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

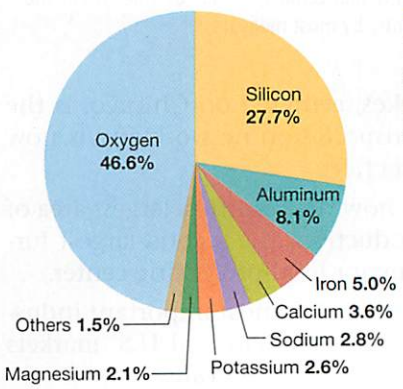
Minerals are either nonmetallic or metallic. In weight, more than 90 percent of the minerals that humans use are nonmetallic. Important nonmetallic minerals include building stones, gemstones such as diamonds, and minerals used in the manufacture of fertilizers such as nitrogen, phosphorus, potassium,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

METALLIC MINERALS

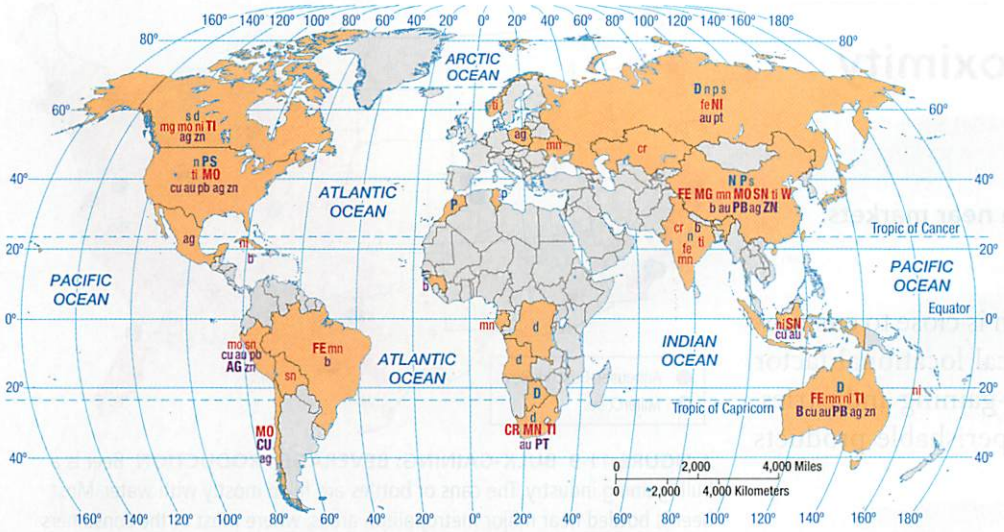
Metallic minerals have properties that are especially valuable for fashioning machinery, vehicles, and other essential elements of contemporary society. They are to varying degrees malleable (able to be hammered into thin plates) and ductile (able to be drawn into fine wire) and are good conductors of 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.

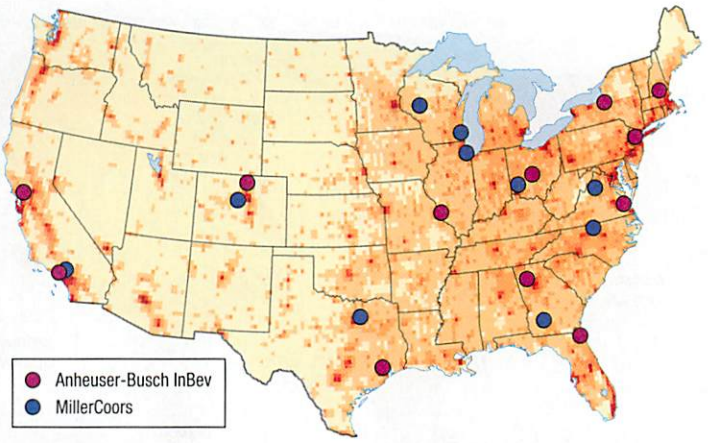
For many firms, the optimal location is close to customers. Proximity to markets is a critical locational factor for three types of industries: bulk-gaining industries, single-market manufacturers, and perishable products companies.

