPPEARING ARAL SEA** In 1975 (upper left), 1989 (upper right), 2003 (lower left), and 2009 (lower right).

- **2003.** By 2003, the sea was divided into two portions, western and eastern (Figure 11-38, lower left).
- **2009.** In 2009, the western portion had not changed much, but the eastern portion had dried up into a wasteland of salt. A small northern lake also remained (Figure 11-38, lower right).

The Aral Sea died because beginning in 1954, the Soviet Union diverted its tributary rivers, the Amu Dar'ya and the Syr Dar'ya, to irrigate cotton fields. Ironically, the cotton now is withering because winds pick up salt from the exposed lakebed and deposit it on the cotton fields. Carp, sturgeon, and other fish species have disappeared; the last fish died in 1983. Large ships lie aground in salt flats that were once the lakebed, outside abandoned fishing villages that now lay tens of kilometers from the rapidly receding shore.

Pause and Reflect 11.3.3

How might sustainable agriculture practices , as discussed in Chapter 10, help to improve water quality?

IMPACT OF WATER POLLUTION ON AQUATIC LIFE

Polluted water can harm aquatic life. Aquatic plants and animals consume oxygen, and so does the decomposing organic waste that humans dump in the water. The oxygen consumed by the decomposing organic waste constitutes the **biochemical oxygen demand (BOD).** If too much waste is discharged into water, the water becomes oxygen starved and fish die.

This condition is typical when water becomes loaded with municipal sewage or industrial waste. The sewage and industrial pollutants consume so much oxygen that the water can become unlivable for normal plants and animals, creating a "dead" stream or lake. Similarly, when runoff carries fertilizer from farm fields into streams or lakes, the fertilizer nourishes excessive aquatic plant production—a "pond scum" of algae—that consumes too much oxygen. Either type of pollution reduces the normal oxygen level, threatening aquatic plants and animals. Some of the residuals may become concentrated in the fish, making them unsafe for human consumption. For example, salmon from the Great Lakes became unfit to eat because of high concentrations of the pesticide DDT, which washed into streams from farm fields.

Many factories and power plants use water for cooling and then discharge the warm water back into the river or lake. The warm water may not be polluted with chemicals, but it raises the temperature of the body of water it enters. Fish adapted to cold water, such as salmon and trout, might not be able to survive in the warmer water.

CHECK IN: KEY ISSUE 3

Where Does Industry Cause Pollution?

- ✓ **Industry is a major polluter of air, land, and water.**
- ✓ **Air pollution can occur at global, regional, and local scales.**
- ✓ **Solid waste that is not recycled is either transported to landfills or incinerated; some of it is hazardous.**
- ✓ **Water pollution can have point or nonpoint sources.**

KEY ISSUE 4

Why Are Situation and Site Factors Changing?

- Changes within Developed Regions
- Emerging Industrial Regions
- Renewed Attraction of Traditional Industrial Regions

Learning Outcome 11.4.1

Explain reasons for changing distribution of industry within the United States.

Industry is on the move around the world. Changing site factors have been especially important in stimulating industrial growth in new regions internationally and within developed countries. At the same time, some industries remain in the traditional regions, primarily because of changing situation factors.

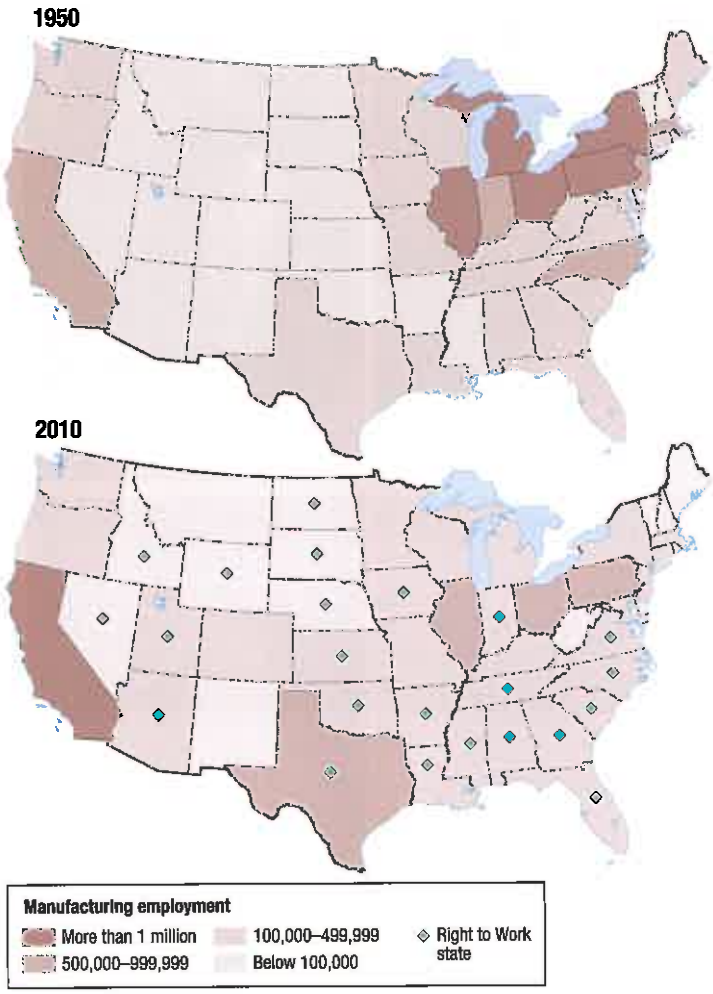
Changes within Developed Regions

Within developed countries, industry is shifting away from the traditional industrial areas of northwestern Europe and the northeastern United States. In the United States, industry has shifted from the Northeast toward the South and West. In Europe, government policies have encouraged relocation toward economically distressed peripheral areas.