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.

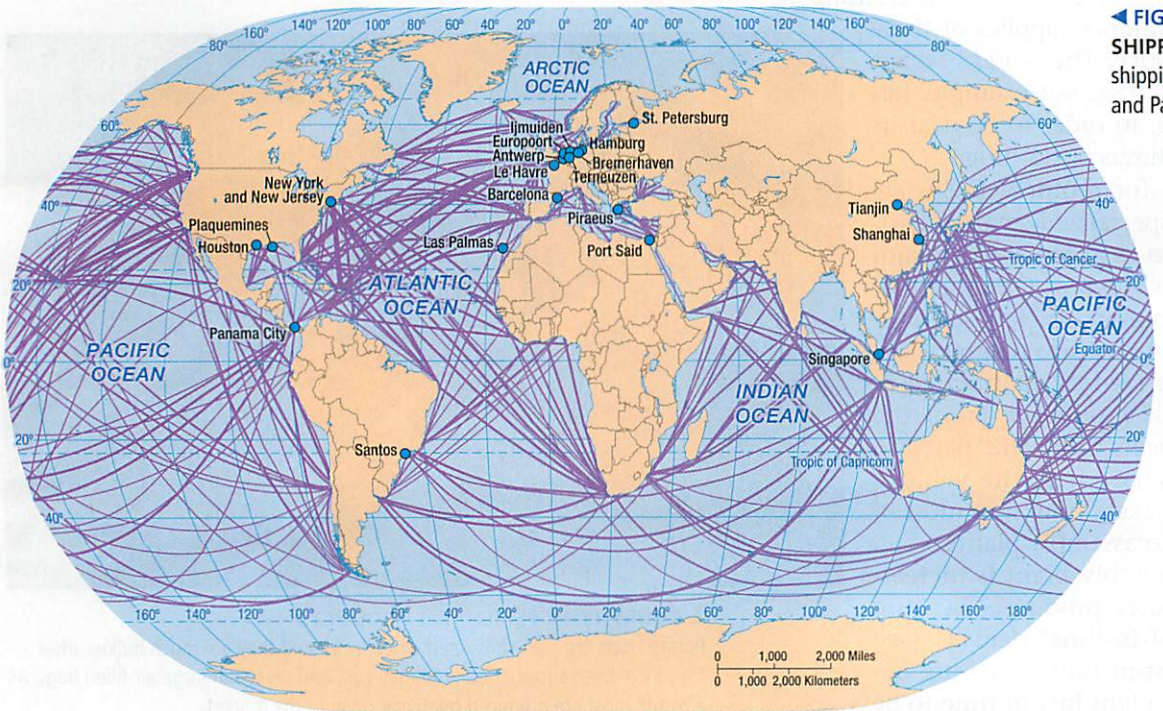
The farther something is transported, the lower is the cost per kilometer (or mile). Longer-distance transportation is cheaper per kilometer in part because firms must pay workers to load goods on and off vehicles, whether the material travels 10 kilometers or 10,000. The cost per kilometer decreases 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, airfreight 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.

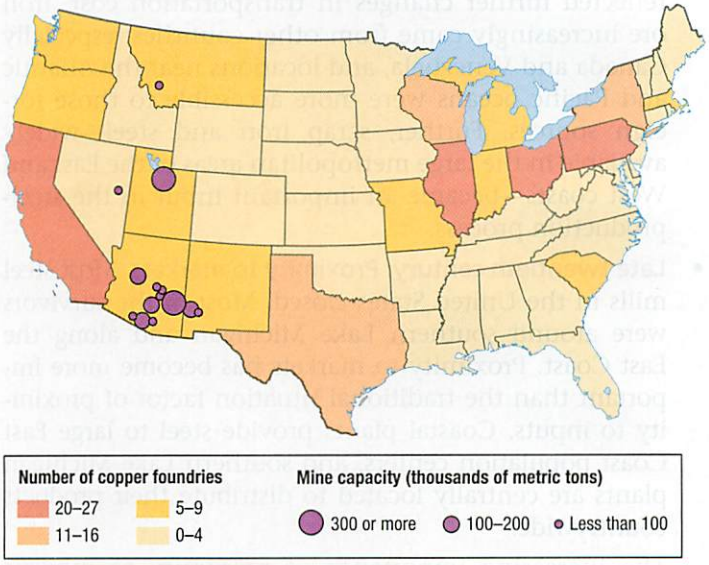
Changing Situation Factors in Key Industries

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.

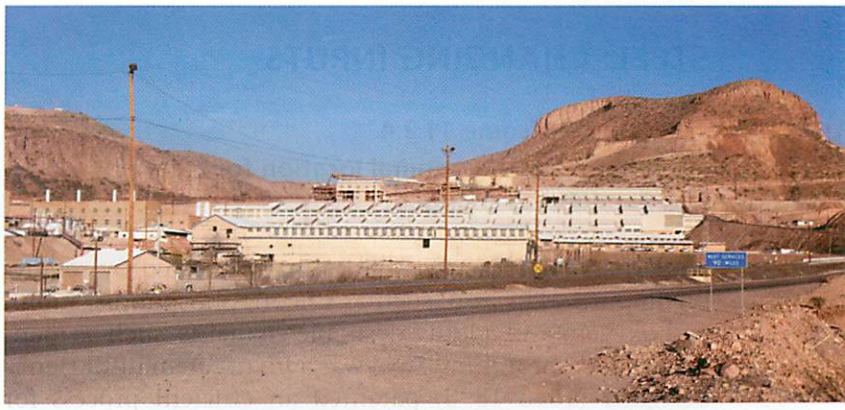
COPPER: PROXIMITY TO INPUTS OR MARKETS?

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

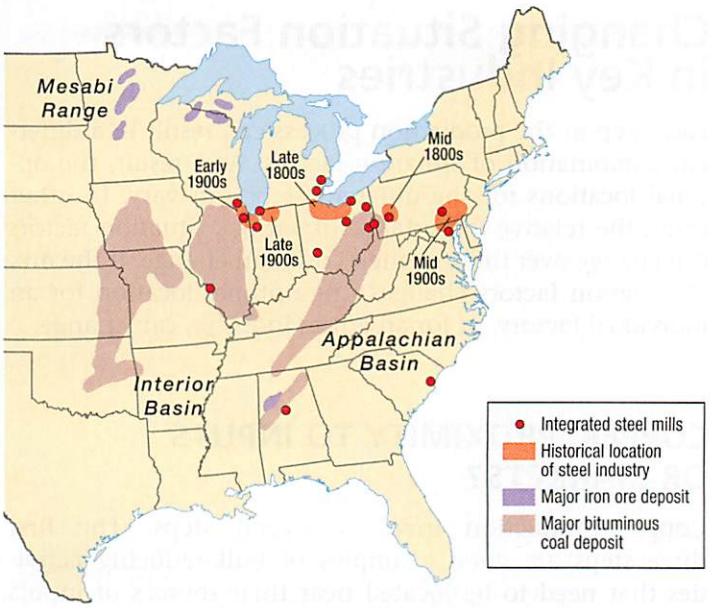
Learning Outcome 11.2.4

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.