SHIFTS WITHIN THE UNITED STATES

The northeastern United States lost 6 million jobs in manufacturing between 1950 and 2010 (Figure 11-39). Especially large declines were recorded by New York State and Pennsylvania, states that once served as centers for clothing, textile, steel, and fabricated metal manufacturing. Meanwhile, 2 million manufacturing jobs were added in the South and West between 1950 and 2009. California and Texas had the largest increases.

Industrialization during the late nineteenth and early twentieth centuries largely bypassed the South, which had not recovered from losing the Civil War. The South lacked the infrastructure needed for industrial development: Road and rail networks were less intensively developed in the South, and electricity was less common than in the North. As a result, the South was the poorest region of the United States. Industrial growth in the South since the 1930s has been stimulated in part by government policies



▲ **FIGURE 11-39 CHANGING U.S. MANUFACTURING** Manufacturing has decreased in the Northeast.

to reduce historical disparities. The Tennessee Valley Authority brought electricity to much of the rural South, and roads were constructed in previously inaccessible sections of the Appalachians, the Piedmont, and the Ozarks. Air-conditioning made living and working in the South more tolerable during the summer.

Steel, textiles, tobacco products, and furniture industries have become dispersed through smaller communities in the South, many in search of a labor force willing to work for less pay than in the North and forgo joining a union. The Gulf Coast has become an important industrial area because of its access to oil and natural gas. Along the Gulf Coast are oil refining, petrochemical manufacturing, food processing, and aerospace product manufacturing.

RIGHT-TO-WORK LAWS. The principal lure for many manufacturers has been right-to-work laws. A **right-to-work law** requires a factory to maintain a so-called "open shop" and prohibits a "closed shop." In a "closed shop," a company and a union agree that everyone must join the union to work in the factory. In an "open shop," a union and a company may not negotiate a contract that requires workers to join a union as a condition of employment.

Twenty-three U.S. states (refer to Figure 11-39) have right-to-work laws that make it much more difficult for unions to organize factory workers, collect dues, and bargain with employers from a position of strength. Right-to-work laws send a powerful signal that antiunion attitudes will be tolerated and perhaps even actively supported. As a result, the percentage of workers who are members of a union is much lower in the South than elsewhere in the United States. More importantly, the region has been especially attractive for companies working hard to keep out unions altogether.

Pause and Reflect 11.4.1

Laws to curb unions have been enacted or proposed in several U.S. states in the past few years. What are the arguments in favor of and against restricting unions?

TEXTILE PRODUCTION. The textile and apparel industry has been especially prominent in opening production in lower-wage locations while shutting down production in higher-wage locations. The U.S. textile and apparel industry was heavily concentrated in the Northeast during the early twentieth century, and then it shifted to the South and West.

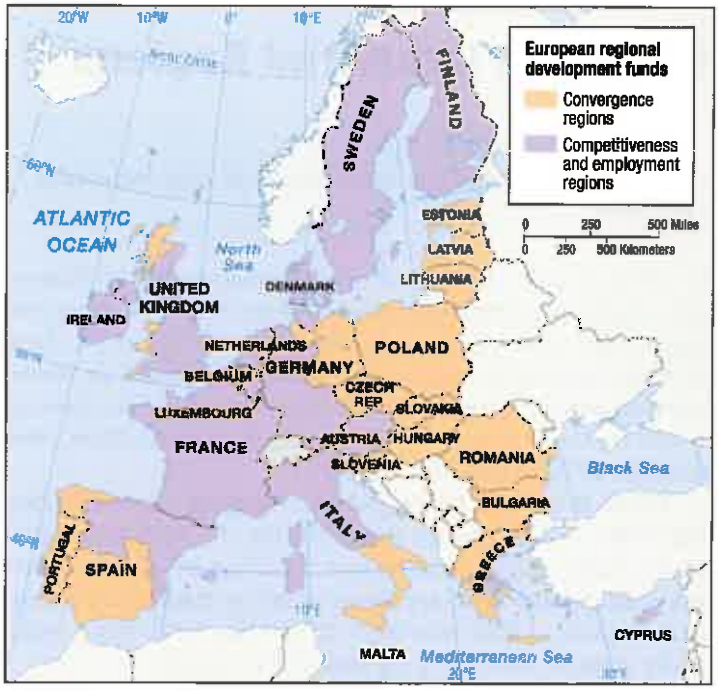
Most textile and apparel production in the United States moved from the Northeast to the Southeast during the mid-twentieth century. Favored sites were small towns in the Appalachian, Piedmont, and Ozark mountains, especially western North and South Carolina and northern Georgia and Alabama. The area is home to 99 percent of U.S. hosiery and sock producers, half of them in North Carolina.

In the mid-twentieth century, prevailing wage rates were much lower in the Southeast than elsewhere in the United States. Even more important for manufacturers, workers in the Southeast showed little interest in joining the unions established by Northeastern textile and apparel workers to bargain for higher wages and safer working conditions.

INTERREGIONAL SHIFTS IN EUROPE

Manufacturing has diffused from traditional industrial centers in northwestern Europe toward Southern and Eastern Europe. In contrast to the United States, European government policies have explicitly encouraged this industrial relocation (Figure 11-40). The European Union Structural Funds provide assistance to what it calls convergence regions and competitive and employment regions:

- Convergence regions are primarily in Eastern and Southern Europe, where incomes lag behind Europe's average.
- Competitive and employment regions are primarily Western Europe's traditional core industrial areas, which have experienced substantial manufacturing job losses in recent years.



▲ **FIGURE 11-40 EUROPEAN UNION STRUCTURAL FUNDS** The European Union provides subsidies to regions with economic difficulties because of declining industries, as well as to regions that have lower-than-average incomes.