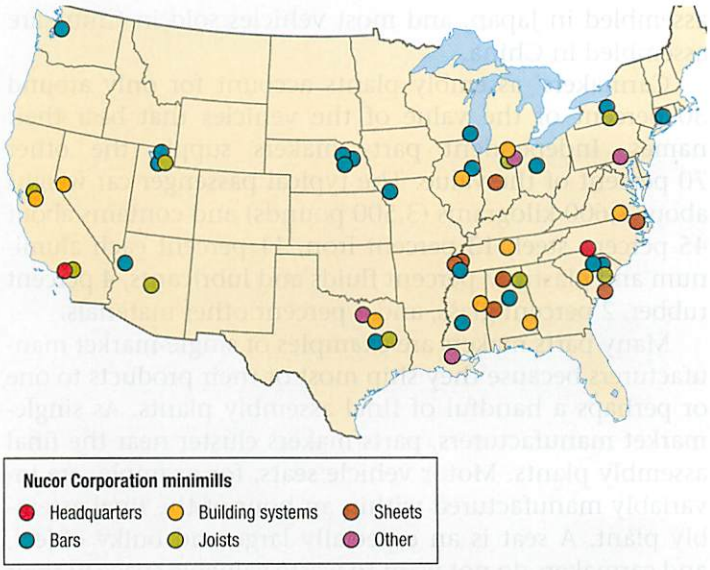


▲ **FIGURE 11-15 INTEGRATED STEEL MILLS IN THE UNITED STATES** Integrated steel mills are highly clustered near the southern Great Lakes, especially Lake Erie and Lake Michigan. Historically, the most critical factor in situating a steel mill was to minimize transportation cost for raw materials, especially 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.

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.
- **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.

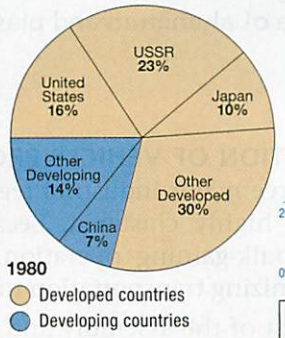
CHANGING DISTRIBUTION OF THE WORLD STEEL INDUSTRY. The shift of world manufacturing to new industrial regions can be seen clearly in steel production. In 1980, 80 percent of world steel was produced in developed countries and 20 percent in developing countries (Figure 11-17, top). Between 1980 and 2010,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

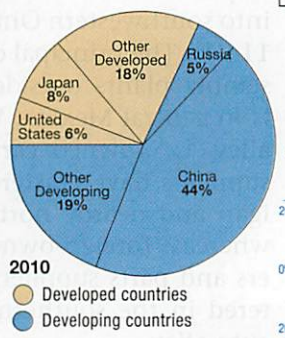
World steel production doubled between 1980 and 2010, from around 700 million to around 1,400 million metric tons. China was responsible for 600 million of the 700 million metric ton increase, and other developing countries (primarily India and South Korea) for the other 100 million (Figure 11-18). Production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

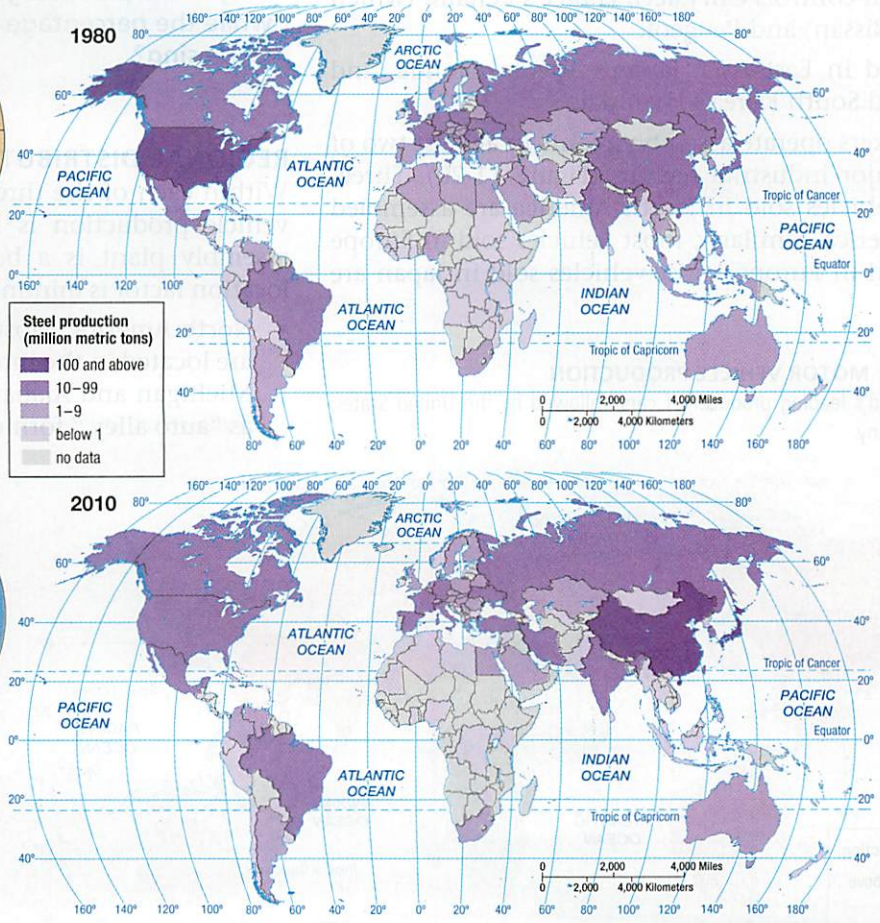
Pause and Reflect 11.2.4

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.

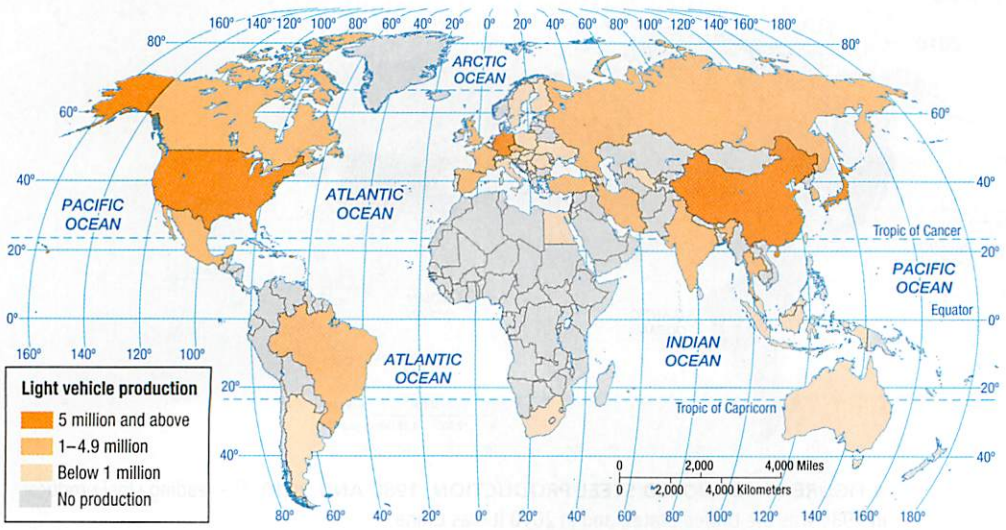
Pause and Reflect 11.2.5

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:

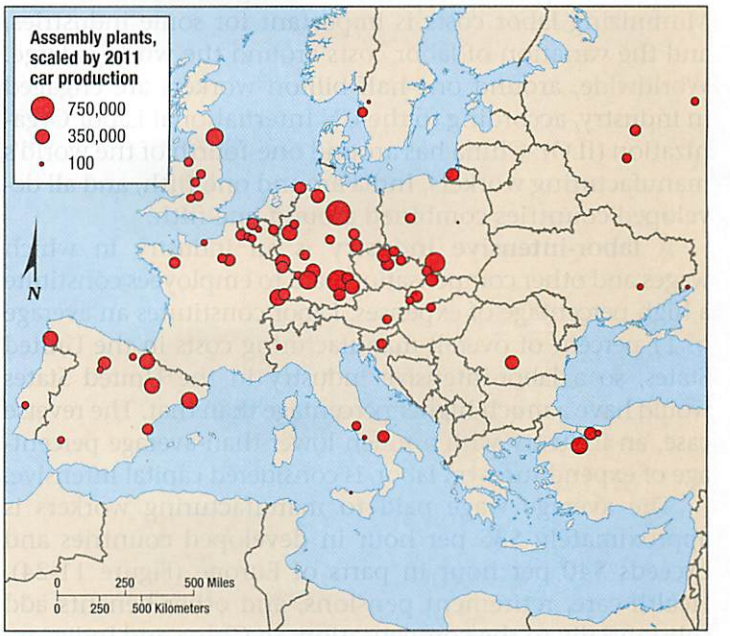
- **North America.** Most of the assembly and parts plants are located in the interior of the United States, between Michigan and Alabama, centered in a corridor known as "auto alley," formed by north–south interstate highways 65 and 75, with an extension into southwestern Ontario (Figure 11-21). The 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.