The Western European country with the most rapid manufacturing growth during the late twentieth century was Spain, especially after its admission to the European Union in 1986. Until then, Spain's manufacturing growth had been impeded by physical and political isolation. Spain's motor-vehicle industry has grown into the second largest in Europe, behind only Germany's, although it is entirely foreign owned. Spain's leading industrial area is Catalonia, in the northeast, centered on the city of Barcelona. The region has the country's largest motor-vehicle plant and is the center of Spain's textile industry as well. Spain's industry, though, has been especially hard hit by the severe recession of the early twenty-first century.

Several European countries situated east of Germany and west of Russia have become major centers of industrial investment since the fall of communism in the early 1990s. Poland, Czech Republic, and Hungary have had the most industrial development, though other countries in the region have shared in the growth. The region prefers to be called *Central Europe*, reverting to a common pre–Cold War term, to signify its more central location in Europe's changing economy. Central Europe offers manufacturers an attractive combination of two important site and situation factors: labor and market proximity. Central Europe's workers offer manufacturers good value for money; they are less skilled but much cheaper than in Western Europe, and they are more expensive but much more skilled than in Asia and Latin America. At the same time, the region offers closer proximity to the wealthy markets of Western Europe than other emerging industrial centers.

Emerging Industrial Regions

Learning Outcome 11.4.2
Explain reasons for the emergence of new industrial regions.

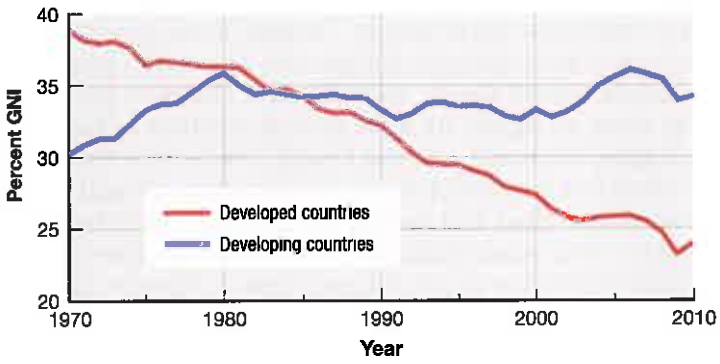
In 1970, nearly one-half of world industry was in Europe and nearly one-third was in North America; now these two regions account for only one-fourth each. Industry's share of total economic output has steadily declined in developed countries since the 1970s (Figure 11-41). The share of world industry in other regions has increased—from one-sixth in 1970 to one-half in 2010.

Labor is the site factor that is changing especially dramatically in the twenty-first century. To minimize labor costs, some manufacturers are locating in places where prevailing wage rates are lower than in traditional industrial regions. Labor-intensive industries have been especially attracted to emerging industrial regions.

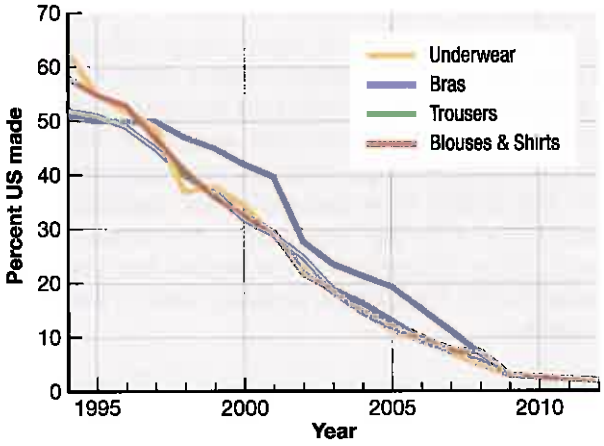
For example, the number of apparel workers in the United States declined from 900,000 in 1990 to 500,000 in 2000 and to 150,000 in 2010. During this period, most apparel sold in the United States switched from being domestically made to being foreign made (Figure 11-42). As apparel from other countries has become less expensive and less complicated to import into the United States, mills in the Southeast paying wages of $10 to $15 per hour have been unable to compete with manufacturers in countries paying less than $1 per hour. European countries have been even harder hit by international competition. Compensation for manufacturing employees exceeds $30 per hour in much of Europe.

OUTSOURCING

Transnational corporations have been especially aggressive in using low-cost labor in developing countries. To remain competitive in the global economy, they carefully review their production processes to identify steps that can be performed by low-paid, low-skilled workers in developing countries. Despite the greater transportation cost, transnational corporations can profitably transfer some work



▲ **FIGURE 11-41 MANUFACTURING VALUE AS A PERCENTAGE OF GNI** Manufacturing has accounted for a much higher share of GNI in developing countries than in developed countries since the 1990s.



▲ **FIGURE 11-42 U.S. CLOTHING** The percentage of clothing made in the United States declined from around 50 percent in the 1990s to around 2 percent today.

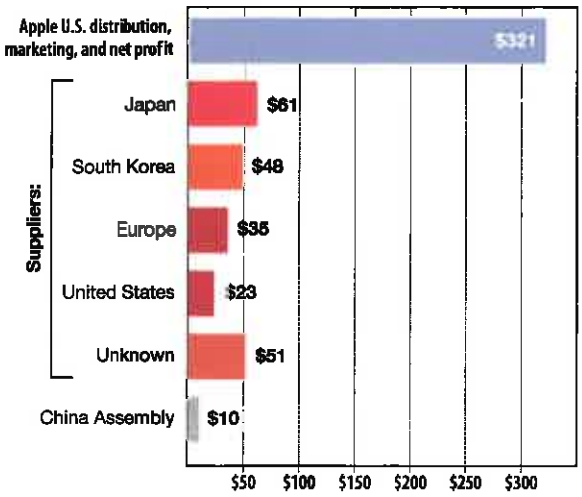
to developing countries, given their substantially lower wages compared to those in developed countries. At the same time, operations that require highly skilled workers remain in factories in developed countries. This selective transfer of some jobs to developing countries is known as the **new international division of labor.**

Transnational corporations allocate production to low-wage countries through **outsourcing**, which is turning over much of the responsibility for production to independent suppliers. Outsourcing contrasts with the approach typical of traditional mass production, called **vertical integration**, in which a company controls all phases of a highly complex production process. Vertical integration was traditionally regarded as a source of strength for manufacturers because it gave them the ability to do and control everything. Carmakers once made nearly all their own parts, for example, but now most of this operation is outsourced to other companies that are able to make the parts cheaper and better. As another example, the parts in an iPhone are made by independent companies.