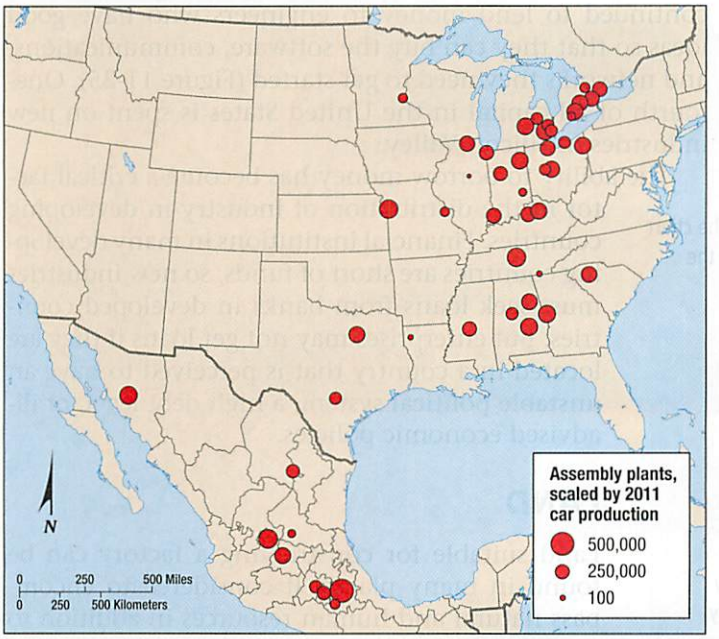


◀ **FIGURE 11-20 ASSEMBLY PLANT IN EUROPE** Toyota's factory near Burnaston, in the United Kingdom, is surrounded by farmland.

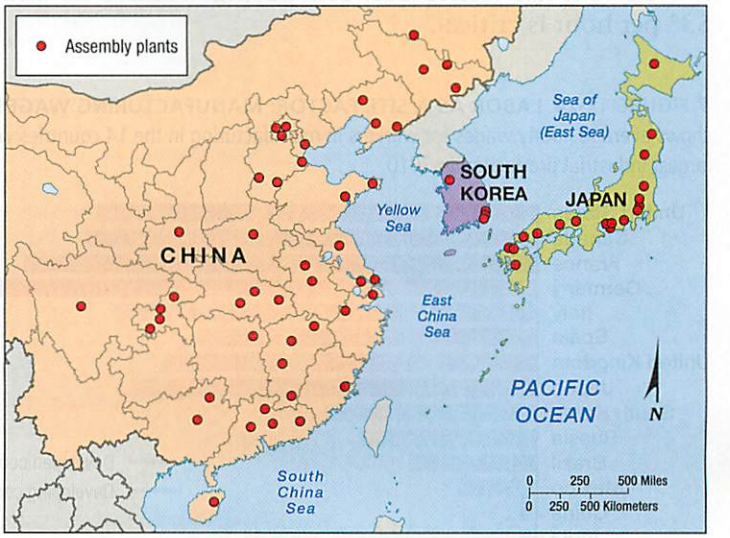
- **Europe.** Most plants are clustered in an east–west corridor between the United Kingdom and Russia (Figure 11-22). Germany is the leading producer of vehicles in Europe. Since the end of communism in Eastern Europe in the early 1990s, that region has had most of the growth in vehicle production. 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.

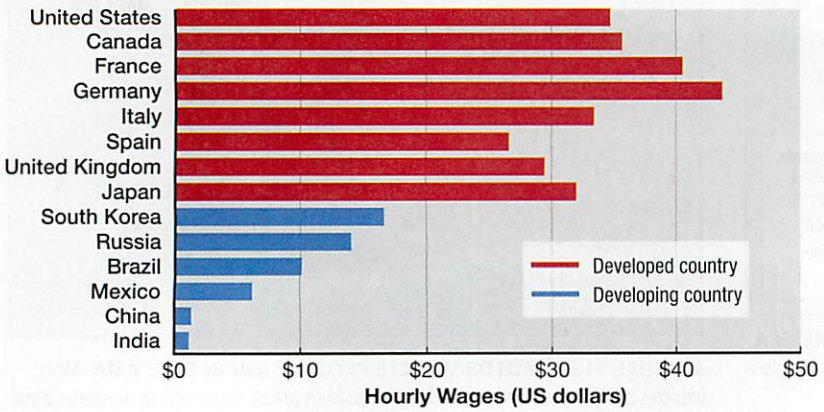
LABOR

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.

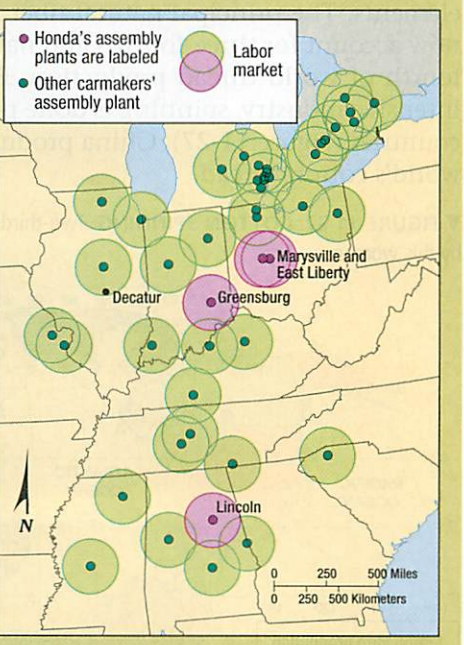
CONTEMPORARY GEOGRAPHIC TOOLS

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.

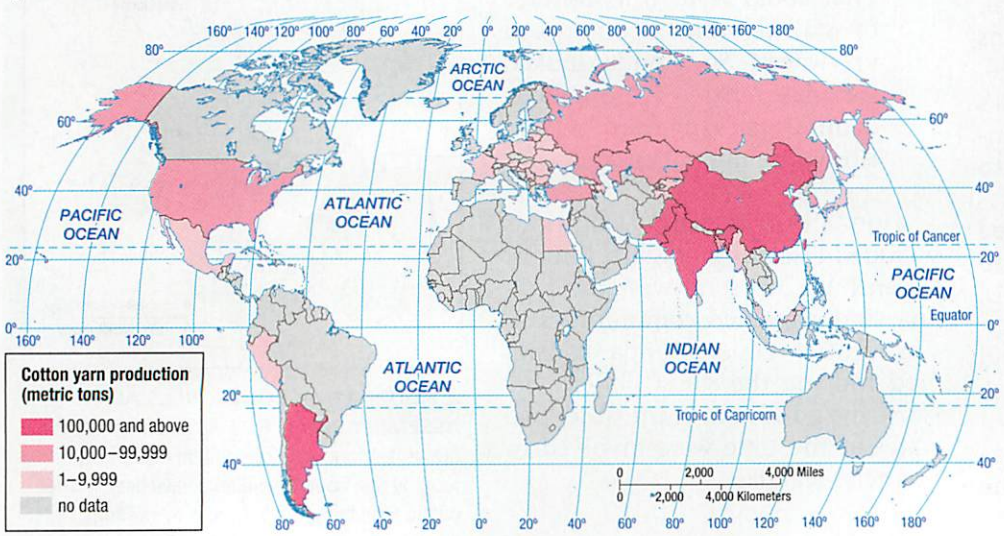
For mechanized weaving, labor constitutes a high percentage of the total production cost. Consequently, weaving is highly clustered in low-wage countries (Figure 11-28). Despite their remoteness from European and North American markets, China and India have become the dominant fabric producers because 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.