Outsourcing has had a major impact on the distribution of manufacturing because each step in the production process is now scrutinized closely in order to determine the optimal location. For example, most of the cost of an iPhone is in the parts, which are made by relatively skilled workers in Japan, Germany, and South Korea. Most of the profits go to the United States, where Apple is based. But one step in the production process is especially labor intensive—snapping all the parts together at an assembly plant—and this step is done in China, by relatively low-wage, low-skilled workers (Figure 11-43).

MEXICO AND NAFTA

Manufacturing has been increasing in Mexico. The North American Free Trade Agreement (NAFTA), effective in 1994, eliminated most barriers to moving goods among Mexico, the United States, and Canada. Because it is the nearest low-wage country to the United States, Mexico attracts labor-intensive industries that also need proximity to the U.S. market.



▲ FIGURE 11-43 **IPHONE PRODUCTION** iPhones are assembled in China from parts made in the United States, Europe, and East Asia.

Plants in Mexico near the U.S. border are known as **maquiladoras.** The term originally applied to a tax when Mexico was a Spanish colony. Under U.S. and Mexican laws, companies receive tax breaks if they ship materials from the United States, assemble components at a *maquiladora* plant in Mexico, and export the finished product back to the United States. More than 1 million Mexicans are employed at over 3,000 *maquiladoras*.

Integration of North American industry has generated fear in the United States and Canada:

- Labor leaders fear that more manufacturers relocate production to Mexico to take advantage of lower wage rates. Labor-intensive industries such as food processing and textile manufacturing are especially attracted to regions where prevailing wage rates are lower.
- Environmentalists fear that NAFTA encourages firms to move production to Mexico because laws governing air- and water-quality standards are less stringent than in the United States and Canada. Mexico has adopted regulations to reduce air pollution in Mexico City; catalytic converters have been required on Mexican automobiles since 1991. But environmentalists charge that environmental protection laws are still not strictly enforced in Mexico.

Mexico faces its own challenges: It lost a quarter-million *maquiladora* jobs during the first decade of the twenty-first century. Electronics firms were especially likely to pull out of Mexico. The reason: Although much lower than in the United States, Mexican wages at $6 an hour were higher than $1 wages in China and India. Despite the higher site costs, however, Mexico still competes effectively with China because of situation factors. Because of its proximity, Mexico has much lower shipping costs to the United States than does China.

Pause and Reflect 11.4.2

Can you identify any products in your house that were made in Mexico?

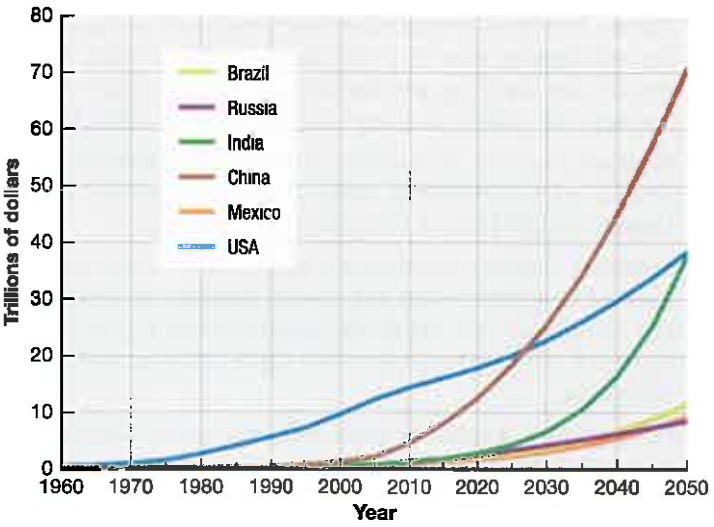
BRIC AND BRICS

Much of the world's future growth in manufacturing is expected to locate outside the principal industrial regions described earlier. The investment banking firm Goldman Sachs coined the acronym BRIC to indicate the countries it expects to dominate global manufacturing during the twenty-first century: Brazil, Russia, India, and China. The foreign ministers of these four countries started meeting in 2006. The four BRIC countries together currently control one-fourth of the world's land area and contain 3 billion of the world's 7 billion inhabitants, but the four countries combined account for only one-sixth of world GDP (Figure 11-44). Their economies rank second (China), seventh (Brazil), ninth (Russia), and eleventh (India) in the world.

China is expected to pass the United States as the world's largest economy around 2020, and India is expected to become second around 2035. In 2050, Brazil and Russia are expected to rank sixth and seventh. Two other developing countries, Indonesia and Nigeria, are expected to be fourth and fifth. Thus, in 2050 the United States would be the only developed country to rank among the world's seven largest economies.

China and India have the two largest labor forces, whereas Russia and Brazil are especially rich in inputs critical for industry. As an industrial region, BRIC has the obvious drawback of Brazil's being on the other side of the planet from the other three. China, India, and Russia could form a contiguous region, but long-standing animosity among them has limited their economic interaction so far. Still, the BRIC concept is that if the four giants work together, they can be the world's dominant industrial bloc in the twenty-first century.

In 2010, South Africa was invited to join a meeting with the other four emerging countries, and the group adopted the acronym BRICS. Although South Africa has the largest economy, population, and land area in the southern portion of sub-Saharan Africa, it is much smaller by all of these measures than the four original BRIC members.



▲ FIGURE 11-44 **GDP FOR BRIC COUNTRIES** The BRIC countries are expected to increase GDP relatively rapidly during the twenty-first century.

Renewed Attraction of Traditional Industrial Regions

Learning Outcome 11.4.3
Explain reasons for renewed attraction of traditional industrial regions.