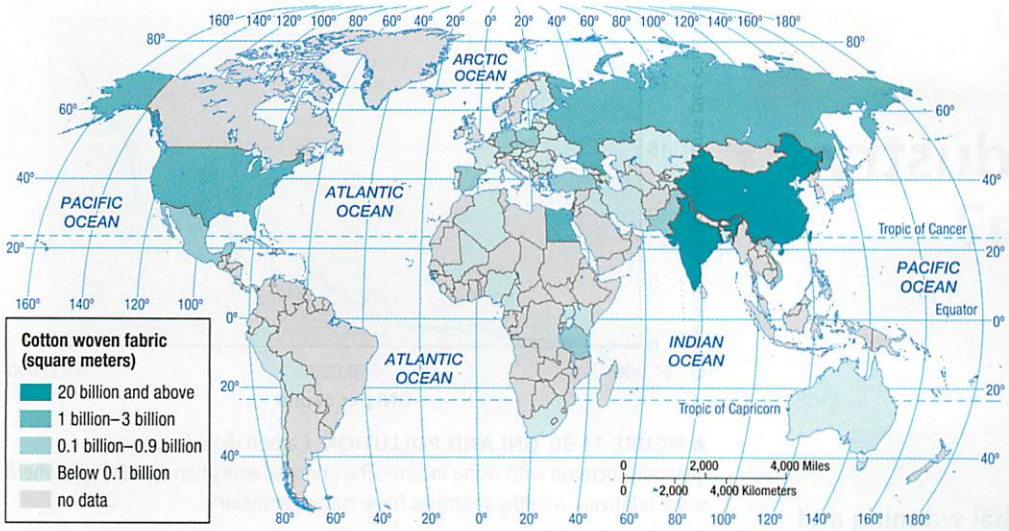
TEXTILE AND APPAREL ASSEMBLY. Sewing is probably an even older human activity than spinning and weaving. Needles made from animal horns or bones date back tens of thousands of years, and iron needles date from the fourteenth century.

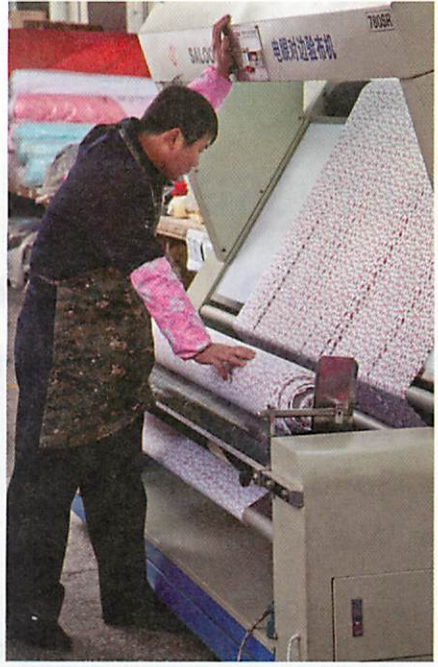
The first functional sewing machine was invented by French tailor Barthelemy Thimonnier in 1830. In 1841, Thimonnier installed 80 sewing machines in a factory in St.-Etienne, France, to sew uniforms for the French army. However, Parisian tailors, fearing that the machines would put them out of work, 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.