Given the strong lure of low-cost labor in new industrial regions, why would any industry locate in one of the traditional regions, especially in the northeastern United States or northwestern Europe? Two location factors influence industries to remain in these traditional regions: availability of skilled labor and rapid delivery to market.

PROXIMITY TO SKILLED LABOR

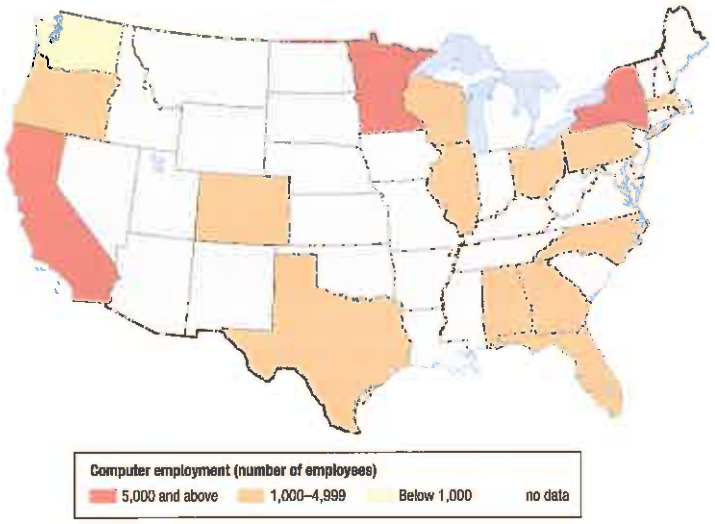
Henry Ford boasted that he could take people off the street and put them to work with only a few minutes of training. That has changed for some industries, which now want skilled workers instead. The search for skilled labor has important geographic implications because it is an asset found principally in the traditional industrial regions.

Traditionally, factories assigned each worker one specific task to perform repeatedly. Some geographers call this approach **Fordist production**, or mass production, because the Ford Motor Company was one of the first companies to organize its production this way early in the twentieth century. At its peak, Ford's factory complex along the River Rouge in Dearborn, Michigan, near Detroit, employed more than 100,000. Most of these workers did not need education or skills to do their jobs, and many were immigrants from Europe or the southern United States.

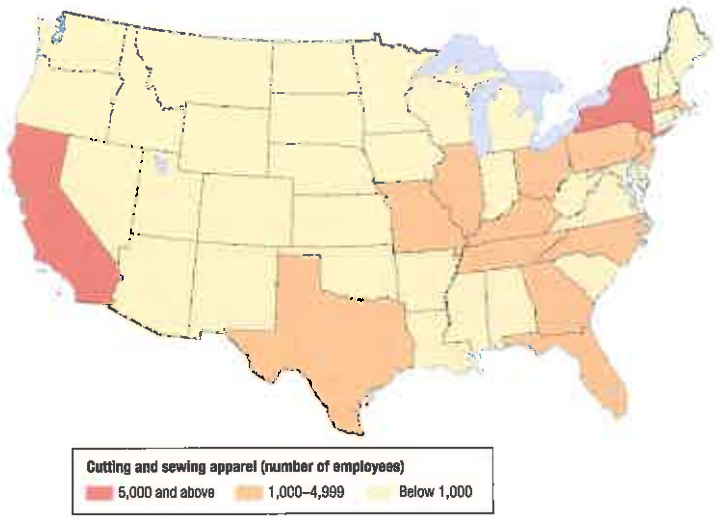
Many industries now follow a lean, or flexible, production approach. The term **post-Fordist production** is sometimes used to describe lean production, in contrast with Fordist production. Another carmaker is best known for pioneering lean production—in this case, Toyota. Four types of work rules distinguish post-Fordist lean production:

- **Teams.** Workers are placed in teams and told to figure out for themselves how to perform a variety of tasks. Companies are locating production in communities where workers are willing to adopt more flexible work rules.
- **Problem solving.** A problem is addressed through consensus after consulting with all affected parties rather than through filing a complaint or grievance.
- **Leveling.** Factory workers are treated alike, and managers and veterans do not get special treatment; they wear the same uniform, eat in the same cafeteria, park in the same lot, and participate in the same athletic and social activities.
- **Productivity.** Factories have become more productive through introduction of new machinery and processes. Rather than requiring physical strength, these new machines and processes require skilled operators, typically with college degrees.

Computer manufacturing is an example of an industry that has concentrated in relatively high-wage, high-skilled communities of the United States (Figure 11-45). Even the clothing industry has not completely abandoned the Northeast. Dresses, woolens, and other "high-end" clothing products are still made in the region. They require more skill in cutting and assembling the material, and skilled textile workers are more plentiful in the Northeast and California than in the South (Figure 11-46).



▲ **FIGURE 11-45 COMPUTER AND PERIPHERAL EQUIPMENT MANUFACTURING** Manufacturers of computing equipment seek access to skilled workers to perform precision tasks. The assembly work that requires lower-skilled workers is done abroad, mostly in Asia, as shown in the case of the iPhone (Figure 11-46).



▲ **FIGURE 11-46 THE APPAREL INDUSTRY** What's left of the U.S. apparel industry is concentrated in California and the Northeast.

JUST-IN-TIME DELIVERY

Proximity to market has long been important for many types of manufacturers, as discussed earlier in this chapter. This factor has become even more important in recent years because of the rise of **just-in-time delivery**. As the name implies, just-in-time is shipment of parts and materials to arrive at a factory moments before they are needed. Just-in-time delivery is especially important for delivery of inputs, such as parts and raw materials, to manufacturers of fabricated products, such as cars and computers.

Under just-in-time, parts and materials arrive at a factory frequently, in many cases daily or even hourly. Suppliers of the parts and materials are told a few days in advance how much will be needed over the next week or two, and first thing each morning, they are told exactly what will be needed at precisely what time that day. To meet a tight timetable, a supplier of parts and materials must locate factories near its customers. If given only an hour or two of notice, a supplier has no choice but to locate a factory within 50 miles or so of the customer.

Just-in-time delivery reduces the money that a manufacturer must tie up in wasteful inventory. In fact, the percentage of the U.S. economy tied up in inventory has been cut in half during the past three decades. Manufacturers also save money through just-in-time delivery by reducing the size of the factory because space does not have to be wasted on piling up a mountain of inventory. Leading computer manufacturers have eliminated inventory altogether. They build computers only in response to customer orders placed primarily over the Internet or by telephone. In some cases, just-in-time delivery merely shifts the burden of maintaining inventory to suppliers. Wal-Mart, for example, holds low inventories but tells its suppliers to hold high inventories "just in case" a sudden surge in demand requires restocking on short notice.

Just-in-time delivery means that producers have less inventory to cushion against disruptions in the arrival of needed parts. Three kinds of disruptions can result from reliance on just-in-time delivery:

- **Labor unrest.** A strike at one supplier plant can shut down the entire production within a couple of days. A strike in the logistics industry, such as a strike by truckers or dockworkers, could also disrupt deliveries.
- **Traffic.** Deliveries may be delayed when traffic is slowed by accident, construction, or unusually heavy volume. Trucks and trains are both subject to these types of delays, especially crossing international borders.
- **Natural hazards.** Poor weather conditions can afflict deliveries anywhere in the world. Blizzards and floods can close highways and rail lines. The 2011 earthquake and tsunami in Japan put many factories and transportation lines out of service for months. Carmakers around the world had to curtail production because key parts had been made at the damaged factories. Superstorm Sandy, which hit the East Coast of the United States in 2012, severely disrupted transportation and delivery of goods and energy in the most densely population region of the country (Figure 11-47).

➤ **FIGURE 11-47** NATURAL HAZARDS: SUPERSTORM SANDY Superstorm Sandy, which hit the East Coast of the United States in 2012, disrupted travel for several days. In New York City, subways and tunnels were closed because of flooding. People walked across the Brooklyn Bridge to get to work, while private cars, taxis, and delivery trucks sat bumper-to-bumper on the bridge.

A GLOBAL INDUSTRY: WHAT IS AN AMERICAN CAR?

Distinctions between "American" and "foreign" motor vehicles have been blurred for the past three decades. Popular media have delighted in showcasing examples of "American" vehicles produced by the Detroit 3 (Chrysler, Ford, and General Motors) that have lower U.S. content than those produced by "Japanese" carmakers such as Honda and Toyota. The U.S. government distinguishes between domestic and foreign vehicles in three ways:

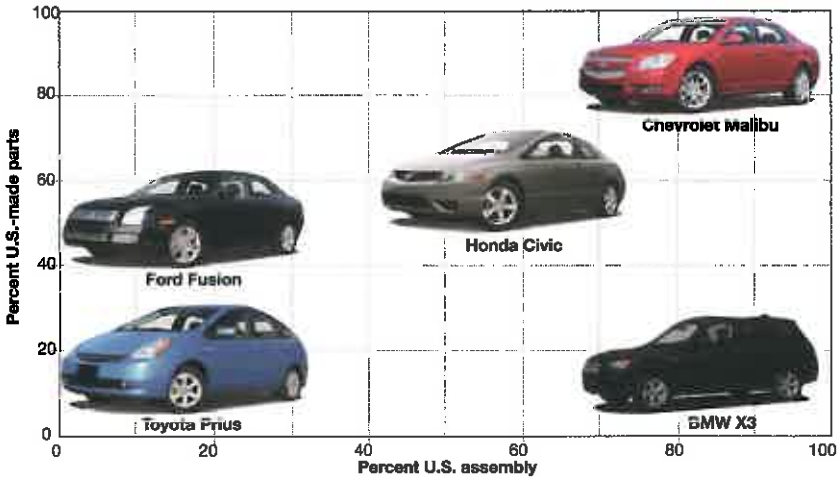
- For measuring fuel efficiency, the U.S. Environmental Protection Agency considers a vehicle domestic if at least 75 percent of its content comes from North America, originally defined as the United States and Canada, and, after enactment of the North American Free Trade Agreement (NAFTA), including Mexico.
- For setting import tariffs, the U.S. Department of Treasury Customs Service considers as domestic a vehicle having at least 50 percent U.S. and Canadian content.
- For informing consumers, the American Automobile Labeling Act of 1992 considers a vehicle domestic if at least 85 percent of the parts originate in the United States and Canada; a part is counted as domestic if at least 70 percent of its overall content comes from the United States and Canada.

According to data derived from Labeling Act reports, vehicles built by foreign-owned carmakers at assembly plants located in the United States have around 60 percent domestic content. Domestic content for the Detroit 3 is 76 percent. The lower domestic content for foreign carmakers masks differences among individual companies. Honda and Toyota have a level of U.S. content comparable to that of the Detroit 3. German-owned carmakers such as BMW and Daimler-Benz have much lower percentages.

After opening assembly plants in the United States during the 1980s, Japanese-owned carmakers convinced many of their Japanese-owned suppliers to build factories in the United States. The gap in domestic content has also narrowed because the Detroit 3 bought more foreign parts. More than one-fourth of all new vehicle parts are imported. Mexico has become the leading source of imported parts, and China has been increasing its share rapidly.

Figure 11-48 shows the extent to which several popular vehicles are "American." The x axis shows the percentage of these vehicles sold in the United States that were assembled in the United States in 2011. The y axis shows the percentage of U.S.-made parts in these vehicles.

- GM's Chevrolet Malibu was assembled entirely in the United States with all but a handful of U.S.-made parts.
- Toyota's Prius was assembled in Japan with Japanese-made parts.
- Ford's Fusion was assembled in Mexico with about one-half U.S. parts.



▲ FIGURE 11-48 "AMERICAN" AND "FOREIGN" CARS The x axis shows the percentage of these vehicles sold in the United States that were assembled in the United States in 2011. The y axis shows the percentage of U.S.-made parts in these vehicles.

- BMW's X3 was assembled in the United States with parts mostly imported from Germany.
- Honda Civics were assembled either in the United States with mostly U.S.-made parts, assembled in Canada with mostly U.S.-made parts, or imported from Japan with mostly Japanese-made parts.

Pause and Reflect 11.4.3

Why might weather conditions encourage companies to locate factories in the U.S. South rather than the North?

CHECK-IN: KEY ISSUE 4

Why Are Situation and Site Factors Changing?

- ✓ **Industry is moving from the North to the South within the United States; in many cases, lower-cost nonunion labor is the principal factor.**
- ✓ **Low-cost labor is also inducing firms to locate in countries that are not part of the traditional industrial regions.**
- ✓ **On the other hand, some industry is attracted to traditional industrial regions because of the need for skilled labor or rapid delivery to consumers.**

Summary

KEY ISSUE 1

Where Is Industry Distributed?

The concept of manufacturing goods in a factory originated with the Industrial Revolution in the United Kingdom.

LEARNING OUTCOME 11.1.1: Describe the locations of the principal industrial regions.

- Most of the world's industry is clustered in the three regions: Europe, North America, and East Asia.

THINKING GEOGRAPHICALLY 11.1: What are the principal manufacturers in your community or area? How have they been affected by increasing global competition?

GOOGLE EARTH 11.1: Coalbrookdale, England, is considered the birthplace of the Industrial Revolution, because a factory here was the first to produce high-quality iron using coal. What structure, visible in 3D, was the first in the world to be made of cast iron?

Key Terms

Acid deposition (p. 414) Sulfur oxides and nitrogen oxides, emitted by burning fossil fuels, that enter the atmosphere—where they combine with oxygen and water to form sulfuric acid and nitric acid—and return to Earth's surface.

Acid precipitation (p. 414) Conversion of sulfur oxides and nitrogen oxides to acids that return to Earth as rain, snow, or fog.

Air pollution (p. 412) Concentration of trace substances, such as carbon monoxide, sulfur dioxide, nitrogen oxides, hydrocarbons, and solid particulates, at a greater level than occurs in average air.

Apparel (p. 410) An article of clothing.

Biochemical oxygen demand (BOD) (p. 417) The amount of oxygen required by aquatic bacteria to decompose a given load of organic waste, a measure of water pollution.

Break-of-bulk point (p. 402) A location where transfer is possible from one mode of transportation to another.

Bulk-gaining industry (p. 400) An industry in which the final product weighs more or comprises a greater volume than the inputs.

Bulk-reducing industry (p. 398) An industry in which the final product weighs less or comprises a lower volume than the inputs.

Chlorofluorocarbon (CFC) (p. 413) A gas used as a solvent, a propellant in aerosols, a refrigerant, and in plastic foams and fire extinguishers.

Cottage industry (p. 395) Manufacturing based in homes rather than in factories, commonly found prior to the Industrial Revolution.

Ferrous (p. 398) Metals, including iron, that are utilized in the production of iron and steel.

Fordist production (p. 422) A form of mass production in which each worker is assigned one specific task to perform repeatedly.

Greenhouse effect (p. 412) The anticipated increase in Earth's temperature caused by carbon dioxide (emitted by burning fossil fuels) trapping some of the radiation emitted by the surface.

Industrial Revolution (p. 395) A series of improvements in industrial technology that transformed the process of manufacturing goods.

Just-in-time delivery (p. 423) Shipment of parts and materials to arrive at a factory moments before they are needed.

Labor-intensive industry (p. 408) An industry for which labor costs comprise a high percentage of total expenses.

KEY ISSUE 2

Why Are Situation and Site Factors Important?

Manufacturers select locations for factories based on assessing a combination of situation and site factors.

LEARNING OUTCOME 11.2.1: Identify the two types of situation factors and explain why some industries locate near inputs.

- Situation factors involve minimizing the cost of shipping from sources of inputs or to markets.
- A location near sources of inputs is optimal for bulk-reducing industries.
- Industries that extract a large amount of minerals tend to be bulk-reducing industries.

LEARNING OUTCOME 11.2.2: Explain why some industries locate near markets.

- Bulk-gaining industries, single-market manufacturers, and perishable products companies tend to locate near markets.

LEARNING OUTCOME 11.2.3: Explain why industries use different types of transportation.

- Trucks are most often used for short-distance delivery, trains for longer trips within a region, ships for ocean crossings, and planes for very high-value packages.
- Some firms locate near break-of-bulk points, where goods are transferred between modes of transportation.

LEARNING OUTCOME 11.2.4:

Describe how the optimal location for steel production has changed.

- Steel production has traditionally been located near inputs, but the relative importance of the two main inputs—coal and iron ore—has changed.
- Some steel production, especially minimills, is now located near the markets.
- Industries that extract a large amount of minerals tend to be bulk-reducing industries.

LEARNING OUTCOME 11.2.5:

Explain the distribution of motor vehicle production.

- Because they are bulk-gaining products, most motor vehicles are assembled near their markets.
- The distribution of motor vehicle production has changed because the distribution of buyers has changed.

LEARNING OUTCOME 11.2.6: List the three types of site factors.

- The three site factors are labor, capital, and land.
- A labor-intensive industry has a high percentage of labor in the production process.

LEARNING OUTCOME 11.2.7: Explain the distribution of textile and apparel production.

- The clothing industry is a labor-intensive industry.
- Three steps in production are spinning, weaving, and sewing. Most spinning and weaving occur in low-wage countries, but some sewing occurs in developed countries near consumers.

THINKING GEOGRAPHICALLY 11.2: To induce Kia to build its U.S. production facility in Georgia, the state spent $36 million to buy the site, $25 million to prepare the site, including grading, $30 million to provide road improvements, including an interchange off I-85, $6 million to build a rail spur, $20 million to construct a training center, $6 million to operate the center for five years, $6 million to develop a training course, $76 million in tax credits, $14 million in sales tax exemptions, and $41 million in training equipment. Did Georgia overpay to win the Kia factory? Explain.

GOOGLE EARTH 11.2: The largest steel works in the United States, the US Steel complex at Gary, Indiana, sits at the south end of Lake Michigan. How many modes of transport delivering raw materials to the plant can you see?

Maquiladora (p. 421) A factory built by a U.S. company in Mexico near the U.S. border, to take advantage of the much lower labor costs in Mexico.

New international division of labor (p. 420) Transfer of some types of jobs, especially those requiring low-paid, less-skilled workers, from more developed to less developed countries.

Nonferrous (p. 398) Metals utilized to make products other than iron and steel.

Nonpoint-source pollution (p. 416) Pollution that originates from a large, diffuse area.

Outsourcing (p. 420) A decision by a corporation to turn over much of the responsibility for production to independent suppliers.

Ozone (p. 413) A gas that absorbs ultraviolet solar radiation, found in the stratosphere, a zone 15 to 50 kilometers (9 to 30 miles) above Earth's surface.

Photochemical smog (p. 414) An atmospheric condition formed through a combination of weather conditions and pollution, especially from motor vehicle emissions.

Point-source pollution (p. 416) Pollution that enters a body of water from a specific source.

Post-Fordist production (p. 422) Adoption by companies of flexible work rules, such as the allocation of workers to teams that perform a variety of tasks.

Right-to-work law (p. 418) A U.S. law that prevents a union and a company from negotiating a contract that requires workers to join the union as a condition of employment.

Sanitary landfill (p. 414) A place to deposit solid waste, where a layer of earth is bulldozed over garbage each day to reduce emissions of gases and odors from the decaying trash, to minimize fires, and to discourage vermin.

KEY ISSUE 3

Why Does Industry Cause Pollution?

Industry is a major polluter of air, land, and water.

LEARNING OUTCOME 11.3.1: Describe the causes and effects of global warming and damage to the ozone layer.

- Air pollution occurs at global, regional, and local scales.
- At the global scale, the principal pollution is global warming, caused primarily by burning of fossil fuels in factories and vehicles.

LEARNING OUTCOME 11.3.2: Describe the causes and effects of regional and local-scale air pollution and solid waste pollution.

- Acid deposition is a major form of regional-scale air pollution. Sulfuric acid and nitric acid generated by burning of fossil fuels fall into bodies of water.
- Carbon monoxide, hydrocarbons, and particulates are the major forms of local-scale air pollution.
- Solid waste is typically placed in landfills or incinerated.

LEARNING OUTCOME 11.3.3: Compare and contrast point and nonpoint sources of water pollution.

- Point-source pollution originates from a specific place, such as a pipe, generated principally by factories and sewage disposal.
- Nonpoint sources are generated primarily by agricultural runoff.

THINKING GEOGRAPHICALLY 11.3: What are the major polluters in or near your community?

GOOGLE EARTH 11.3: The world's largest electronics manufacturer, FoxConn, has a large complex in Longhua, Shenzhen, China. How many different FoxConn buildings are labeled in Longhua?

KEY ISSUE 4

Why Are Situation and Site Factors Changing?

Industry is on the move within developed countries, as well as to emerging developing countries.

LEARNING OUTCOME 11.4.1: Explain reasons for changing distribution of industry within the United States.

- Industry is moving from the North to the South within the United States.
- Lower labor costs and absence of unions are major factors in the migration.

LEARNING OUTCOME 11.4.2: Explain reasons for the emergence of new industrial regions.

- Some jobs have been transferred to low-wage countries as part of the new international division of labor.
- The BRIC countries (Brazil, Russia, India, and China) are expected to be the top industrial powers by the middle of the twenty-first century.

LEARNING OUTCOME 11.4.3: Explain reasons for renewed attraction of traditional industrial regions.

- Traditional industrial regions attract and retain industries that need skilled labor.
- Just-in-time delivery has increased the attraction of locating near consumers.

THINKING GEOGRAPHICALLY 11.4: What have been the benefits and costs to Canada, Mexico, and the United States as a result of NAFTA?

GOOGLE EARTH 11.4: If you fly to Ciudad Acuna, Mexico, several *maquiladora* plants can be seen on the northern edge of the city, near the U.S. border, along the Rio Grande River (Rio Bravo in Spanish). What is the distance from the *maquiladora* complex to the nearest border crossing?

Site factors (p. 398) Location factors related to the costs of factors of production inside a plant, such as land, labor, and capital.

Situation factors (p. 398) Location factors related to the transportation of materials into and from a factory.

Textile (p. 410) A fabric made by weaving, used in making clothing.

Vertical integration (p. 420) An approach typical of traditional mass production in which a company controls all phases of a highly complex production process.

Chapter

12 Services and Settlements

Why is this man carrying raw pig meat on his back? Page 440

Why are these farm fields long and narrow rather than square? Page 449

KEY ISSUE 1

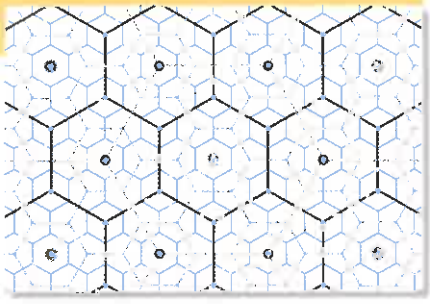
Where Are Services Distributed?

More and More Services p. 431

Most jobs—and most of the growth in jobs—is in services.

KEY ISSUE 2

Where Are Consumer Services Distributed?



Services for People p. 434

Services for people are located where the people are.